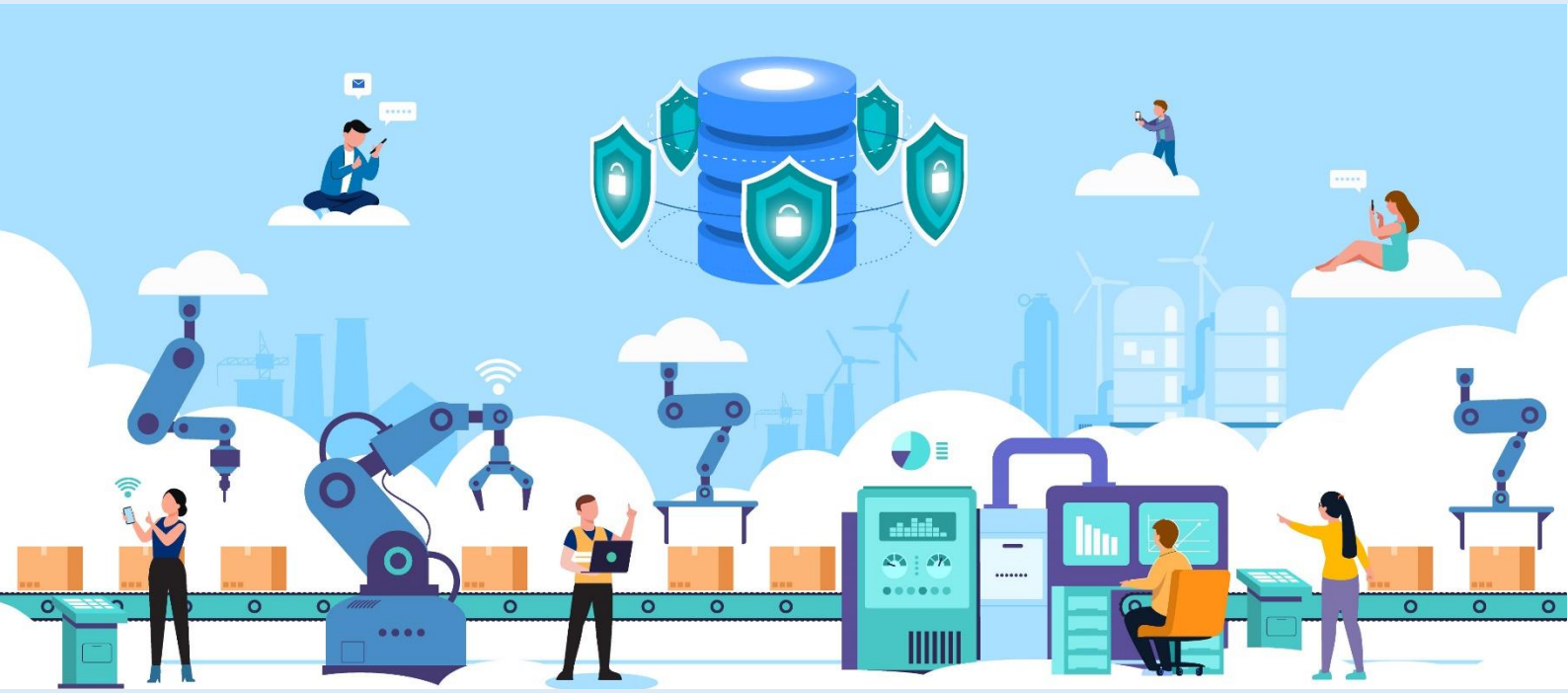
Strategic Partnerships for school education 2019-1-PL01-KA201-065137
Project: Teacher4.0 - comprehensive method of implementation of Industry 4.0 concept into didactic practice in primary and secondary schools

Enchiridion 4.0 program



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1. Project objectives

There is a growing challenge for educational systems, that is created by rapid digitalization and Industry 4.0 processes. This tendency can be found not only in advanced industry, but also in other fields. The Teacher 4.0 project is created to enhance professional development of teachers. Through that it will strengthen teaching professions by helping them gain new professional skills and knowledge related to the concept of Industry 4.0 and affiliated technologies. The project is focused mostly on teachers teaching non-IT subjects in primary and secondary schools. Teacher 4.0 is innovative in comparison to the previous projects. It is designed to target the new group of non-IT subject teachers, develop an innovative training course and provide guidance in terms of awareness and the ability to use Industry 4.0 possibilities in educating. It is the only project in the Erasmus + Project Results Platform that is addressed to non-IT subject teachers in relation to Industry 4.0.

In order to achieve goals mentioned before, creators of the project established three specific objectives:

- To extend and develop Non-IT subject teachers competences needed for effective teaching in Industry 4.0 context.
- To support the implementation of Industry 4.0 didactic possibilities in primary and secondary school programs.
- To strength the capacity of Non-IT subject teachers to develop pupils' critical thinking and creativity through integration of innovative approaches into teaching process.

Due to the large scope of those objectives a selected consortium has been created. The consortium consists of partners from five European Union countries. The partners are covering a wide range of expertise and experience related to the range and aims of the Teacher
4.0 project. The partnering organizations come from different professional fields and bring in various competences. to the project. Consortium consists of:

- comprehensive schools
- teacher training centres
- professional training institutions.

2. Intellectual Outputs

To achieve the above mentioned objectives and meet the needs of the project, the partnership will developed two intellectual outputs (IO). The outputs and its elements will be coordinate by different members of the consortium.

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Intellectual output 1: Enchiridion 4.0 for non-IT subjects teachers

Content divided into six modules, each allocated to a partner:

- Augmented Reality as a real alternative to analogue didactic materials
- Artificial intelligence as your classmate
- Collaborative Robots do not have to be expensive
- Cloud computing as a main source of information
- Cybersecurity in the Classroom and after school
- Digital Twin – a new way of presentation
- Additional module: 3D printing

Intellectual output 2: lessons scenario video set

This output is going to be a set of demonstrative and instructions video for Non-IT subjects teachers. The IO2 corresponds to the objective: Specific Objective 3: To strength the capacity of Non-IT subjects teachers to develop pupils' critical thinking and creativity through integration of innovative approaches into teaching process; The scenarios will be developed by the partners and they will discuss "real life" educational problems with strong focus on critical thinking and creativity. In order to produce these Lesson scenarios, project partners will take into account the results of the focus groups conducted within IO1 to make sure that the content is a direct response to the needs of project's target groups.

These objectives and outputs meet the prior aims of the partner organizations. Firstly to develop teachers' digital competence that allows to raise attractiveness of teaching enhancing the performance of the pupils in formal as well as non-formal learning. Secondly, the innovative practices using Industry 4.0 possibilities, help support the idea of changing gradually traditional teaching methods into modern ones. The developed intellectual outputs will be applicable not only in school activities, but also in all kinds of organizations that relate on working with pupils. Examples being: NGO, private sector, libraries, non-formal education providers and many others.

3. Project assumptions

The project aims at contributing to solve the main school education problems:

- under-achievement in science subjects
- low motivation of pupils to learn
- the shortage of teachers' competencies to integrating innovative and attractive ICT into the teaching process

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- lack of knowledge and good practices to deal with diverse groups of pupils using modern technologies in classroom and beyond

Beyond that, the project also corresponds with the horizontal priority related to open and innovative practises in a digital area. It promotes new methods and pedagogies and helps promote innovative technologies through presenting models of lesson plans incorporating Industry 4.0 concepts. Additionally Teacher 4.0 project develops tools supporting effective usage of ICT in education. Above and beyond, teachers involved in the project will share experiences while developing outputs. Products will be created in six languages, making it easy to share to a wide range of teaching professionals internationally.

4. Content

Content divided into seven modules, each allocated to a partner:

- Digital Twin – a new way of presentation
- Cybersecurity in the Classroom and after school
- Collaborative Robots do not have to be expensive
- Cloud computing as a main source of information
- Augmented Reality as a real alternative to analogue didactic materials
- Artificial intelligence as your classmate
- 3D Printing

Each module includes lesson plans (2 per module) and interactive exercises.

Digital Twin – a new way of presentation

Learning outcomes

After the teachers get acquainted with the theoretical part of the Module "Digital Twin – a new way of presentation", **they will**:

- learn about the importance of Digital Twin concept in Industry 4.0;
- learn about the differences and connections between Digital Twin and IoT;
- gain the necessary knowledge how to teach pupils with the use of Digital Twin concept in didactic materials;

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- gain the skills needed to teach pupils with the use of Digital Twin concept in the classroom;
- they will be able to introduce elements Digital Twin concept their didactic approaches.

Introduction

Presentation of use of Digital Twin concept in Industry 4.0

Industry 4.0 relies very heavily on collecting and processing digital data. One specific – and very important area which is strongly connected to data processing its so-called Digital Twin.

The first definition of the Digital Twin was proposed by the NASA as "an integrated multi-physics, multi-scale, probabilistic simulation of a vehicle or system that uses the best available physical models, sensor updates, fleet history, etc., to mirror the life of its flying twin. It is ultra-realistic and may consider one or more important and interdependent vehicle systems": this definition first appeared in the draft and after in the final release of the NASA Modeling, Simulation, Information Technology & Processing Roadmap in 2010.

In simple terms, it is entirely digital and exact replica of physical assets, products and processes. It's not just a copy or blueprint, because it is connected and changing. Main source of information is typically significant number of sensors – Industrial IoT, but also engineers and designers, data from production machines, testing machines and feedback from products itself, e.g. performance and maintenance data from engines, turbines, etc. Area of application is very extensive and still widening. Digital twins offer unique potential, e.g. offering predictable failure estimates, wear estimates, giving at the same time feedback data to alert manufactures of e.g. component which wears faster than estimates.

It is worth noting that Digital Twin is still emerging technology and many researchers have different ideas what it should do, how to implement it and what areas are involved.

To date, the most commonly used definition of digital twin was proposed by Glaessegen and Stargel in 2012: "Digital Twin means an integrated multiphysics, multiscale, probabilistic simulation of a complex product, which functions to mirror the life of its corresponding twin". Digital Twin consists of three parts: physical product, virtual product and the linkage between physical and virtual product (Glaessgen and Stargel2012).

In the research paper by Fei Tao, Fangyuan Sui, Ang Liu, Qinglin Qi, Meng Zhang, Boyang Song,Zirong Guo, Stephen C.-Y. Lu & A. Y. C. Nee (2018): Digital twin-driven product design framework, International Journal of Production Research, DOI: 10.1080/00207543.2018.1443229 – there are several phases of building general functional Digital Twin for a product. It consists of three parts, physical entities, virtual models and the connected data which links the two together.

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In the same paper, authors identified 6 steps necessary in their opinion to build functional Digital Twin.

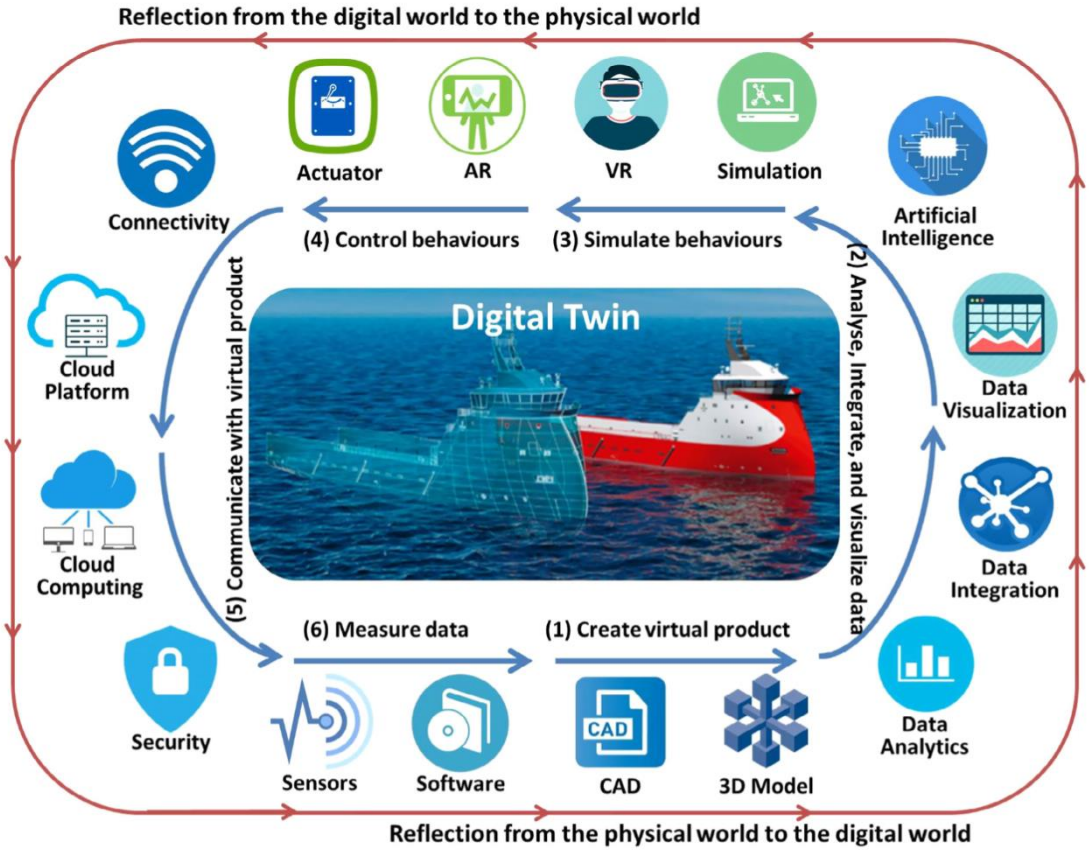

Figure 1 Digital Twin Model. Source: Tao et all, DOI: 10.1080/00207543.2018.1443229

The steps are outlined below, but it is important to mention that different industries might take different approaches, add steps or remove some of them, possibly perform some concurrently or outsource some elements to external entities.

Step 1: Build the virtual representation

The representation normally comes in shape of CAD files and 3D modelling. Since CAD is commonly used in product design, the files are usually ready, however for the purpose of Digital Twin, it is advisable to not only include geometric model, but also expected product behaviour and rules. Behaviour might describe intended purposes and user interactions, while rules relate to product optimisation, maintenance and evaluation.

Step 2: Data processing to enable and facilitate feedback from physical product to virtual model.

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This data comes from various sources, mostly from the product itself, IIoT sensors, maintenance data, performance data, etc. This data is next processed, integrated, and visualised, to allow designers insight into real-world performance, parts and processes which are performing as intended, but also e.g. parts which wear too quickly in given conditions. Data integration and modelling allows also to discover hidden patterns, normally not visible from single source. Some elements of artificial intelligence might be incorporated into this step, like image recognition, pattern search and even cognitive algorithms, which might enable simple recommendations to be made automatically.

Step 3: Simulate physical products in virtual environment

This step uses simulations, virtual reality and high density displays to simulate real product in virtual reality. Digital Twin enables quick and essentially costless changes in the product, to study desired properties and behaviours, including data from the previous step, which helps simulate e.g. wear depending on the physical properties, alloy structure and many other variables.

Step 4: Request changes within physical products as recommended by the Digital Twin.

Based on the findings from the Digital Twin model, physical product might need adjusting, changing processes, functions and even structure. This might be achieved by means of various actuators, which can act either automatically or as requested by the operator. Actuators might be of various types, pneumatic, electric, hydraulic and even mechanical. Changes are confirmed with the use of sensors. Actuators and sensors are two backbone, enabling technologies for the Digital Twin – and in fact, Industry 4.0. Additionally, Augmented Reality might be used to verify and monitor state of the specific products and devices, typically overlying real-time data over specific parts or the whole device.

Step 5: Establishing secure bidirectional data transmission between physical and virtual product.

It is a crucial step, to enable communication to and from the physical device. Available transmission means vary and are actively developed. Depending on the devices, networking technologies might include wireless networks like Bluetooth, WLAN, Z-Wave, LTE and 5G data transmissions, but also wired – from Ethernet-based to fibre and even serial connections, all depending on the product and need. The virtual part of the Digital Twin often relays on Cloud Computing, which enables easy access to both users, designers and engineers. Data security is very large area which is crucial for the secure and efficient operation of the Digital Twin. It goes way beyond this module, but due to connected nature of Industry 4.0, it is immensely important, complex and expensive.

Step 6: Collecting and integrating product data from available sources.

Various categories of data can be obtained from the product, including physical data, environmental data, interactive data and so on. This type of data can be obtained from specialised sensors, often incorporating connected IoT technology. Amount of data varies greatly between products, e.g. large wind turbines, permanently connected to power and Internet can transmit real-time data about

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performance, operating and environmental parameters, while long distance transport ships might not have all the prerequisites to do that. Collected data is usually pre-processed and fed back to step 1 of the model, to close the loop and make the virtual product more complete and functional.

Once such model is built and verified, it can be used as a framework for Digital Twin based product design. Having in place comprehensive data from the real product, enable designers to analyse weak spots and problematic areas, immediately test within virtual product and possibly even implement improvements remotely. Several researchers also pointed possibility to generate new solutions based on functioning Digital Twin, using design theory and methodology.

Connections between Digital Twin and IoT

The Digital Twin requires several enabler (required) technologies, which have been mentioned above. One of those is Internet of Things – IoT and also Industrial Internet of Things – IIoT.

Many of us already use various smart devices – aka IoT devices. Connected bathroom scales, thermometers, power controllers, smart locks and cameras, heating and cooling, lighting, even home appliances with various levels of connectivity.

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Figure 2 Netatmo smart thermometer and air quality sensor. Image source: Unsplash

They need to be easy to install, easy to use and preferably compatible with home automation standards, like Apple HomeKit, Amazon Echo, Google Home, etc. However, home use devices often suffer from lack of updates – and standards, they are unsuitable for possibly harsh industrial environments and very often possess security risks. For home use, connectivity often relies on WiFi – which is another potential security risk.

Industrial IoT are fundamentally different in construction, need to be deployed often in massive numbers comparing to home use, provide complete remote management and maintenance, be very precise and secure.

Figure 3 Industrial electric motor multi-sensor from ABB. Image source: abb.com

Very often they do not provide any user interface, as communication is often only “machine to machine” – M2M. They are also built for continuous work, even in difficult conditions.

Industrial Internet Systems

Modern industry obviously requires robust network connectivity. The so called Industrial Ethernet is not fundamentally different from the Ethernet we use in our offices and homes, the difference is mostly in cabling and connectors. High temperatures, vibration, interference and humidity makes typical category 5 and 6 cables with typical plastic RJ45 connectors unsuitable.

One technology which is able to mitigate by design some of those problems is fibre optics, which is completely immune to interference, while cabling can be robust enough to withstand other conditions. Standard fibre-optic connectors are also more resistant to humidity and dust.

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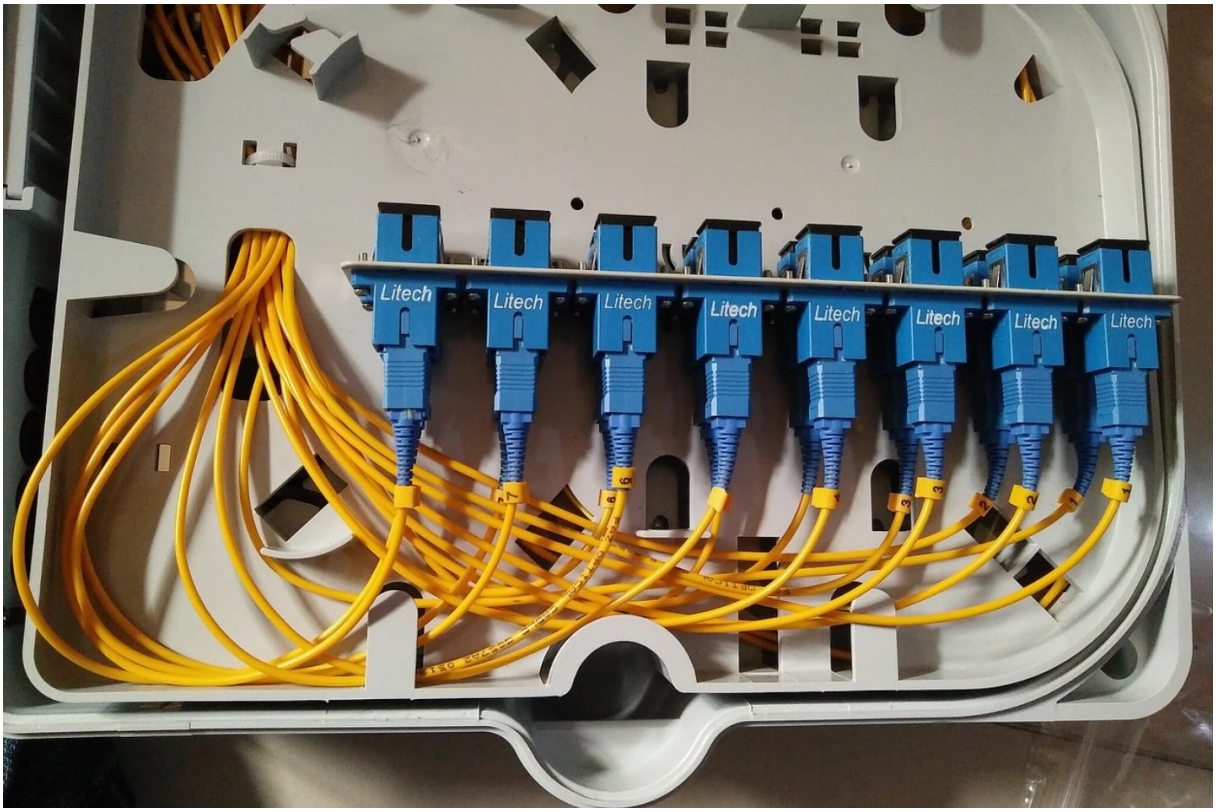

Figure 4 Fibre optics connector box. Source: https://pixabay.com/images/id-3864383/

Unfortunately, Ethernet based network is not without problems, especially when time critical traffic is concerned. In the office setting, reaction time for remote site within 100ms is acceptable, while industrial machinery and IIoT often requires times within microseconds.

To address this issue, various approaches are used, Encapsulated Field Bus, fast addressing using only Ethernet hardware addresses, traffic prioritising among multiple channels and so on.

The real challenges start with integration of old – even analogue – communication channels into modern network. This requires often good understanding of the industrial processes, creativity and very often investments, as there is basically no “one fits all” approach.

Wireless Communication

Very often, IIoT (and in fact, IoT) requires wireless connection to be feasible. Over last 20 or so years, multiple technologies, with different purposes. Most known, WiFi (based on 802.11 standard) is excellent for home laptops, high throughput and bandwidth, but power hungry and with security problems. It is also easily congested with multiple access points overlapping.

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Figure 5 ACKSYS Industrial Access Point. Image: acksys.com

Quite often, IIoT devices do not require high bandwidth, as the transferred data amounts are low. Bluetooth low energy - also known as Bluetooth 4.0 or Bluetooth Smart - is the version of the Bluetooth Technology specifically designed for the IoT and IIoT. As its name suggests, this is a power and resource friendly version of the technology, and it's designed to run on low-power devices that typically run for low periods, either harvesting energy or powered from a coin-sized battery. One of Bluetooth's main strengths is that it has been around for years, so there are billions of Bluetooth-enabled devices. Also, Bluetooth is a well-established and recognized standard wireless protocol with vast multi-vendor support and interoperability, which makes it an ideal technology for developers. Other advantages are its low peak, average and idle power, which allows devices to run on low-power sources.

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Figure 6 Nordic Semiconductor Industrial Bluettoth LE vibration and temperaturę sensor. Image: https://www.nordicsemi.com

Yet another promising standard is called ZigBee with its variant ZigBee IP. It is based on open global wireless technology, designed for use in various environments, including industry.

RFID

Not strictly communication, but important and popular technology, which uses tags to store electronic information. The information can be passively or actively read via electromagnetic field.

RFID technology is used in many industries to identify and track inventory, people, objects, and other assets due to the tag's versatility and ability to be attached to just about anything. RFID does not always require close contact; in some cases, even the briefest contact at a distance is all that is required. An example of this is the timing of sports cars lapping a track. Even at those high speeds, RFID works efficiently and reliably and produces accurate timing. Another advantage of RFID is that the tags do not need line of sight or even need to be visible, so they can be easily concealed in packaging and products. RFID tags can be read simultaneously by a reader if they are in range, which is a big advantage over barcodes, which are read one at a time. Hundreds of RFIDs can be read at

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once. Miniaturization has greatly enhanced the use of RFID, as now tags can be microscopic in size. Hitachi has so far produced the smallest miniaturized RFID tag at 0.05mm x 0.05 mm and these dust-sized tags can hold a 38-digit number on a 128-bit ROM.

Other, worth mentioning technologies which are used – or being considered are NFC (Near Field Communication), networking protocol called "Thread", 6LoWPAN – low-power radio transmission and others

Security in Industrial Networks

Traditional industrial networks of the past were built with little security in mind. Devices like PLC (Programmable Logic Controller) and specialised hardware wasn't even connected to the IP network, there was no need for that. Many old communication protocols were non-IP capable (ModBus, CanBus, RS232, RS485, etc) so there was no way for them to be exposed to any danger coming from outside world.

The introduction of IIoT changed things drastically – and not necessarily for the better in terms of security.

Former industrial devices were operating with very low speeds, almost exclusively via wired connections, with very high availability, reaching years. Typical lifecycle was (and still is) about 20-25 years, so many currently active devices pre-date the year 2000. They are also very expensive, both to buy, but also to maintain, since downtimes of production lines must be planned well in advance and cause significant losses.

Currently, Industry 4.0 expects IIoT to be connected to an IP network, with minimum latency, high level of security and very high operating time. Due to pretty conflicting interests, IT security and industrial goals are quite different and very often contradicting each other, what adds another level of complexity.

The purpose of this module is not to explore security, as we have another module for that, but to highlight challenges with IIoT, as significant building block for the Digital Twin.

The Rolls-Royce success story.

Rolls-Royce is one of leading engine manufacturers for airplanes and ships. RR invested a lot of resources into new technologies, including IIoT, Big Data and Digital Twin.

Its engines and propulsion systems are equipped with hundreds of sensors which record massive amount of information. Using the Digital Twin idea, the data is sent to the processing and visualisation, where it helps engineers to monitor their operation, schedule maintenance or dispatch team to fix any problems – often before the problem would cause a disruption in operation.

A practical implementation of this can be found in the Rolls-Royce Engine Health Management. In the civil aviation industry, sensors incorporated into engines sends terabytes of data after each flight to

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the Big Data analytics centre, where adjustments can be made which optimise efficiency, fuel consumption and maintenance windows. Engineers look also for any anomalies, signs of vibration, temperature, pressure and other indicators.

Figure 7 Rolls-Royce Trent XWB engine fan. Image: Matti Blume / CC BY-SA / WikiMedia

Having access to information of this level of detail, RR started a new service model, called Total Care, where customer pay only for hours of engine work, with all the service costs underwritten by the Rolls Royce.

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Possible benefits of Digital Twin modelling in education

There are numerous advantages of using the Digital Twin in education. In the current age, both teachers and students should be aware of Industry 4.0 principles and advantages.

The digital twin technology and its advantages have got a great application in university education. Well-equipped technical laboratories in colleges or universities, advanced software and computers as well as well-educated staff of professors and doctors can make a full use of the benefits of the technology. On the other hand, it is very important to start catching students' attention not on the academic level, but earlier- when they make a critical decision about their future. Implementation of digital twin technology may have a great impact on their future decisions enlarging the awareness of the work with technology. The students may even do not know about existing such technologies and for the first time they couldn't find the practical application in live. The best option is to introduce some of the basic aspects of digital twin technology at the high school level, especially technical high school. In technical high school young people are focused on technology more and majority of them have got a great interest in science. The technology could be applied for example during mechanics lessons when students learn about materials strength. It is possible to use different kinds of materials like aluminium, steel or plastic materials, synthetic polymers like PLA, PET, PETG, or ABS. The school's laboratories do not have any of the equipment that is needed to perform professional test, but it is a great beginning to catch students' attention and show them the principles of operation of the technology. The teacher can prepare small samples of materials, make a simulation, then make an experiment with real piece of material and check if the simulation was coherent with real observation. The interdisciplinary connection of milling metal materials, 3D printing of synthetic polymers and testing the digital twin technology on self-made samples, will show the students not only the application of the digital twin technology in simple cases, but also will teach them the correlation between many branches of different sciences. Every time when the teacher starts students' interest in topic, it is possible that the students start exploring it and it may lead some of them to study it at the higher level.

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Cybersecurity in the Classroom and after school

Learning outcomes

The aim of Module is to develop and strengthen the competences of non-IT teachers' in the field of cybersecurity.

After the teachers get acquainted with the theoretical and practical parts of the Module "Cybersecurity in the classroom and after school", they will:

- learn about the importance of General Data Protection Regulation during on-line education (this involves focused training about day to day responsibilities, including cyber security, handling GDPR risks and what they should do in the event of a data breach);
- gain the necessary knowledge how to teach pupils to protect themselves from being exposed to inappropriate, offensive or illegal material using social media/networks;
- learn how to teach pupils about the types of malware and how to protect their devices and personal data themselves;
- provide the teachers with the necessary knowledge and useful tips needed to teach students cyber security in the classroom and after school.

The **theoretical part** of the module includes building up on the non-IT teachers' knowledge whereas the **practical part** provides them with exercises and lesson plans to teach cybersecurity skills to students.

Introduction

The days of handwritten homework assignments, heavy printed textbooks, and mailed paper report cards are slipping away. **Learning has become digital in the 21st century.** This has particularly become true during the COVID-19 pandemic, which has changed education forever. If earlier students used digital tools to occasionally to complete their homework, communicate with classmates, check their grades, and conduct research for assignments online, during the pandemic, a distinctive rise of e-learning has been observed. Now that all of the teaching is undertaken remotely and on digital platforms, the question of safeguarding sensitive data, both organizational and personal, has become of highest importance. The responsibility falls not only on the school staff and data protection officers, but also on teachers themselves. For this reason, educating all members of the school community to maintain "digital health" – adopt good cybersecurity practices – comes at the top of the priority list.

Nowadays students are considered to be more tech-savvy than their teachers, for they know how to use apps, mobile devices and online platforms, since they've been using them their whole lives. However, the **cyber world of modern education can be dangerous** both to the students and to the

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teachers. Therefore, in our technology-infused era the ability to safely navigate throughout our daily lives, becomes just as important as the ability to read or write. It is a strong argument for providing schoolchildren with basic cybersecurity knowledge and skills.

This module covers the following topics of cybersecurity: *implementation of the General Data Protection Regulation Law in on-line education*, *secure use of messengers and social media*, *preventing malware*; useful *tips for both teachers and students on how to stay safe in the virtual environment*.

Introducing GDPR for education

The General Data Protection Regulation (GDPR) is a new, Europe-wide law that came into force on 25th May 2018. GDPR applies to all organizations, including schools, and individuals in EU. The regulation is designed to protect all EU citizens' data privacy and to harmonize all data privacy laws across Europe. It sets new standards for data protection that: GDPR will affect what data you have, how you use it, where it is stored, and how long it can be stored for.

The GDPR has 7 key principles:

Lawfulness, fairness and transparency	Data must be processed lawfully, fairly and in a transparent way e.g. terms of consent must be clear and in a plain language that is not designed to confuse users
Purpose limitation	The collection and processing of personal data must have a clearly defined purpose. Such data cannot be reused for another purpose that is incompatible with that original purpose.
Data minimization	Institutions should not collect more personal data than they need.
Accuracy	Data must be accurate and, where necessary, kept up to date.
Storage limitation	Data should be stored for no longer than necessary.
Integrity and confidentiality (security)	Personal data must be protected against unlawful processing, accidental loss, destruction or damage.
Accountability	Institutions are accountable for the handling of the personal data. They must be able to demonstrate and document how they are complying with data.

The principles have been designed to guide how people's data can be handled. They don't act as hard rules, but instead as an overarching framework that is designed to layout the broad purposes of GDPR.

Know the difference: personal and sensitive data

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Personal data comprises any information that can help identify a person or their family. In school records, this would be their **name**, their **address**, their **contact details**, their **disciplinary records**, as well as their **marks** and **progress reports**. This sort of data remains "personal" even if an individual chooses to publicize it.

A **special category** of data touches on more sensitive topics. Where schools are concerned, this includes students' **biometric data** (e.g. fingerprints, photos), **religious beliefs** (e.g. a student's opting out of religion class), **health** (e.g. allergies) or **dietary requirements** (which may hint at their religion or health). Data in this category may pose a risk to people and hence can only be processed under certain conditions. Schools likely won't be able to use it without parental consent.

What does GDPR mean for every person individually?

GDPR gives an individual much greater control over their data and secures these 8 rights:

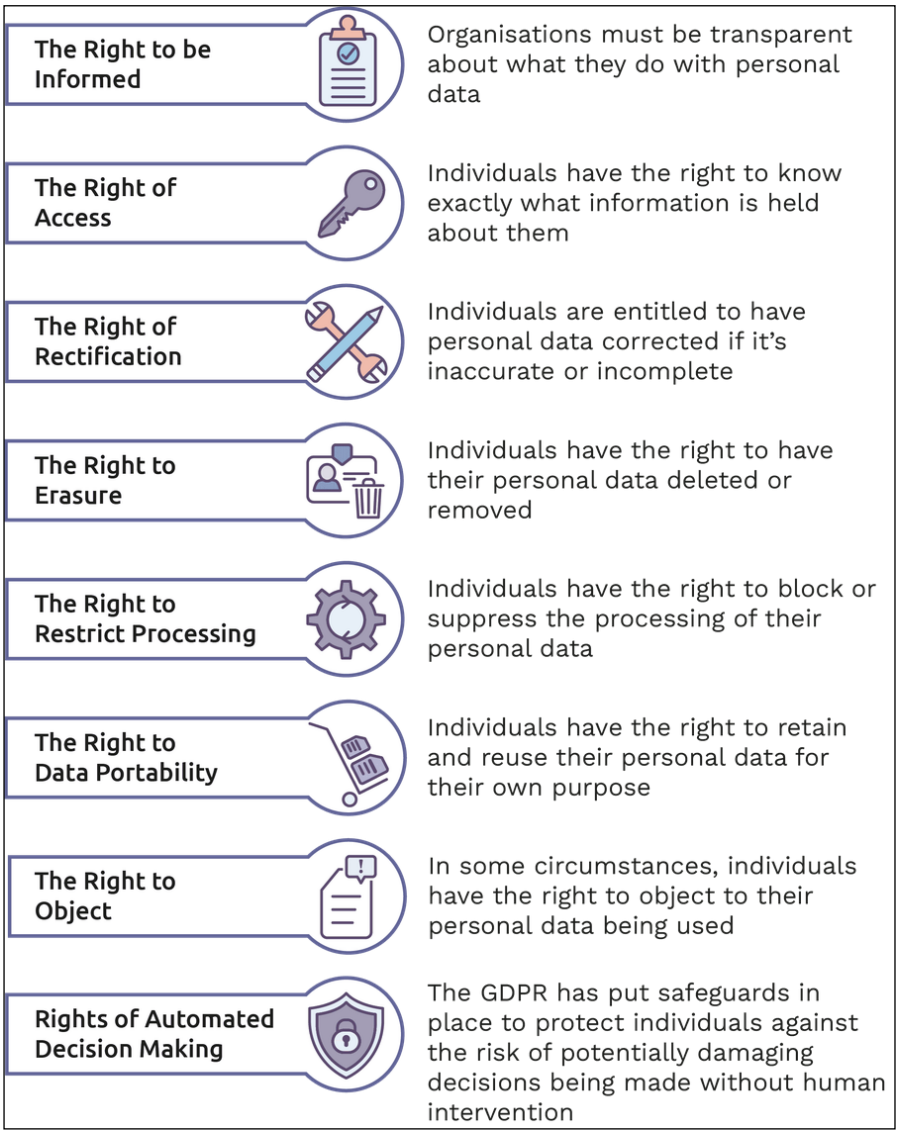

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Figure 1. 8 rights which GDPR secures (*Blackwood, 2020*)

Managing the personal data in the virtual environment

Managing the personal data starts with: deciding which data to collect, considering how the personal data should be gathered, where it will be stored, who should have access to it and how changes and deletions will be enabled.

It is important that all members of the school community, including the staff, teachers, students and parents/careers are bound by the same rules of confidentiality and data protection in virtual environments that they would be in physical learning environments. Staff should only communicate personal information about students on a need to know basis where there is a lawful purpose, in accordance with the institution's safeguarding and data protection policies.

To ensure that the online learning platforms are compliant with the data protection requirements, it is important to:

Identify the correct lawful purposes for collecting personal data online

Every teacher should be aware of what personal data is being collected by the online learning programs/platforms. This information should be revealed to the students and their parents/careers.

Ensure that the online platforms do not collect more personal data than is necessary and is only using that personal data for the purposes agreed upon.

Most online learning forms require the assistance of a technology or software platform such as *Microsoft Teams, Zoom and Google Meet,* etc. Most of these platforms require, as a minimum, the name and email addresses of students, teachers and staff members using the facility. This is necessary for the platform to manage identification, accounts and log-ins. Where possible individuals should only use institutional email addresses, not personal ones. Additionally, these platforms might use images, audio and/or free-text messaging. Platforms may also collect data via cookies or other online identifiers.

It is important that the teacher is aware whether the platforms they use for teaching/communication meet the requirements of the data protection law and are compliant with the privacy laws in the target country. The processor's terms and conditions of use and privacy policies are to be reviewed.

The teacher should remain conscious and warn school staff/ school data protection officers in case he spots that the online teaching/learning platforms he uses, collect sensitive personal data.

Assess risks and mitigate any harm associated with carrying out live-streaming and/or recording online sessions.

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Teachers should be aware of the possible risks live-streaming sessions, because they might include, for example, the inadvertent disclosure of confidential or inappropriate information. This can be mitigated by educating students, their families and staff about the location of meetings and general house-keeping rules for using online platforms. For example:

- advising them to have a neutral background to meetings so that no additional information can be collected about their location
- ensuring there is no personal or sensitive (or special category) data visible during the meeting
- ensuring that cameras (and audio) are disabled when the meeting has concluded.

If institutions or teachers wish to record virtual educational meetings (lessons, teacher-parent conferences, staff meetings, etc.) it is suggested that they only do so if they consider it necessary to achieve a specific learning or safeguarding objective, and if they cannot achieve that objective in other ways. Institutions should also consider the risks and benefits of recording as part of their risk assessment. These will include the same issues set out above for live-streaming. Additional considerations include the storage, access, control and retention of the recording.

Review and update the data protection and information security policies.

The teacher/ educational institution should ensure that the data protection and information security policies and systems enable them to conduct online classes safely and securely. Where relevant, they should also enable teachers to store any recordings securely, retaining them for no longer than is necessary.

Inform and educate students, parents/careers and staff about the risks and benefits of online learning.

It is important that all students, their parents/careers understand the risks and benefits of online learning. Institutions might also find it beneficial to issue guidance on their community's use of online platforms and processors. In case the recordings are going to be made of some educational sessions, the community should be informed and made aware of this, and of how the recordings will be used. Where institutions wish to use online resources for activities outside of the core educational services, they should consider whether they need to obtain consent from students or their parents (depending on the student's age), in accordance with their internal policies and relevant legal requirements.

In compliance with the requirements of the GDPR, the educational institution should ensure the security of the devices and protection of the personal data of their community (staff, teachers, students and their parents). The responsible personnel should constantly monitor intrusions, infections, theft and abnormal behaviors, also, educate students and staff on best practice of personal data protection for home computers.

Secure use of messengers and social media

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Social media is computer-based technology that facilitates the sharing of ideas, thoughts, and information through the building of virtual networks and communities. By design, social media is internet-based and gives users quick electronic communication of content which includes personal information, documents, videos, and photos. Users engage with social media via computer, tablet or smartphone via web-based software or web application, often utilizing it for messaging.

Nowadays social media is widely used at school mostly for communication: staying connected with students, fellow teachers, checking e-mail and posting news/ notifications. Also, for organizing the educational process online.

There are many forms of social media. The most popular social media websites (2019) are as follows:

Facebook (2.27 B (billion users))
YouTube (1.9B)
WhatsApp (1.5B)
Facebook Messenger (1.3B)
WeChat (1.08B)
Instagram (1B)
QQ (803M (millions))
QZone (531M)
Douyin/Tik Tok (500M)
Sino Weibo (446M)
Zoom (10 M in December, 2019, 300 M in April, 2020)

Social media refers to websites and applications which are designed to allow people to share content quickly. Most social media apps (*Facebook messenger, WhatsApp, Viber, Signal, Telegram*, etc.) allow sharing private messages, however, it is important to make that the conversations are secure. To do so, it is advised to make sure that the content is **encrypted**, which means that only the sender and the recipient can read them. Some social media websites such as *Signal* and *Telegram* are end-to-end encrypted, whereas *email, Facebook Messenger, Twitter direct messages, private messages on forums* etc. - are not encrypted by default. That means the provider of the service (or someone breaking into your account) can read them and could if required hand them over to law enforcement. In order to safeguard the conversations, encryption should be turned on manually by the users themselves. Guidelines on how to make the messenger safe, are available below:

How to make your Facebook Messenger conversations secure by encrypting them

How to make Facebook Messenger as secure as possible

One of the biggest hazards of social media is **cyberbulling**. *Students* may be cyberbullied on their phones, computers, and *other digital* devices. It is difficult to identify it and intervene. Nevertheless, every teacher should familiarize themselves with the most common types of cyberbulling in order to protect their students from its upsetting effects.

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There are lots of different types of cyberbulling (Schuster,2020):

Trolling: intentionally posting provocative and insulting messages about sensitive subjects, such as racist and sexist material, in order to elicit a response.

Flaming: sending provocative messages to start an argument/ a fight.

Harassment: specifically targeting an individual or group with persistent actions meant to make the receiver(s) frightened or scared.

Cyberstalking: tracking down someone's personal and private information and using it to make them afraid, texting them hundreds of times a day to let them know you are watching them, 'creeping' on their social media accounts to learn where they are so you can show up uninvited.

Catfishing: stealing someone's online profile or setting up fake profiles to trick others into starting online relationships. This form of cyberbullying can also be used to spy on, shame, or manipulate children, teens, and even adults.

Fraping: impersonating someone or logging in to their profile to post inappropriate content. This is a serious offense and could be subject to criminal law.

Griefing: abusing and angering people in online games.

Outing: publicly sharing someone else's personal, private, or embarrassing information, photos, or videos. This can be very damaging, especially amongst children and adolescents, who may not react compassionately.

Roasting: when an individual or, usually, a group, gangs up on an individual online until the victim "cracks."

The effects of cyberbullying can be dire, leading to low self-esteem, depression and mental trauma. Like other forms of bullying, it can lead to long-term consequences that affect a victim's whole life. **Raising students' awareness about the different types of cyberbullying and educating them how to save themselves from its** hazards, could minimize its negative effects.

The teacher should be well aware of the flagwarning signs which indicate a student who is being bullied online:

Cyberbullied children **appear more lonely or isolated**. They may withdraw from their friends or feel as if they can't trust anyone.

Sometimes, students change their **friendship group unexpectedly. They may** no longer want to spend time with the friends who have bullied him or her.

Cyberbullied children become withdrawn, anxious, sad, or angry.

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They cry frequently, unusually, or in seemingly strange circumstances. This could occur when other students mock the victim or remind him or her of what happened online.

Cyberbullied students' academic performance may decline due to feeling upset, being scared, or being unable to focus.

Students who have dealt with cyberbullying may get easily distracted and lack focus in the classroom. They may be worrying about their fear or embarrassment instead of thinking about their schoolwork.

Students whose classmates have cyberbullied them may want to avoid school so they don't have to deal with their attackers.

Cyberbullied children and teens may **lose interest in extracurricular activities.**

Children and teens who are victims of cyberbullying often feel less confident as a result, since they may believe the negative things their attackers say about them.

The emotional and mental stress of cyberbullying may cause victims' physical health to worsen.

The earlier the teacher notices the harmful behavior online, the easier it is to intervene and stop the malpractice. **One of the best ways to prevent cyberbullying is to teach students about it.**

Safeguarding Students' Social Media

Teens spend an increasing amount of time on social media. A survey conducted in the US (*Statista*, 2018) showed that "**70% of teenagers (13-17) check their social media several times a day,** up from just 34% in 2012. More astoundingly, however, 16% of today's teens admit to checking their social feeds nearly constantly and another 27% do so on an hourly basis." Given these statistics, **it's almost certain that high school students are on social media throughout the school day.**

Many teenagers post personal data online, such as **the details of their personal lives, sometimes intimate** photos, emotional or improper comments, without much consideration. Such sensitive information could **hurt their future reputations** and **prevent them from attending the universities of their dreams or getting the jobs they want.** Other sensitive information, such as revealing the location **(geotagging and geolocation)** and activities in real time on social media, can create cybersecurity problems as well. **Cyberbullies, stalkers, phishing scammers, or even identity thieves can use all of this data to hurt students.** The teachers' task would be advising them to be scrupulous about anything they reveal on social media and encourage them to consider how others might perceive their posts.

Malware protection

Malware is any malicious software that is written and distributed with the intent to cause digital harm. This could mean anything from stealing data, slowing down its basic functions to damaging devices. Any device including computers, tablets, phones, computer systems, networks, and more could be at risk. Malware can corrupt or take control of these devices' operations, giving the hacker

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total control. There are numerous types of malware, with the list growing every day. Hackers' efforts are increasing in sophistication, so it's vital to know to protect your digital devices from them.

Most malware infections occur when the user performs an action that causes the malware to be downloaded. This action might be clicking a link in an email, or visiting a malicious website. Also, by loading the firmware of a USB stick or flash drive or external hard drives onto the device's internal hardware. In other cases, hackers spread malware through peer-to-peer file sharing services and free software download bundles such as screensavers, toolbars or torrents from an untrustworthy source. Clicking on pop-ups or downloading pirating software, music, or movies can also install malware on the device. Embedding a bit of malware in a popular torrent or download is an effective way to spread it across a wide user base. Mobile devices can also be infected via text messages.

Once the malware has been installed, it infects the digital device and begins working towards the hackers' goals. It's beneficial to learn about the various types of malware and ways to protect the digital devices used by teachers and students to safeguard their personal data from hacker's attacks.

1. Spyware

Spyware is a type of malware designed to allow a hacker to spy on users, gathering information like internet activity, login credentials, and more. When a hacker uses spyware, they can gain access to any type of sensitive information your users view. This means personal details, card payment information, HIPAA-covered data, and more. While spyware is dangerous, it's fortunately fairly easy to remove.

2. Adware

Adware is a type of malware that causes ads to show up on your computer in an attempt to generate revenue for the ad creator. Sometimes, adware is closely related to spyware and commonly shows up in the form of pop-up ads or ads embedded in software or a program.

3. Ransomware

Ransomware does exactly what its name describes – holds your computer or device under the hacker's control in an effort to gain ransom money. In this scenario, hackers infiltrate devices with ransomware, locking users out unless they pay. In some cases, the ransomware hackers will threaten to release sensitive data to the public or on the dark web unless the ransom is paid.

4. Trojan Horse

A Trojan horse malware attack is one of the most common kinds of threats. In this attack, hackers disguise the malware as something appealing, like a free download, special gift, or exclusive offer. Once the disguised malware infiltrates the network, any data can be stolen.

5. Viruses

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A virus is a malicious program that replicates itself, spreading to other devices, networks, or programs. Your documents, applications, programs, and other vital business features could be compromised in an instant.

6. Worm

In many ways, worm malware is like a virus. Both types of malware can replicate themselves and spread to other devices and systems. However, worms can be far more destructive than other forms of malware since they can replicate and spread on their own. They don't need to be attached to an existing program and they don't require action from users to spread like a virus does.

7. Hybrids

In many cases today, malware is a combination of two different types of attacks. This usually means a combination of a worm or Trojan Horse with malware or adware attached. These hybrids, or bots, aim to make infected parties part of a bigger network controlled by a single botnet master. Once a group of computers is connected, these botnets can be rented out to other hackers for their own exploitative purposes.

8. Malvertising

Malvertising is not quite the same as adware. With malvertising, legitimate ads are compromised with malware, which is then delivered to a target's computer. So, when you click on the ad, your computer will be affected, unknown to you or the original advertiser.

Below are some tips for both teachers and students that will help them to mitigate the risk of a malware attacks:

- Never open, click, or download anything that you deem too suspicious, like files, ads, emails, etc.
- Purchase, run, and regularly update anti-malware and anti-spyware software.
- Prevent pop-ups ads and banners.
- Install spam filters to block any possibility of infected information across all devices.
- Only connect to secure Wi-Fi networks. Connecting to public Wi-Fi at coffee shops or libraries can open your networks up to potential harm.
- User browsers with good security settings, such as *Chrome* or *Firefox*.
- Install firewalls capable of detecting any suspicious activity.
- Regularly update your devices' operating systems. Doing so will keep them up-to-date on the latest safety features.
- Regularly change your password and adhere to password best practices, like using numbers, complex word combinations, and upper and lowercase letters.
- Adopt a secure file sharing solution to help you better protect your sensitive files.
- Cybersecurity in the classroom and after school: hints and tips for teachers

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- Be knowledgeable, curious and eager to update your knowledge regarding cybersecurity, possible malware threats and how to mitigate them.
- Discuss cyberbulling with your students and provide them a set of guidelines to prevent and handle cyber harassment online.
- Learn to recognize students who are being cyberbullied and be prepared to support them.
- Be a role model to follow. Children and teens need someone they can look up to. If you consider yourself to be a bad example, consider introducing them to personalities they can emulate.
- Set rules to the learning environments online. So that the students do not access and bring any unsuitable online content.
- Encourage your students to let their teacher or councellor know if they feel unsafe in a virtual classroom, session or forum and report wider concerns to any staff member with whom they feel comfortable.
- Ensure that your institution will prevent inappropriate and harmful material from being shared online.

Coordinate with parents. During a parent-teacher meeting or open house, tell them about the school policy regarding the use of school digital devices. Encourage parents to reinforce the concepts you are teaching in class. Teach parents how to monitor their kids' activity online. Educate them how to ensure safe use of private digital devices such as smartphones, digital watches and toys (which can access the internet) after school.

Work cybersecurity into the curriculum. Teaching students how to email responsibly, create strong passwords and connect to secure internet networks. The sooner that students feel that cybersecurity is a natural part of their lives, the more likely they will
grow up security-conscious.

Maintain personal privacy: be conscious about what information you as their teacher, post online: be cautious not to reveal too many details about your personal life. It's important that you **remain a trusted and respected figure** in their lives.

Google yourself. Googling yourself will reveal almost any personal information that is publicly available. Once you know what data about yourself is online, you can find its source and delete anything you wouldn't want your students (or anyone else) to see.

Use your school email address to create education-related accounts. This will help keep your personal email address separate from accounts students may have access to. Don't forget to log out from your e-mail accounts every time you finish work or leave your digital device.

School staff should only store personal data on school equipment, use strong passwords, and set their devices to auto-lock after five minutes. If personal data is downloaded to removable media, like a USB stick, it must be encrypted and password-protected, and kept away from other users. Staff

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should also undergo training on social engineering, phishing, cloud technologies, ransomware attacks and the like.

Safeguard your social media accounts so that your pupils cannot easily access all of that information: **create complex passwords, change your passwords frequently, use a different password for each unique account, use biometric passwords.**

Disable wi-fi and Bluetooth as often as possible. Leaving wi-fi and Bluetooth on lets hackers know that you're there.

Use only trustworthy websites and mobile apps. Adjust your privacy settings to limit different applications' access to your data.

Update your devices regularly and remove cookies.

Delete and/or deactivate accounts you aren't using. This will prevent imposters hijacking the account and posting as you.

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Collaborative Robots do not have to be expensive

Learning outcomes

This module aims to develop basic skills for the construction of mechanisms that can give rise to collaborative robots. The purpose of these robots is to facilitate teachers in their educational practice, in turn also facilitating the motivation of students in their learning process, in the context of Industry

- 4.0. The specific objectives of this module are the following:
- Develop competences of project work in group;
- Self-regulate the students' learning process;
- Identify the difference between the concept's robots and collaborative robots;
- Know the purpose and function of algorithms;
- Understand and apply basic block programming language;
- Develop programmed robotic mechanisms.

Introduction

Robots and Industry 4.0

The theoretical part will focus on two important aspects. The first refers to the concept of what is meant by collaborative robots in industry 4.0 learning. The second refers to the possibility of using and building collaborative robots in an inexpensive way.

Robots are starting to enter our daily life and are present in several activities that were previously performed by people. For example, nowadays, when we travel on motorways, payment management is done by robots. Other examples can be found in banks or hospitals, where people's routing can also be performed by robots. In other words, there is an increasing proximity between these sophisticated electronic entities and people, and there is a need to introduce a broader understanding of how this communication takes place. When that communication and interface takes place directly between robots and people, when performing shared tasks, we are talking about collaborative robots. This is the theme we will address, where robotic collaboration fits into the mediation that these mechanisms have in facilitating Industry 4.0 learning in primary and secondary education. Let's start this subject by going a little deeper into what we mean by Industry 4.0. According to Wikipedia (https://pt.wikipedia.org/wiki/Ind%C3%BAstria_4.0), industry 4.0 refers to the concept of "intelligent factories" which operate with interconnected systems, in the form of an increasingly holistic network, only possible with the globalization of communication systems, through the Internet and Artificial Intelligence. Industry 4.0, also known as the fourth industrial revolution (see figure 1), was only possible with the so-called digital revolution (industry 3.0), which emerged

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with industrial automation, which integrates mechanical and electronic systems and also the evolution of digital computing developed between the 50s and 70s of the twentieth century.

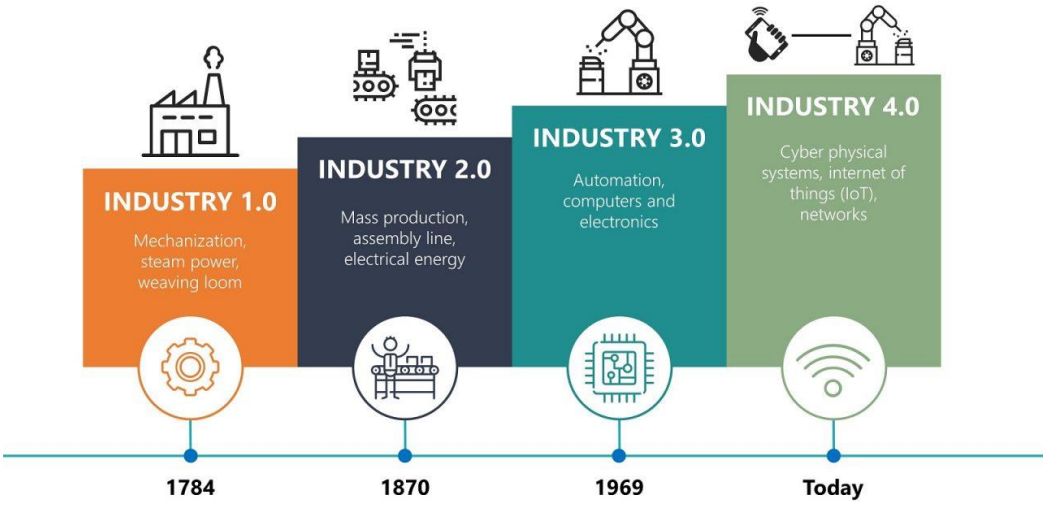

Figure 1: Industrial Evolution

The impact of Industry 4.0 reveals itself in a particular way, in the limitation of jobs by human beings, being partially replaced by robots commanded by artificial intelligence, intelligence capable of making decisions without human mediation, requiring increasingly higher qualifications as well as an increase in human-machine interaction, bringing significant changes in the nature of the work performed (Figure 2).

So, it becomes vital for the new generations to understand the importance of using the tools of this industry, having as a consequence the need to access them. This will be one of the purposes of the second part of this module, in which we will try to build and program low-cost electronic components and robots that can facilitate that learning.

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Figure 2: Universe of Industry 4.0

Resources for Building Low-Cost Collaborative Robots

Before approaching the construction of low-cost collaborative robots, we must take into account the resources needed for their use and construction. Thus, there are some important factors to take into account such as: What low-cost robots are available in the market? Which programmable electronic components can we use? What type of programming language will we use? What platforms or applications for programming execution exist? What other materials can we use?

So, one thing is clear. There is always a need for a basic investment in building collaborative robots and their costs increase with their complexity and functionality.

What low-cost robots are on the market?

We work in advance with some low-cost robots that come with interesting activities and can be purchased by schools. From early childhood education levels to more advanced high school and adult levels. Here are some suggestions:

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• *Bee-Bot Robot* - is a robot (figure 3) designed specifically for use with young children. This small colorful robot is easy to operate and friendly is a perfect tool to teach logic sequences and problem solving. Price approx. 85 euros (2021).

Figure 3: Bee-Bot Robot

Mind Designer Robot - This Robot (figure 4) guides the child in the process of learning mathematics and geometry following the school syllabus. It introduces the child to geometric design by creating geometric shapes and drawings of some complexity with extreme precision. It can be programmed manually or by voice using the voice recognition function. Mind can also be programmed to solve arithmetic functions using an activity board. The child is encouraged to solve challenges and develop their logical thinking skills; using their free App. The child can create complex geometric shapes and play with various interactive code games. Also, via bluetooth all content can be constantly updated - Approximate price €43 (2021).

Figure 4: Mind Designer Robot

Robot Zowi - BQ: It aims to teach children that technology can be transparent, accessible and fun. It is a toy (figure 5), but it is also a system with a great didactic component. In addition, it is a free robot: both its physical design and its programming and app are available to anyone who wants to understand and modify them. It costs approximately 99 euros (2021).

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Figure 5: Robot Zowi

Maqueen lite-micro: is a robot that works with block programming. It is suitable for STEM learning. It works with programming on the makecode platform from microbit. Depending on its complexity of components so varies its cost. Price approximately 90 euros (2021).

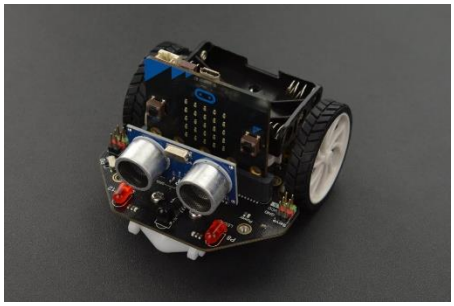

Figure 6: Maqueen from Microbit

Lego Mindstorms EV3: Lego Mindstorms EV3 (figure 7) is a set that allows you to build and program five starter robot models. It comes with a programmable block, plus a set of motors and sensors, including colour, touch and infrared that help the robot move and communicate. The robot is programmable through programming by blocks in an application produced by Lego. Approximate price €200 (2021).

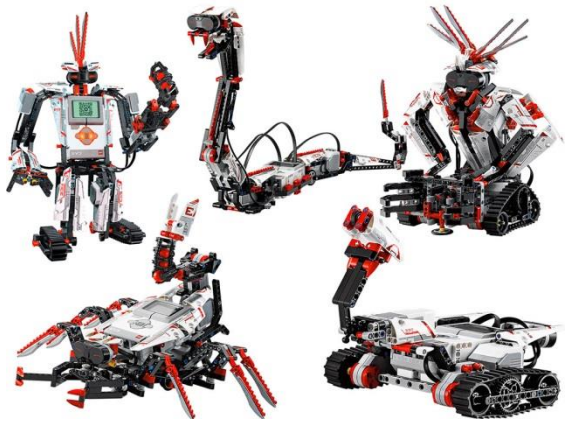

Figure 7: Lego Mindstorms EV3

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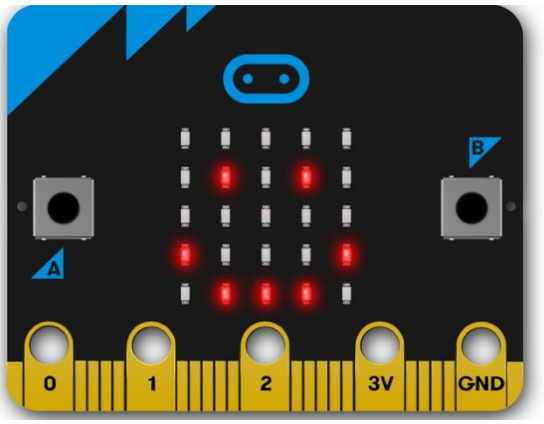
What programmable electronics can we use?

Another work alternative is the collaborative electronics that can be programmed. Within this work proposal we found two programmable boards with a reduced price:

The microbit board is a board that allows you to explore basic programming language by blocks, using the makcode platform. It allows to explore light and sound effects.



Price approx. 25 € (2021) - (https://makecode.microbit.org/)

Figure 8: Microbit board

Arduino: is a brand that offers a set of programmable boards (figure 8) low cost. Depending on the goal we want we find several solutions. From single boards that can cost 25 euros, to modules and electronics kits that can cost 60 or more euros. To program the *arduino* in this teacher 4.0 project we use the software provided by the *mblock* platform (https://www.mblock.cc/en-us/blog/category/arduino-programming/)

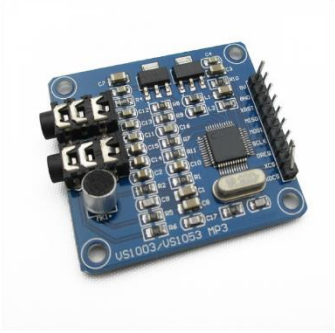


Figure 9: Arduino boards

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Once again, we reiterate that the use of programmable robotic devices always requires an initial investment. However, these resources can be used by a wide variety of learners individually or in small group work, developing skills not only in the context of electronics and programming, but also prosocial skills. It is the differentiation of strategies of use that makes them inexpensive.

What kind of programming language and platforms will we use?

The adapted programming used in the first contact with these devices is called block programming language. Blocks translate into a visual language through blocks that fit into each other, allowing instructions to be given through visual algorithms to objects, making them easier to understand. In Figure 10 and 11 we can see an example of the use of block programming and the corresponding JavaScript code that the child is developing

Figure 10-Block programming

Figure 11: Corresponding JavaScript Code

Algorithms are mathematical functions, which follow a certain logical sequence and allow us to solve challenges. In this context, there are different platforms that provide us with extensive knowledge with different degrees of complexity. Within programming with blocks we discovered the code.org platform (www.code.org). The course chosen for this purpose was the Express Course version 2020. This course has different tutorials to support the teacher already organized and ready to be used. It has the advantage of being in different languages, which facilitates understanding and communication.

With this course, in which students develop their knowledge of the programming language, they can check the effects of their language through the gaming environment. Teachers have access to

premade plans (figure 11) and the progression of their pupils. On this platform it is not possible to program devices, only to develop simulated programming knowledge and skills. Access to this platform is free and you only need a personal e-mail address to register.

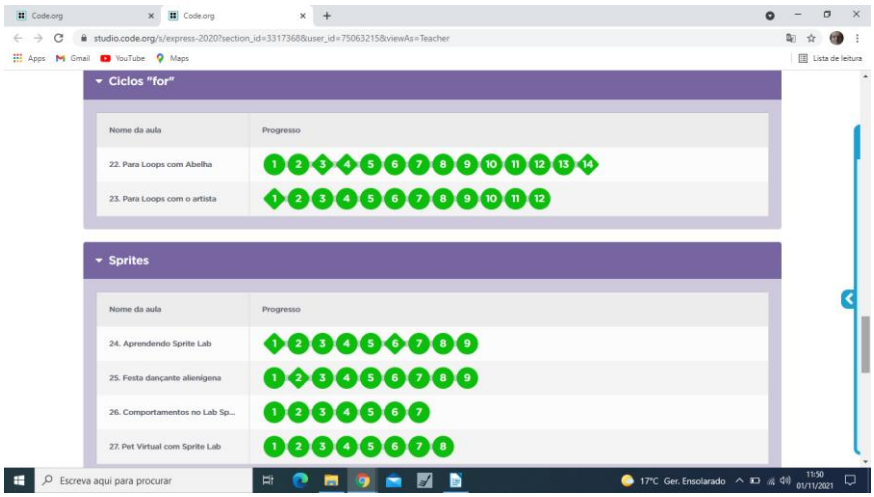
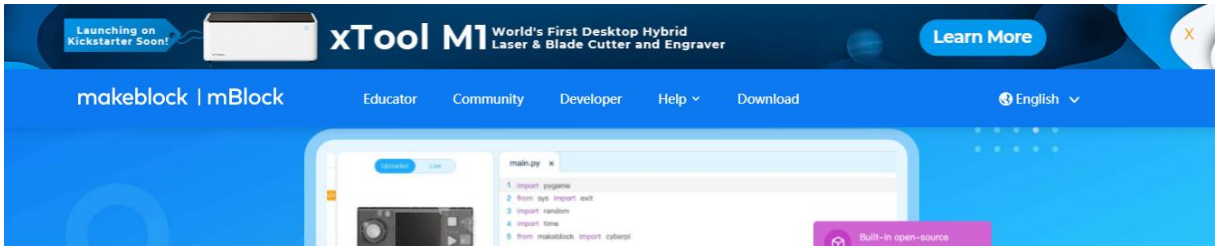


Figure 11: Monitoring a student´s progress on code.org.

The second alternative we suggest is to use the microbit platform at https://microbit.org/ . On this platform we can produce code using block programming and then program the microbit board and also maqueen. This platform is free and only requires validation with email.

We also have the mblock application and app that can be purchased at https://mblock.makeblock.com/en-us/ . On this platform we can download the program that allows us to work with block programming for Arduino. The programming applications are free.



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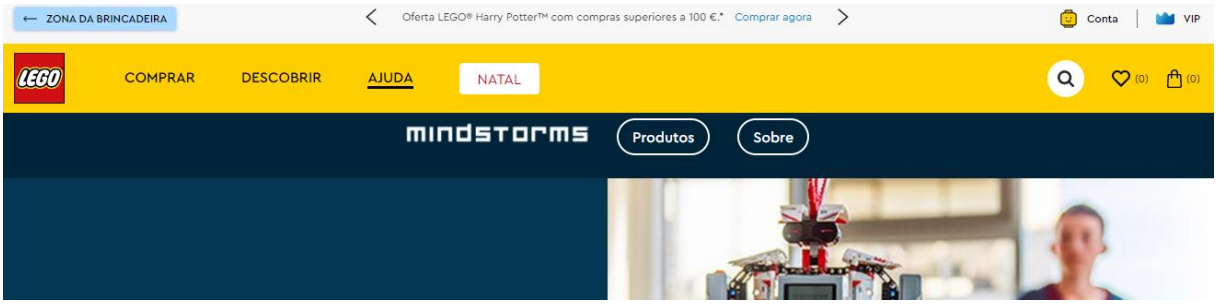
We finish with the Firmware, which is the software that is in the EV3 Block and that is programmable with the EV3 Programme app. (see website: https://www.lego.com/pt-pt/themes/mindstorms/learntoprogram).

This app is provided free of charge and can be downloaded from the play store. All instructions and exercises are described on the Lego website where there are explanatory videos as well as precise guidelines on how to use them. We can access extra information by registering on their website via an email account.



We can therefore say that the knowledge and use of these forms is a success factor for the transition of the school to Industry 4.0. They present many advantages, such as the variety of resources available, their easy access and the possibility of being interpreted in different languages. As for the disadvantages they require prior knowledge by the teacher about their functionalities and interface, requiring prior registration based on an email account.

What other materials can we use?

Depending on the knowledge we have regarding the use of electronic components and electricity, we can use different materials reusing resources. Then we can use an arduino board and explore its potential in low-cost educational constructions. Here are some examples. With the use of cardboard soda caps electrical wires, an arduino board and the mblock we can for example explore sounds, colours, dialogues between characters. Here are some examples (figure 12).

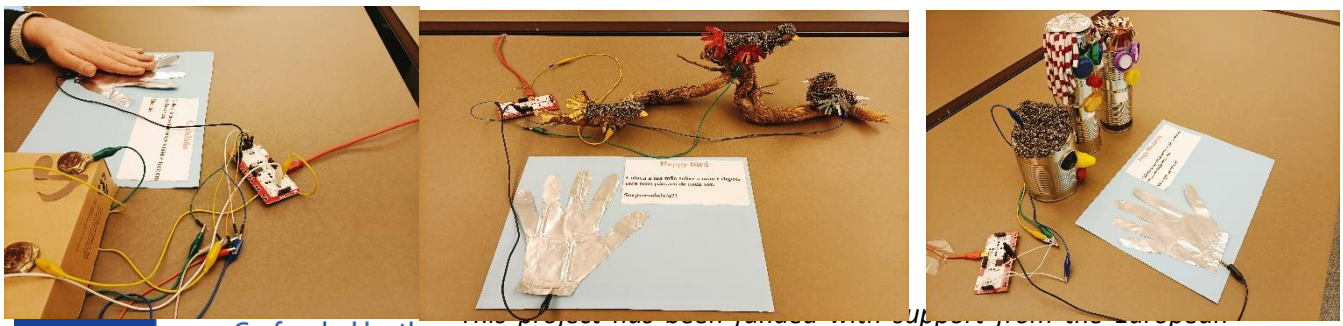


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Figure 12: Use of an arduino board and its use with different reused materials.

Assessment of learning

The assessment will be made using the practical exercises described in the activity sheets that are described in the plans that accompany this module. However, it is important that the teacher check how students solve the different challenges, giving them positive feedback in order to maintain motivation and prevent abandonment of the activity.

Literature

https://www.i-scoop.eu/industry-4-0/

https://library.oapen.org/bitstream/handle/20.500.12657/43836/external_content.pdf?sequence=1&isAllowed=y

https://www.researchgate.net/publication/332440369_An_Overview_of_Industry_40_Definition_Components_and_Government_Initiatives

Youtube:

https://youtu.be/57RDKUktTj8

https://youtu.be/7iGN-16BKiE

https://youtu.be/HLptVgTN5cg

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Cloud computing as a main source of information

Learning outcomes

After the teachers get acquainted with the theoretical part of the Module " *Cloud Computing as the main source of information*", they will:

- learn about the importance and benefits of using Cloud Computing as the main source of information in education;
- learn to use cloud computing tools and applications in the teaching-learning-assessment process, but also in collaborative activities;
- gain the necessary knowledge how to teach students with the use of cloud computing tools in the development of didactic materials;
- gain the skills needed to teach students using the concept of cloud computing in the classroom;
- be able to introduce elements of Cloud computing in their didactic approaches.

The theoretical part of the module includes building up on the non-IT teachers' knowledge whereas the practical part provides them with exercises and lesson plans to teach Cloud Computing skills to students.

Introduction

Against the backdrop of the coronavirus pandemic, which has pushed many states to close schools for a long time, teachers around the world are now challenged to adapt quickly and send an important message to students: lifelong learning beyond school and with online tools accessible to all and a lot of determination, we can make progress together and, more than ever, we can encourage students to learn and work independently.

In order to create successful habits, the management of each school must coordinate the organization of the online school and the teachers must communicate with each class, in instant messaging groups organized in advance. All this context means more training time and a greater coordination effort for teachers. Even though physical classroom interaction will not be fully recovered and not all classes will be organized online, the successful examples of those who have already begun to apply these measures show that no matter how difficult the process is, it is feasible, motivated and patient. The success of such an approach depends first of all on the best possible planning.

Teaching - learning - assessment in CLOUD aim to explore new dynamic ways to educate. This is in line with the way we think, share, learn and collaborate, in different sectors of education, by exploiting the opportunities that arise from the "cloud" environments.

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Cloud Computing has already changed the way we live and work. We have access to information everywhere, always being connected with others through various technical means.

Cloud Computing brings to education powerful innovative software and hardware resources, where and when we need them, in the form we want. The challenge is to apply appropriate educational approaches to maximize this potential. Working tools have the ability to engage and motivate students, but also to shape a new profile of teacher, leader in technology and Cloud Computing.

New cloud-based approaches allow us to identify dynamic ways to educate and learn, which align with the way we think, share, study and collaborate inside and outside the classroom.

What is Cloud Computing as the main source of information?

What is cloud computing, in simple terms?

Cloud computing (pronounced in English / klaʊd kəmˈpjuːtɪŋ /, literally "cloud computing") is a modern concept in the field of computers and computing, representing a distributed set of computing services, applications, access to information and data storage, without the user need to know the location and physical configuration of the systems that provide these services.[1]

The expression cloud computing derives from a symbolic graphic representation of the Internet often found in the form of a cloud ("the cloud"), used when the technical details of the Internet can be ignored, as in the image below (fig.1). The English concept and term appeared in practice in 2006-2007.[2]

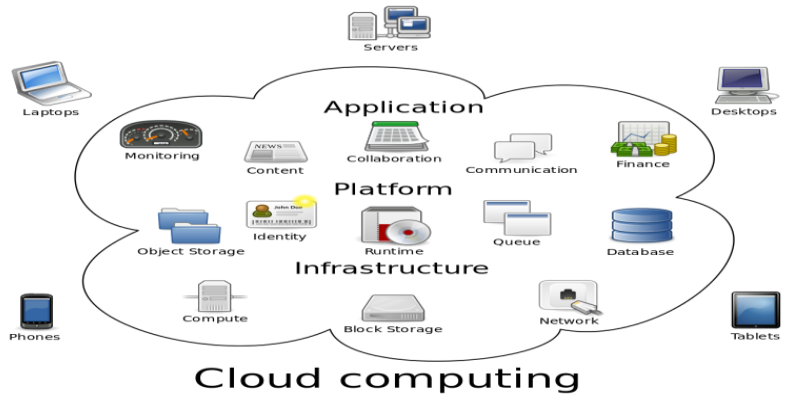

Fig.1 - Created by Sam Johnston

Cloud computing is the delivery of on-demand computing services -- from applications to storage and processing power -- typically over the internet and on a pay-as-you-go basis.

[1] https://ro.wikipedia.org/wiki/Cloud_computing
[2] [2] https://ro.wikipedia.org/wiki/Cloud_computing

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In simple terms, cloud computing is rented instead of your IT department. Instead of investing heavily in databases, software and equipment, companies choose to use their computing power over the internet and pay for it while using it.

Defining features of cloud computing

The concept of **cloud computing** has become so ubiquitous in economic and social activity that it is normal to know or understand what it means. The principles and concepts that govern this concept are becoming increasingly transparent to the end user.

Key features of cloud infrastructures include on-demand self-service, broadband network access, shared resources, rapid flexibility, and tools to measure the quality of services provided. Access to the cloud is allowed concurrently to a large number of consumers through virtualization technologies with automated self-scaling and provisioning functions depending on the number of processing requests. Theoretically, the amount of processing and storage resources that a user can benefit from is unlimited.

Cloud computing implementation models

At the base of modern information systems is technically the network level. The production, monitoring, record-keeping and sales assistance equipment are interconnected, thus ensuring the smooth flow of the information circuit. Data collection and processing requires storage space to ensure persistence over time. Computing equipment has essential physical resources: processor and RAM to enable or disable virtualization functions, necessary to meet the basic principles of modern information architectures: efficient use of resources, flexibility, extensibility, separation of responsibilities, ensuring high level availability. Physical equipment needs specific operating systems to create or not a virtual service network topology that allows the installation of application server support components through processing interfaces. The application level is the one that allows users access to carry out current activities, the other levels are often transparent to it.

Goetsch (2014) considers that this general model of architecture is applicable to all forms of implementation of information systems, both in the cloud and locally, the difference between the models being given primarily by the mode of administration and ownership of equipment.

The technical and academic literature is generous in terms specific to cloud computing or which have been adopted and adapted in this increasingly broad field. Some authors consider the concept itself a "buzzword" 16 or a sum of them. Recent developments confirm to us that the cloud is a concrete and mature model of providing information services, exceeding the periodicity with which the terms are run, which prove to be only elements of promotion under another appearance of older concepts. XaaS or EaaS (Everything as a Service) - Anything like a Service, they really contain excessive derivatives of aaS that are considered really defining for cloud computing.

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Sosinsky (2011) stipulates that in this sea of concepts, however, there is a generally accepted consensus on two sets of models, which allow the classification of cloud services:

Implementation models - *with reference to the form of ownership, location and management of cloud infrastructure: public, private, hybrid, etc.*

Service models - *with reference to the types of services that are offered to customers through cloud implementations: SaaS, PaaS, IaaS, etc.*

The technical and scientific articles treat in a different order the analysis of implementation and service models, some authors preferring to detail the services before the implementation models. The order of presentation in this material is justified by the fact that in order to be able to deliver services to consumers, suppliers need an implemented infrastructure.

The concept of the cloud has also captured the interest of large software companies as well as very large corporations as well as regulators, research institutions and government agencies. Depending on the origin of the amounts invested, the form of ownership and the nature of the clients, three main models of cloud computing implementation have been delimited over time and a form that is not yet very well regulated:

Public cloud - *based on the investments of a large software company and intended for global consumers regardless of size and field of activity;*

Private cloud - *based on the investments of a company or a conglomerate of vertical companies, intended largely exclusively for consumers within the company;*

Hybrid cloud - *based on the use of services offered by the public cloud interconnected with internal information entities, intended mostly for very large companies and aims to expand certain internal processing capabilities in order to serve consumers within the company.*

In the specialized articles we identify other forms of implementation of cloud technologies, the most representative being that of community cloud but also derived forms such as: **Distributed Cloud Computing** with reference to distributed information systems, governed by the principles and characteristics of the cloud (Antonescu & Braun, 2014); **inter-cloud architectures** with reference to methods and how to integrate services and resources between several public cloud providers and several private clouds (Buyya, Ranjan, & Calheiros, 2010); **multi-cloud architectures** (Petcu, 2014) with reference to the methods of management and operation of several cloud providers integrated with private clouds.

CLOUD COMPUTING IN EDUCATION

Traditional forms of e-learning require significant investments for building appropriate IT infrastructure and regular costs for maintaining, upgrading and managing hardware and software. The increased costs for hardware and software are beyond the strength of the majority of schools that have limited financial resources. Cloud computing is one of the global trends in ICT development

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and its implementation in education can be an effective way to solve existing problems and achieve goals at minimal cost.

ADVANTAGES OF CLOUD COMPUTING FOR EDUCATION

Cloud computing offers an infrastructure, platform and educational services that create an affordable and innovative learning environment. Such an environment allows collaboration between all participants in the learning process and between different educational institutions that reflects on the quality of education.

The benefits of the cloud computing model are for teachers and students as well as for the educational institutions.

The advantages of cloud services for education can be considered from different aspects (4-7).

The use of applications and services, delivered by external providers, is a cost-effective and efficient solution for educational institutions and allows enhancing financial flexibility. The advantages of cloud computing model, compared to the traditional approach, are expressed in: **reduced costs for hardware and software** as well as **reduced costs for IT staff**; **payment for actual consumption**; **provision of many free services**. Cloud computing offers a faster return of investments and dealing with rapidly changing software and hardware needs at a lower cost. There is a flexibility of the employment of resources combined with economic efficiency.

The educational institutions can implement effectively their strategy through cloud computing without the need to take care of its physical (hardware and software) provision. They have options to acquire and implement new IT solutions and to hire IT resources quickly. Service providers ensure the maintenance and management of IT resources. Cloud computing guarantees the use of modern ICT by educational organizations, something that cannot be achieved if they use their own IT infrastructure.

Cloud computing provides an easy and unrestricted access to services and resources at any time and place through a variety of devices both for teachers and students. The comprehensive accessibility by different devices enables the realization of ideas for mobile and lifelong learning – mobile learning that is expressed not only in using mobile devices, but primarily in the mobility of participants in the learning process.

Cloud computing tools useful in the process of collaboration, but also of teaching-learning

In your experience, have you encountered the message "Upload file to OneDrive or Google Drive to view them from any device"? Nowadays, people are talking more and more about Cloud Computing, but how they realize what Cloud Computing is and how I can use it.

According to the National Institute of Standards and Technology, Cloud Computing is defined as “A model to allow convenient on-demand network access to a common set of configurable computing

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resources, which can be provided and delivered quickly, with minimal management effort or interaction with service provider. "

Let's try to define it simply. Cloud Computing provides users with an efficient way to access, work, share, and store information and / or applications that use the Internet, rather than saving or installing them on a computer. In essence, the data is stored on web servers owned by a third party. Through their servers, companies provide users with storage, databases, networks, software, analytics and more. In fact, companies like Amazon, Google and Microsoft have invested a lot of money in creating their own clouds. This investment can be seen in the recent ranking provided by Forbes, which highlighted the top 5 cloud computing providers. Currently, the main companies are:

- Microsoft
- Amazon (AWS)
- IBM
- Salesforce
- SAP

There are also third-party tools to provide extensive data management capabilities in addition to those offered by the cloud provider, such as NetApp's AWS storage solution.

Why do we mention these companies? This is because Enterprise Cloud Computing is another term when we talk about Cloud Computing. In general terms, Enterprise Cloud Computing is a computing environment that provides software (SaaS), infrastructure (IaaS), and platform services (PaaS) to an organization. Some of the main advantages of purchasing these services are:

- Faster provision of information technology services and resources
- Infrastructure costs and lower operating costs
- Safer IT environment

People regularly use Cloud Computing without even noticing them. As users, people do not need knowledge about the technology behind this internet-based technology. They can simply access the information from anywhere and anytime and share resources with a lot of users.

Cloud Computing can be applied in different areas and domains. Because Education is our area of interest, we will focus on using Cloud Computing for teaching.

Benefits of Cloud Computing for students and teachers

- New innovative methods for teaching and learning.
- Fast access to the class material.

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- Flexible communication between professors and students (they do need to be in the classroom).
- Promotion of E-learning (use of technology in learning and the promotion of online courses)
- Stimulation of a collaborative learning environment among students when working together.
- Enrichment of the group based work allowing students to share references material, papers, journals, software, etc.

Better interaction between students and instructors during the class. Professors can ask questions during their lectures and allow students to participate by using an online interactive software (This is really useful when having large classes). Having the students answers on real-time help instructors to focus on student weaknesses instead of repeating and what student already are good at.

Allowance of real-time feedback for the students when they are working on assignments (Professors can access to students' work using the cloud-based storage service).

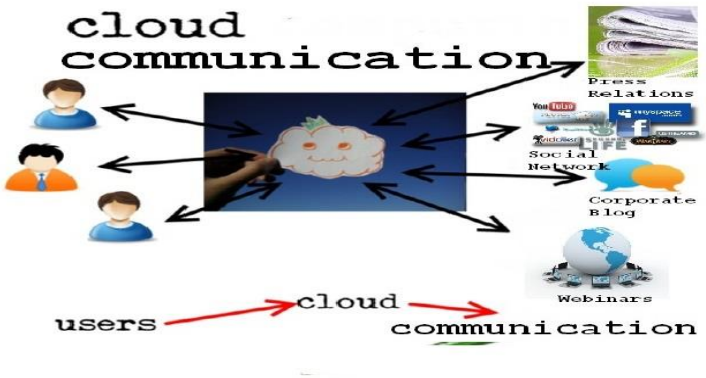
So, what are you waiting for? Start using Cloud Computing in your classes!!

"Using cloud-based learning, teachers are improvising on teaching methodologies by integrating modern technologies such as blended learning and collaborative learning, thus creating an effective learning environment for students" – Jhansi Mary (A lead analyst for education technology research)

The key is the content

Cloud communication ensures that every information, news or research produced by your company will be offered to the market through different channels like PR, corporate blog, video channels, podcasts, face to face encounters or web seminars at the same time, in different formats. The same content in various formats.

Cloud communication demands a content in different formats Text, video, audio, Notes for the school blog, site – Videos for YouTube – Audios for radios and podcast – Coments – FAQs



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Strategic Partnerships for school education 2019-1-PL01-KA201-065137
Project: Teacher4.0 - comprehensive method of implementation of Industry 4.0 concept into didactic practice in primary and secondary schools

Collaboration in cloud computing

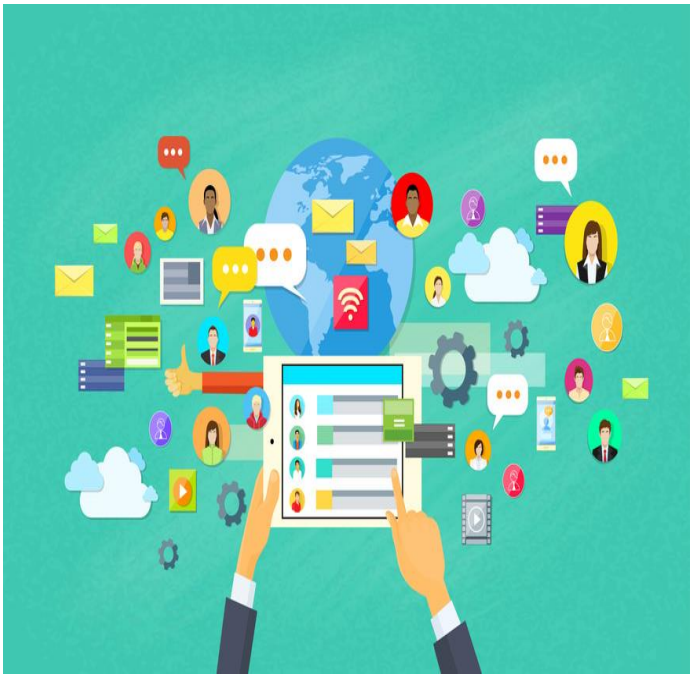
Defined as:

Interaction between multiple parties

All parties are doing work and with a shared purpose or goal All parties will get something in return for their efforts

- Collaboration can be across boundaries
- Increases output for all participants in the collaboration
- Creates new opportunities, starting ongoing dialogues with other customers and companies
- However there are consequences for large scale collaboration
- Companies will begin to shrink

Providing a Structure for Collaboration



Most important part for collaboration is establishing a strong foundation for collaboration

Create a structure that enables trust

Create the environment where a social network can live, or become part of existing networks

Share the vision, the goals

Motivate people in the right way and give them the freedom to deliver

Talk about the rules that guide collaborative behavior

Although these might not make a direct effect it will definitely make co-workers trust one another

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Email: Web-based email services like Gmail and Hotmail deliver a cloud computing service: users can access their email "in the cloud" from any computer with a browser and Internet connection, regardless of what kind of hardware is on that particular computer. The emails are hosted on Google's and Microsoft's servers, rather than being stored locally on the client computer.

Productivity Software: Office 365, Google docs and Zoho office. This software allow you to keep and edit your documents online. By doing so, the documents will be accessible anywhere, and you can share the documents and collaborate on them. Multiple people can work in the same document simultaneously.

Storage: One Drive, Google Drive, iCloud and Drop Box.

Examples of Cloud Collaboration Computing Services

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Google Drive

Google Drive's ability to have multiple users collaborating in real-time has modernized the way that group projects are completed. Formerly known as Google Docs, this program is owned by Google Inc. and is a free web-based processor. The users involved work on one text whether it is a document, spreadsheet, presentation, or a drawing. Documents have a maximum capacity of 1,024,000 characters and spreadsheets allow 400,000 cells with a maximum of 256 columns per sheet. Presentations can reach up to 10mb, equivalent to roughly 200 slides. As far as drawings are concerned, Google has yet to witness a drawing that was too large for the Google Drive system. The program currently supports 15 file formats some of which being Microsoft Word, Excel, PowerPoint, and Adobe Photoshop. One perk to Google Drive is the fact that users do not have to download their project(s) to their computer. Rather, changes can be edited and saved on the Internet. Several users are able to edit a document at the same time, with changes being visible to everyone in real-time. Google revolutionized the cloud computing era via the introduction of the main office applications into one, easy to learn program.

iCloud

iCloud is a cloud computing service created by Apple Inc. Similar to Google Drive and Dropbox, users have the ability to wirelessly store music, photos, documents, mail, calendar appointments, and contacts. These applications are stored to other devices that have the iCloud operating system on them. For instance, if one has an iPhone, once an application is downloaded onto the phone, it will be downloaded onto their computer if iCloud is installed. The service offers 5GB of storage for free; however, additional space can be purchased from Apple if the user chooses to do so. Unlike Google Drive which merely requires internet access, iCloud requires an iPhone, iPad, or iPod touch with iOS 5 or a Mac computer by Apple with OS X Lion 10.7.2 in order to create a free account. Computers not affiliated with Apple Inc. can utilize iCloud granted that one of the devices listed

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above is incorporated. Having the iCloud service allows for users to eliminate physical devices such as the external hard drive and others of the sort. While iCloud requires an Apple product to get started using it, its ease of use makes the purchase well worth the price. Dan Sung compares using iCloud to being able to "fall off of a log", that easy. This cloud computing application is more driven towards individuality, rather than group work in the likes of Google Drive.

Dropbox

Operated by Dropbox Inc, the site enables users to share certain files and folders across the Internet, synching any changes that are made in order to provide an opportunity for group collaboration.

Cloud Drive

Amazon introduced Cloud Drive in 2011. All Amazon users were given 5GB of storage from the company upon its release in order to compete with Google Drive, iCloud, and Dropbox. Cloud Drive works by simply uploading files from your computer that are in turn safely stored online. These files can be then accessed from any internet accessible location. Amazon's version of cloud computing does not match up to the others in the category though. The positives of Cloud Drive can be found when a user would like to store a few large files. Users who wish to have a cloud computing service for casual use will find Cloud Drive to be great. However, this service can be quite costly if the storage exceeds 5GB. When storage reaches one terabyte (1000GB), Amazon will charge the user $1,000 annually. In comparison, Google Drive costs $256 for the same amount of storage. The newness of this cloud computing service is rather evident. Cloud Drive does not have nearly as many nifty options and features as Google Drive and iCloud. Given time, a company as large as Amazon will develop features that will allow for Cloud Drive to compete against Google Drive and iCloud in the cloud computing era.

Examples of good practices in cloud computing in education

Over the last ten years, technology and the importance of cloud computing have caused significant shifts in education and how students learn. Previously, teachers could predict careers that students would have in the future and work to prepare them; however, educators no longer have that luxury. By incorporating meaningful technology into the classroom, both students and teachers will see improved outcomes and increased engagement.

Today, it is imperative that students leave class with the mastery of essential skills such as the ability to create, collaborate, think critically, and communicate cogently. One way to foster an environment of innovation in schools is through cloud computing. Cloud computing offers opportunities for innovation and benefits in the classroom that are both safe and cost-effective.

Innovation in the Education Sector

Cloud computing fosters opportunities for change for all users. Teachers can connect their students to multiple programs and applications, allowing for students to be innovative in their presentation of

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mastery of standards. For example, a student could respond to an assignment by uploading a video recording, taking a picture of a piece of artwork they made or sharing a document that they worked on with peers. The cloud offers students opportunities to use their voice and choice in how they demonstrate their learning and allows them the opportunity to utilize many technologies to do so. Through the cloud, teachers and students can customize assignments to meet a student's specific needs.

Just as technology is shaping and changing future jobs, the 21st-century classroom needs more flexibility in terms of design and layout. Teachers can also harness new and innovative classroom structures through cloud computing. Innovative classroom formats such as blended or flipped classrooms are streamlined through the cloud. Both models allow for more face-to-face time with students at the school while they utilize the cloud to access lessons and assignments from home. The cloud helps to create truly modern, innovative classrooms.

Accessible & Reliable Cloud Services

Cloud computing helps schools to meet data protection obligations to ensure student and employee information is kept safe. Most cloud providers invest in security measures that provide a base level of security on their cloud infrastructure. Safety measures utilized in the cloud are easy for users to navigate. The cloud also offers unprecedented reliability - when devices fail, information is not always lost as you can store data in the cloud.

Cloud-Based Collaboration

The ability to collaborate effectively with others is imperative for students to master. The cloud allows all users to have easy access to resources across multiple platforms, creating a strong foundation for developing collaboration skills. For example, students can collaborate with other students on an assignment while their teacher provides feedback in real time. Meaningful feedback is vital in helping students reach their goals. Cloud computing allows for instant feedback and assessment processes, which benefits both students and teachers simultaneously. The cloud also breaks through barriers of working within a group - students no longer need to be in the same place to work on a group project but can access an assignment from any location by the cloud.

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Collaboration is also streamlined for educators. With the cloud, teachers and administrators can easily share lesson plans and can work on them together at any place or time. Through messaging apps and other formats, different schools and districts can break barriers that prevent them from collaborating, which in turn leads to a more global educational community.

Reduce Cost by Moving to the Cloud

Shifting to cloud computing can save users significant amounts of money. Districts would no longer need to keep large staffs of technicians but could have a smaller IT staff to manage the school's or district's cloud. Cloud computing can potentially allow districts and schools to save money on licenses, hardware, power, and support. Additionally, schools will be able to access online editions of textbooks which will save money and ensure students are learning from the most recent books. Cloud computing can also cut the amount of paper used and photocopying costs.

Educational technology is imperative to instilling 21st-century skills into students. Cloud computing offers numerous benefits to students as well as teachers and administrators. The implementation of cloud computing in educational institutions will ultimately help schools to work toward their strategic vision and ensure student success.

Time & Convenience

One of the biggest obstacles for teachers is time. The cloud offers many solutions that give teachers more time to focus on instruction. Since students and teachers can access materials from anywhere, teachers can spend less time making copies. Teachers will no longer have to deal with the frustration of misplaced materials and assignments as the cloud holds all this information. Instead of carrying home stacks of papers and notebooks for grading, teachers can grade and offer feedback on assignments from their device. The cloud also streamlines the process for gathering missing and late work from absent students.

Teachers can save all their lesson plans and assignments to the cloud. From there, they can share them with other teachers and administrators and receive feedback on them. This makes lesson planning from year to year simpler and allows for educators to shift plans easily. If by chance a teacher's laptop fails, all the information will not need to be recreated as the cloud will retain it. Districts and administrators can also organize and share important information and policies with all personnel easily through the cloud. The cloud gives users the flexibility to work from anywhere.

Literature

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Augmented Reality as a real alternative to analogue didactic materials

Learning outcomes

After the teachers get acquainted with the theoretical part of the Module "Augmented reality as a real alternative to analogue didactic materials", **they will**:

- learn the meaning and difference between augmented reality and virtual reality.
- acquire the necessary knowledge on how to teach students using augmented reality among teaching materials
- acquire the necessary skills needed in teaching students using augmented reality
- learn how to incorporate augmented reality into their teaching attempts

A good didactic process should use different methods and graphic training aids. Choosing them and using them in an appropriate way is the key factor. Modern technologies can and should endow the process of teaching. One of examples of using modern technologies in teaching can be so called virtual reality (Virtual Reality – VR) or augmented reality (Augmented Reality – AR) which if introduced properly, can boost teaching effectiveness.[3]

Introduction

Definitions:

Virtual reality (VR) it means a set of techniques which aim at making an impression of being in a different reality than your environment. To make it possible, you need special glasses – VR goggles which have special displays instead of glasses. Thanks to it, a person who is in the virtual reality looks around a world which is generated by a computer in a real time. The precursor of the virtual reality was Myron W. Krueger (born in 1942) – an artist, researcher and computer scientist.

Nowadays, thanks to the development of computer science, virtual reality is created by generating visual and acoustic effects. Tactile experience, fragrance sensation or taste sensation are used rarely. What is more, this technology allows an interaction with the environment generated by different manipulators.[4]

In practice, virtual reality is seen as a system made of special software and equipment. Because of many systems, they used to be defined as virtual reality. The role of software usually focuses on two layers. In one of them, with the help of accelerators, it is aimed at processing the environment into

[3] Marek KĘSY Dr inż., Politechnika Częstochowska, Wydział Inżynierii Mechanicznej i Informatyki, POSZERZONA RZECZYWISTOŚĆ W EDUKACJI THE AUGMENTED REALITY IN EDUCATION
[4] https://pl.wikipedia.org/wiki/Rzeczywisto%C5%9B%C4%87_wirtualna

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images and sounds. Due to stereotaxis it is connected with a lot of mathematical calculations. Sometimes there are calculations made in real time. In some cases the calculations are made before the right screening.

Artificial environment can be similar to real world. Simulations which are handy for pilots or military trainings are created as well as models of renovation, construction and medical works. Their virtual scenario is created in difficult or even extreme and untypical conditions, but they are safe for our health.

There are also mathematical models the world climate which are useful for the weather forecast.[5]

An implied form between the virtual and real world is the Augmented Reality (AR)[6], introduced later than the virtual reality. It is connected with enriching the real environment by the contents made by computers which is completed mainly by graphical contents.

R. Azuma identifies RR as a system which connects the real and virtual world, interactive in the real time, allowing the freedom of movements in three dimensions. Augmented Reality does not create new, fully virtual three-dimensional world, but it completes real world (which does not change) with new images or information (virtual surface) .

We deal with AR when we observe the surrounding world with a smartphone or a tablet but it has graphical elements added.

In the basic version it means a possibility to watch a film, animation or sound with the help of a suitable app and gadget (a tablet or a smartphone) after pointing a tag which releases multimedia message. A tag – marker – it is a graphical material (graphics, picture, text or a different thing) which activates multimedia message (film, animation, audio folder, slideshow).

Technology of Augmented Reality in an advanced version allows an interaction with digital image or a 3D object, for example a virtual person we touch on the screen and who reacts to our gestures, answers our questions, etc.

How does AR work? A camera records a real image, then it passes it to an app (users can usually use their own device having downloaded a special app). The app looks for programmed patterns in the image (markers), then it adds extra graphical elements to the observed image, creating the AR which is seen by the user.

The base of AR system performance is discovering and following chosen points (graphical markers, natural objects such as buildings, objects or different identification points) I the real world in order to put virtual objects on it. A camera follows the marker movements and a computer displays a 3D object created in a real time with the use of any projection medium.

[5] https://pl.wikipedia.org/wiki/Rzeczywisto%C5%9B%C4%87_wirtualna
[6] WIRTUALNA I ROZSZERZONA RZECZYWISTOŚĆ A ZACHOWANIA KONSUMENTÓW Studia Ekonomiczne. Zeszyty Naukowe Uniwersytetu Ekonomicznego w Katowicach Nr 303, Jadwiga Berbeka, 2016

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Virtual information helps the user of the system to do real tasks[7]

VR versus AR

In contrast to AR, VR requires more expenses on devices – a good computer with a modern graphics card and quite expensive VR glasses. Additionally, an exposure administrators should also consider employing is training a person to service such installation. The glasses can be damaged easily and the users having such problems for the first time need assistance. One person can experience virtual reality at the same time (unless two pairs of glasses are prepared).

VR and AR are different in the quality of images and the users experiences. In the case of VR, the experience will be stronger. The user will not see the graphics put on the image from a camera and will be free from the lightening in the room (which can influence the quality of the image displayed on the device). VR world has also its drawbacks, the VR glasses cover the world around us, so some people can feel dizzy or sick, so we need to be careful while presenting them to elderly people or children under 12.

To sum up, if a user observes using a mobile phone or a tablet and he or she can observe there a modified version of reality, it is AR. But if special glasses are needed and a person is isolated from the surrounding world, it is VR. Both, AR and VR influence people's senses, especially the sense of sight. Most users are visualizers, so perception with this sense is crucial and it has impact on the quality of communication with the use of these technologies.

Also RR allows deep feelings, giving new stimulus. The functionality of apps using AR caters for users' convenience. A mobile device which contains different apps is a source of knowledge, it works as an adviser. Thanks to the apps using RR a person downloads them on his/her device, he or she uses it all the time and it leads to a better knowledge of people, they become more connected.

Usage

AR can be widely used [8], in the army, motorisation, navigation, industry, medicine, visualisation of buildings, museums, entertainment and education. The first use of AR in aviation (from 1958) as a head-up display which helped the pilots in manoeuvring influenced the way people started perceiving AR systems and their construction. Regardless technologies made for the purpose of aviation, there were devices which were prototypes of modern augmented reality systems. Currently the army is still interested in using AR systems – as the commander assistant due to their potential of taking fast decisions by the system user.

AR used by the army it is mainly the system of head-up displays HUD- the basic equipment in planes and helicopters. Also, HMD displays are used which are installed in helmets , they put real vector

[7] NOWE TECHNOLOGIE DOI 10.15199/148.2017.7-8.7 Systemy i zastosowania rzeczywistości rozszerzonej Augmented reality systems and their applications HALSZKA KATARZYNA SKÓRSKA
[8] NOWE TECHNOLOGIE DOI 10.15199/148.2017.7-8.7 Systemy i zastosowania rzeczywistości rozszerzonej Augmented reality systems and their applications HALSZKA KATARZYNA SKÓRSKA

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graphics on an image. The popularity of HUD displays in aviation caused that similar solutions started to be developed for the ground force – BARS systems. There was also research done on the effectiveness of AR during training. The first impressions were positive despite a problem the scientists have to face – improving the performance of tracking systems and displays which are key elements of AR systems used for trainings.

The army was interested in using AR for fixing and servicing army vehicles in field conditions.

Such systems were used for the first time by a Boeing company to support the work of mechanics and electricians while assembling wires in planes. Since then a lot of similar projects were developed. ARMAR can be an example created by Columbia University. It is created to make the work of mechanics more efficient and increase work safety. The system used HMD display thanks to which the worker saw an image with AR elements put on it and he was led through next fixing stages.

Similar systems were developed by car makers Volkswagen and BMV, but due to the weight of the device it was not widely used.

Instead, app for tablets and smartphones are developed, they are to help the service technician to carry on the repair, e.g. Volkswagen MARTA app or apps helping drivers with everyday vehicle operating. e.g. eKurzinfo.

Car industry is one of the fields that develops AR the most. This technology, which broadens the driver's reality helps to eliminate the risk of a car dead point, fog, dangerous situations on the road or carelessness.

System AR was used for the first time in 1988 by General Motors in Oldsmobile Cutlass Supreme and Pontiac Grand Prix vehicles. They were known for the military head-up displays. For the next 30 years, because of the exclusivity protected by General Motors patent, such displays were seen mainly in vehicles belonging to this company. The exception were rare on the Japanese market Toyota cars, and in Europe cars produced by BMW AG company.

However, since the termination of the patent, car companies outdo each other in developing new, better head-up displays. HUD displays are still the easiest method of broadening the reality in cars, still the surface displaying data is limited. So, manufacturers are trying to find a technological solution to use the whole windscreen of the car.

Not only would the windscreen work as help for the driver, but it also could be an Infotainment system of the car, being both a system allowing to display information about the surroundings and a source of entertainment. Initially, it would be used to improve the safety and comfort, then AR would become a medium of information and entertainment for the car passengers. There is great potential of the AR usage in navigation and tourism. Currently, they are used in industry, museums, land and air transport.

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The great potential of AR has already been used for entertainment. It is widely used to broadcast sports events, to show the line proving the offside during football matches or the distance a ski jumper gets.

A popular type of app using RR are virtual fitting rooms. Virtual mirrors od AR show the reflection in the mirror of the client's body or a part of the body (face, head, hand) with virtually put products (such as glasses, make up, clothes). Virtual fitting rooms became widely used by clothes and cosmetics companies. They allow customers to see the simulation of a certain product worn by him or an avatar, or personalised model. Customers appreciate the value of entertainment, they are also useful while shopping online.

An app which can put in real time a chosen product on an image from a customer's room and can check if a piece of furniture fits a room and what it looks like there, is a toll helping to make a decision.

AR systems are serving a crucial role in an interactive marketing and e-services. AR is useful especially in visualisation of a product which can be presented only in a virtual form. The reasons of that can be e.g. a high cost of a product or technical problems connected with presenting it. In 2009 French companies Renault and PSA used 3D live show technology to present new car models and their equipment. The technology allowed the visualisation of vehicles without putting the models on a stage. AR systems are used also for Xbox 360 Kinect controllers of Microsoft, PlayStation Vita and Nintendo Wii consoles. The controllers allow an interaction with a console by gestures. Because of common access do mobile devices (smartphones, tablets) more and more games and apps are being created which use AR created for such devices.

In museums, augmented reality can be used in a variety of ways. One of them may be placing an empty pedestal in the center of the room and placing an appropriate print (marker) on it. For the visitor, the pedestal itself and the incomprehensible graphic sign will be visible to the naked eye. If he looks at him through a device with the appropriate application, in place of the marker he will see a three-dimensional (3D) object, previously prepared graphically. This makes it possible to view it from all sides - the visitor can walk around the pedestal, get closer and further away, potentially it can also change and move the object he is watching.

Augmented reality gives the opportunity to freely display digital 3D objects that are a representation of valuable museum exhibits. Thanks to this, you can look closely at the elements of the exhibition - as a result, viewing valuable and protected monuments is not only safe, but also cost-optimal. The graphically illustrated element does not have to be physically in the place of its viewing, and the mobile device - through which it is viewed - belongs to the visitor.

To simplify the issue: the world of augmented reality is the real world observed - by a mobile device - with three-dimensional virtual elements added.

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AR is used in various areas of science and business: in medicine - medical imaging, in aviation - on-board instruments show pilots important data about the terrain they see in front of them, in training - AR provides students and company employees with necessary data about specific objects, on which they work, in the automotive industry - displaying key information or images, e.g. from an on-board computer, radio or navigation system on the windshield of a car or motorcycle, in communication - AR markers are used during marketing campaigns. In tourism, RR is used in the external navigation of tourist special glasses in the form of superimposing interactive information], as well as in the reconstruction of archaeological objects.

New applications are being created and existing ones are being updated.

Augmented reality in education[9]

There is a view that education can expect the most benefits of AR technology, because through the skillful implementation of its solutions in educational processes, all its teaching assets can be used. The usefulness of AR technology in education can be analyzed from the point of view of its technical presentation capabilities, as well as in psychological categories related to, among others evoking positive emotions stimulating interest and willingness to acquire or expand knowledge. The development of AR technology brings successive emergence of new application solutions that are used in various areas of human life. The possibilities of AR technology are increasingly being used in education and vocational training processes. The main reason for this is the large visualization possibilities that can be used, among others in the design of complex technical devices, studying human anatomy or presenting various, difficult or impossible to observe in real conditions processes and phenomena. The effectiveness of AR technology is particularly noticeable in cases where it can help to understand complex and difficult to explain issues, or in cases where the issues discussed are characterized by a high degree of abstraction. Examples of the above teaching problems can be science, i.e. mathematics (spatial geometry), physics or chemistry. An important didactic tool in the above cases is a demonstration, experiment or realistic simulation conducted in real conditions. AR technology can make the use of a “sheet of paper” and an interactive camera transfer its user to a virtual physics or chemistry laboratory. In the basic version, the process of “augmenting reality” is triggered by the identification of a marker (the so-called marker), which, moved under the camera, is read by a computer application, presenting at the same time text information, 3D graphic models, instructional films, animations or sound on the screen of the mobile device. The process initiating tag is any printed or displayed image in the form of e.g. 2D graphics, inscriptions, photos or other objects. In one tag, you can “accumulate” gigabytes of various types of teaching materials.

In the age of Internet development and e-learning, children are also eager to reach for new technological solutions to play and teach. Augmented reality appears in educational courses designed for the youngest - it is usually fun-related learning, educational games, simulations, etc. The

[9] Marek KĘSY Dr inż., Politechnika Częstochowska, Wydział Inżynierii Mechanicznej i Informatyki, POSZERZONA RZECZYWISTOŚĆ W EDUKACJI THE AUGMENTED REALITY IN EDUCATION

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simplest teaching method in early childhood is the use of educational videos related to tasks placed on the Internet in connection with AR.

The big advantage of AR is that it is not a "virtual world", but is a complement or extension of reality, which, when properly presented, can stimulate curiosity and interest. Stimulated emotions, e.g. in history, geography or biology lessons, may encourage you to search for additional information and deepen your knowledge.

Emotions triggered by AR technology can be used didactically, e.g. during field history lessons. Realistic presentations of battle scenes, armaments, characters or buildings associated with a specific place can become an impulse that stimulates interest in history. An example of the didactic intentions presented is, among others the project 'Warsaw'44 - in the footsteps of the Warsaw Uprising via a mobile phone', thanks to which it is possible to connect selected places of Warsaw with events that took place in 1944 during the Warsaw Uprising. On similar grounds - to arouse specific emotions (reflections), awareness campaigns are targeted at road users. The device used in them in the form of autogogli is used to present states of impairment of human senses occurring after alcohol consumption. The states presented include reduced concentration, slower response time, distorted image or errors in distance assessment - are intended to show the mental and physical states of the driver driving a car after drinking alcohol. AR technology provides useful support that gives you the opportunity to quickly obtain information and to acquire or deepen a specific range of knowledge. The so-called application solution is helpful in this respect. 360 degree view, which gives the opportunity to present the object from any distance and from different viewing perspectives. By changing the position of the marker relative to the display device, the position of the observed object changes, which allows you to view it from every angle and at any zoom, making it easier to analyze its structure and understand how it works. An example of the above options may include iSkull application that allows you to study the structure of the human brain. The usefulness of AR technology is particularly evident in areas where it is important to combine theoretical knowledge with practical action. An example here can be technical or medical sciences. It also seems important that AR technology can support both learning processes and real action processes. The evidence can be medical sciences, where AR applications support both educational processes (e.g. in the field of human anatomical structure) as well as surgical procedures and operations. A distinctive feature of AR technology in educational applications is the so-called didactic transfer. It results from the possibility of using a universal application hardware kit and flexible programming tools that allow you to modify the didactic content of the presented materials.[10]

Thanks to AR technology, illustrated children's books, textbooks (e.g. for learning history, physics, chemistry) or albums are gaining a new dimension. Individual pages of the printed book are also markers that trigger multimedia content, including movies, animations, and audio tracks. They require the use of a suitable device (e.g. tablet) that will allow them to run.

[10] Ł. Jaszczyk, D. Michalak, Zastosowanie technologii rozszerzonej rzeczywistości w szkoleniach pracowników podziemnych zakładów górniczych, „Mechanik" 2011, nr 7.

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The above example perfectly illustrates the fact that digital technologies do not have to be a threat to traditional books - on the contrary, they can beautifully enliven and diversify them.

An important aspect of AR, which works great in education, is the ability to participate in a virtually created world. To make this experience as real as possible, some museums use large screens and special cameras.

The widest application of RR in the field of historical education are RR guides to historical cities and museums. The user can navigate the historical site and get information on the display (goggles, phone display, computer display). The information is updated according to how the user moves and displayed simultaneously according to his individual needs.

Table 2. Selected areas of augmented reality applications[11]

Area of application	Description
Historical education	Museums, AR guides, art history trainings, reconstruction of historic buildings in the AR system
Encyclopedic knowledge	AR libraries, augmented reality textbooks
Training for companies	Technical constructions and intra-corporate training
Virtual laboratories	Simulations of experience from various areas of science
Early school education	Initial teaching and learning through play

Augmented reality (AR)[12] enables students and teachers to apply information, illustrations and other content to the image of the real world, creating a new context and providing valuable associations that help in learning and understanding various issues. AR applications in traditional lessons can change the classroom into space, move students in time to see historical events with their own eyes, and even allow them to look inside everyday objects and understand how they are built.

Augmented reality connects the digital world with the real. By placing digital objects and data in the context of the physical world, AR applications on a mobile device allow the imagination of students to seamlessly penetrate reality and create new opportunities for interaction with the environment.

AR applications are valuable educational tools that strengthen commitment and motivation across the entire spectrum of teaching subjects. Teachers can use augmented reality to:

[11] E-mentor nr 2 (44) / 2012 » e-edukacja w kraju » Rzeczywistość rozszerzona i jej zastosowanie w edukacji
[12] https://www.apple.com/pl/education/docs/ar-in-edu-lesson-ideas.pdf

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- Stimulate student engagement through movement and realistic exploration
- Visualize abstract experiments and experiment with them
- To delve into further hidden layers and systems of the examined object
- Tell stories in a whole new way
- Encourage students to move and explore the surrounding world
- Show off both the wide shot and the details
- Use resources that otherwise would not be available
- Build elements that complement current curricula
- Develop projects and provide students with challenges

Virtual education is the acquisition of both theoretical and practical knowledge. The importance of experience cannot be ignored here. In traditional teaching, they must be carried out in laboratories and are expensive. Education combined with AR enables the creation of artificial laboratories where research can be carried out - both amateur (for teaching in schools) and professional (for learning). Most often, laboratories are created to study physical and chemical phenomena and to carry out medical experiments.

From an early age, children function in virtual reality far away from the reality of many schools. A shared platform in which students' needs meet the possibilities of educators is augmented reality. Students' skills in using mobile tools are high and not used in school practice. Instead of prohibiting the use of mobile devices, we want to include them in work and study. By extending digital skills, we make teaching effective and natural, resulting from an environment close to the student.

A modern student connected to the world 24 hours a day behaves differently than his peer years ago. He may not yet know what his schooling should look like, but he has certain expectations of teachers and he does not hide it. He asks and asks for the possibility of using the available mobile devices at school that make his life easier.

Augumented reality in practice

The presented possibilities of augmented reality technology and examples of educational applications show its great didactic potential. Currently, augmented reality in education is used incidentally, usually as a technology curiosity. The encountered applications have a great didactic potential and the legitimacy of widespread use in educational processes. The apparent lack of "software" application is due to the fact that AR technology is at an early stage of development.

It seems, however, that in the near future, augmented reality may become one of the basic presentation technologies in education. The use of commonly available mobile devices and the possibility of free use of programming packages will cause that AR studios and laboratories will show

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the realism of the presented issues with the minimum necessary to incur financial expenses related to their creation and maintenance. Implemented in education processes in a thoughtful way, it can provide an interesting tool that presents a high cognitive value, at the same time conditioning didactic efficiency.

Augmented reality can greatly enhance educational materials, opening up new perspectives for virtual learning. However, it should be remembered that even the most interesting solutions from AR will not replace well-thought-out and appropriately refined training material. Augmented reality is a tool that should be used, bearing in mind the primary educational goal - to provide future recipients with the highest quality information and both theoretical and practical knowledge.

Augmented reality provides teachers and students with new tools and new opportunities. AR applications provide valuable help for students in exploring the world and acquiring knowledge. Over time, new applications and new types of AR applications will appear, creating new experiences and learning opportunities. Regardless of whether augmented reality is to be an addition to a previously developed lesson or an inspiration for completely new classes, the inclusion of the AR application in the teaching process of the subject brings the benefit of greater involvement and better understanding of the issues learned

Augmented reality has a great educational future. Among the most common applications are environmental research, exploring the objects of history and culture. Very often it also means leaving the class, because we can get the most information simply by watching the world around us.

Literature

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WIRTUALNA I ROZSZERZONA RZECZYWISTOŚĆ A ZACHOWANIA KONSUMENTÓW Studia Ekonomiczne. Zeszyty Naukowe Uniwersytetu Ekonomicznego w Katowicach Nr 303, Jadwiga Berbeka, 2016

NOWE TECHNOLOGIE DOI 10.15199/148.2017.7-8.7 Systemy i zastosowania rzeczywistości rozszerzonej Augmented reality systems and their applications HALSZKA KATARZYNA SKÓRSKA

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https://www.apple.com/pl/education/docs/ar-in-edu-lesson-ideas.pdf

YOUTUBE:

https://youtu.be/EstjpvYffgU

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Artificial intelligence as your classmate

Learning outcomes

After the teachers get acquainted with the theoretical part of the Module "Artificial Intelligence as your classmate", **they will**:

learn about different types of Artificial Intelligence

learn about the importance of Artificial Intelligence in Industry 4.0

gain the necessary knowledge how to teach pupils with the use of Artificial Intelligence concept in didactic materials;

gain the skills needed to teach pupils with the use of Artificial Intelligence concept in the classroom;

be able to introduce elements of Artificial Intelligence in their didactic approaches.

Introduction

What is Artificial Intelligence?

The world is constantly evolving and the things we have only heard about in science-fiction films are already a reality. One of the most famous concepts in Industry 4.0 is the Internet of Things (IoT) and **Artificial Intelligence (AI)**.

The definition of Artificial Intelligence is interpreted in different ways in academic circles. The term Artificial Intelligence was first used by John McCarty in 1956. According to him, artificial intelligence is a science that includes mechanical engineering, especially intelligent programs (McCarthy, 2007). This definition was supplemented by the term quoted by Jack Copeland, who defined artificial intelligence as the ability of a digital computer or computer-controlled robot to perform tasks related to intelligent beings (M. Warszycki, 2019). In turn, according to N. J Nilsson from Stanford University in the USA, this is an issue that gives direction to methods of designing intelligent machines in such a way that they imitate human intelligence. (Nilsson, 2004).

As we can see, all definitions are slightly different, but they do have a part in common because Artificial Intelligence is referred to as a computer program or a machine that operates under the control of a computer program. In simple terms, Artificial Intelligence is a system or machine that mimics human intelligence when performing various tasks and has the ability to improve on the basis of information collected.

Artificial Intelligence is already present in our daily lives, but its future applications are expected to bring about huge changes.

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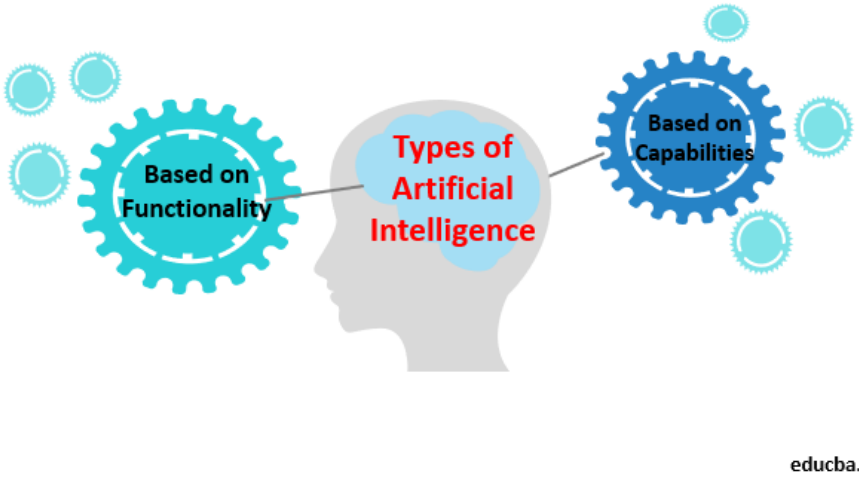

Figure 1. Types of Artificial Intelligence

Source: https://mc.ai/different-types-of-artificial-intelligence/

Types of Artificial Intelligence

Type 1 – Based on Capabilities

Artificial Narrow (Weak) Intelligence (ANI) – applying the AI only to specific tasks or specific types of problems. It focuses on one particular task that can be performed better when compared to humans. Examples of weak artificial intelligence: voice assistant (e.g. Siri), automatic translator (Google Translator, Deepl), self-driving cars (Tesla), Smartphone apps, image identification tools, spam filters, etc. At this stage, the machine does not have the ability to think, it only performs a set of pre-defined functions.

Artificial General Intelligence (AGI) - A kind of Intelligence that is also known as the Strong AI. These are all machines that have the ability to think and that are able to make decisions just like people. At present we do not have any examples of a strong AI, but thanks to the rapid development of technology, we will soon be able to create machines that are as intelligent as people. These systems will have many possibilities covering different areas. They will be able to react and improvise just like people in the face of unprecedented scenarios. A strong AI is seen by scientists as a threat to human existence. Scientists fear that it will compete with people and, as a result, replace them.

Artificial Super Intelligence (ASI) – ASI will be the highest point of development for Artificial Intelligence and will be the strongest form of intelligence ever to exist on Earth. Thanks to an extremely high level of data processing, memory and decision-making capabilities, machines will be able to perform all tasks better than humans. Scientists fear that the emergence of this intelligence

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will lead to 'Technological Singularity', a situation where the development of technology will reach an uncontrolled stage, resulting in an unimaginable change in human civilisation.

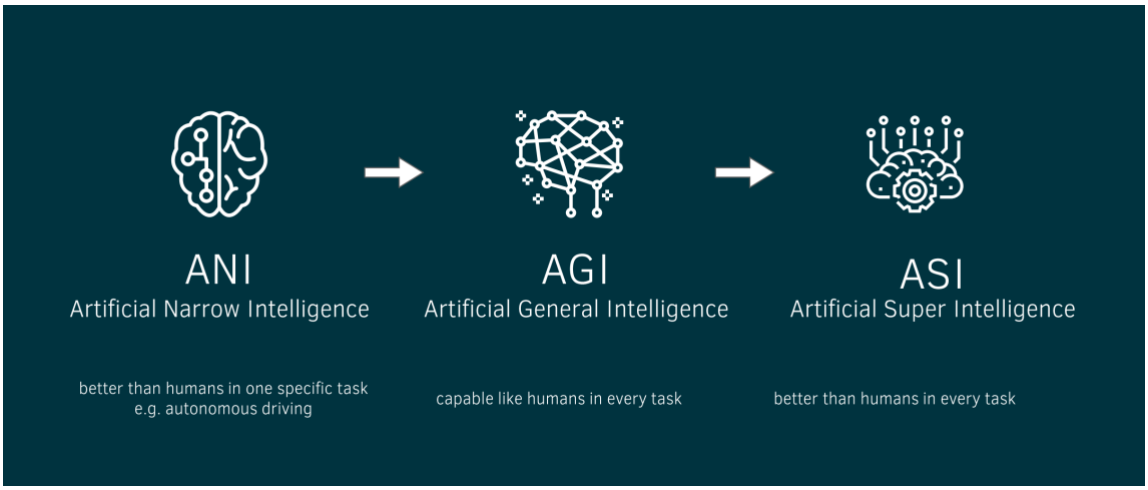

Figure 2: *Artificial Intelligence based on Capabilities*

Source: https://accilium.com/en/autonomous-driving-one-step-closer-to-artificial-intelligence

Type 2 – Based on Functionality:

Reactive Machine – Machines which operate based purely on the data they possess, taking into account only the current situation. This type of artificial intelligence does not have the power of memory and therefore is not able to use previously acquired information to obtain better results in the future. Reactive machines are the oldest and most basic type of artificial intelligence. As an example of this type of intelligence we can consider a chess supercomputer, which is famous for defeating the international champion Garry Kasparov at the end of the 1990s. This computer has the ability to recognize and move around the chessboard, so it chooses the best possible movement for itself. However, it is not possible to learn from its previous moves.

Limited Memory – It is a type of Artificial Intelligence that has its own memory and can make conscious and improved decisions by examining past data. This Artificial Intelligence has short-term or temporary memory and can be used to store past experience and thus evaluate future actions. Examples of this type of intelligence are self-driving cars, which have limited memory and use data from the recent past to make immediate decisions. These cars store data such as GPS location, speed of other cars, identification of civilians crossing the road, traffic lights, etc.

Theory of Mind – This is an advanced type of intelligence that is currently in the research phase and its use is limited to research laboratories. According to scientists, this category of machines will play a key role in psychology because it will focus mainly on emotional intelligence, so as to understand human beliefs and thoughts. Based on understanding human minds, their emotions, etc. It will be

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able to change its own response. The Theory of Mind AI has not yet been fully developed, but intensive research is being conducted in this field. An example of this type of intelligence is the prototype robot developed by researcher Winston, who can predict the movement of other robots and decide which way to turn in order to avoid collisions.

Self-Aware AI – This is the last type of artificial intelligence whose existence is only hypothetical and exists only in science fiction films. This type of intelligence will understand and evoke human emotions, but it will also have the ability to have your own emotions. Scientists believe that we are decades or even centuries away from implementing this type of artificial intelligence. They also believe that we should be careful with them, because machines that achieve a state of super-intelligence may be a problem when they consider humanity to be a potential threat, which may result in the end of the human species on Earth.

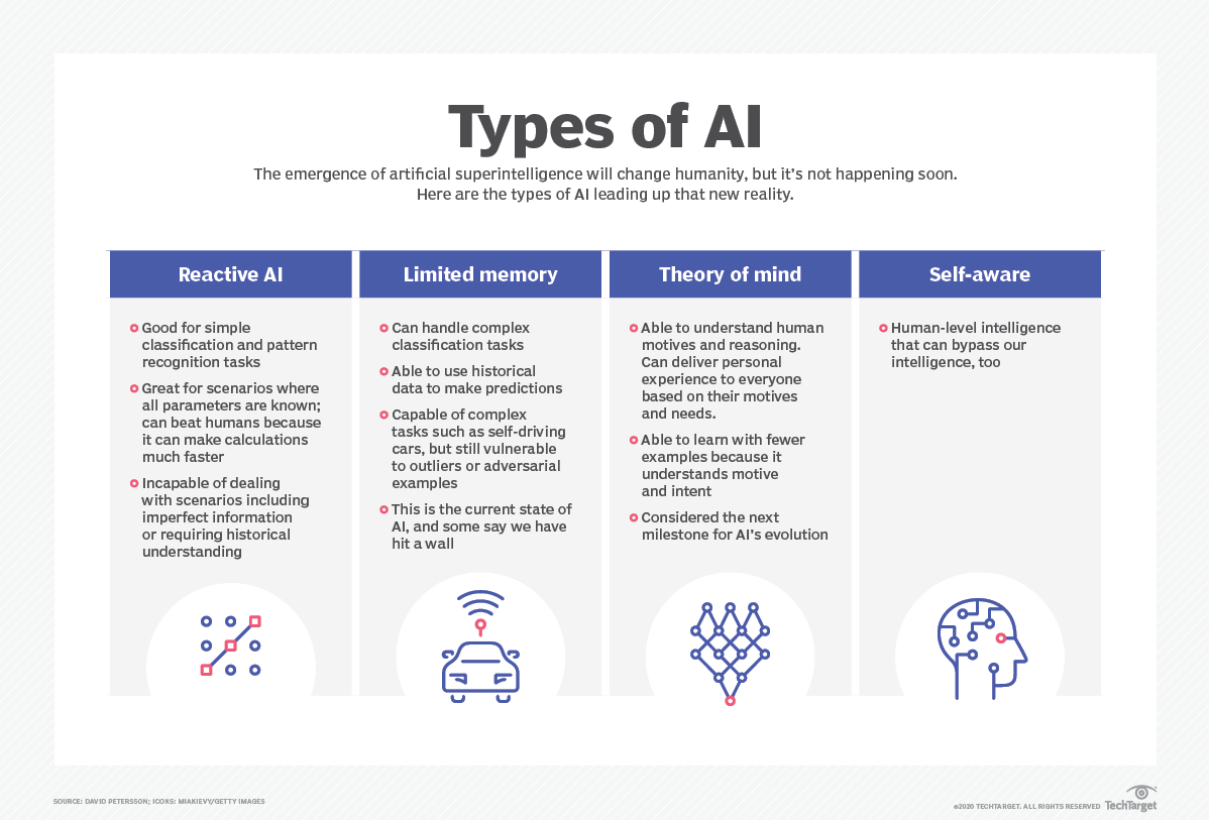

Figure 3. Types of Artificial Intelligence based on Functionality

Source: https://searchenterpriseai.techtarget.com/definition/AI-Artificial-Intelligence

Why is artificial intelligence important in Industry 4.0?

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Technological progress, automation and robotisation make digital technologies drive the economy. The implementation of artificial intelligence by companies requires them to enter the digitisation phase. The use of Artificial Intelligence in a company increases productivity and efficiency. This is due to the fact that processes or tasks that once required human involvement are automated.

Artificial Intelligence is seen as a key element in the digital transformation of society and has become a priority in the EU.

The introduction of value-creating solutions in industry 4.0 requires Artificial Intelligence and Industry 4.0 to cooperate in a three-stage process (R. Poreda, 2019):

Data collection - The industry is able to equip its production lines with sensors that will collect information about the production process (Internet of Things), this is possible by introducing low-cost solutions that collect data.

Data analysis - The amount of data that is collected by people and computers today is enormous. Artificial Intelligence allows for the analysis of countless amounts of information, so that a company is able to identify relevant information and, at the same time, generate solutions that can create added value. Artificial Intelligence systems are used in sectors such as marketing, e-commerce, but are increasingly entering the industrial sector.

Actions - Having collected and analysed data, we can introduce solutions that will create value in industry 4.0.

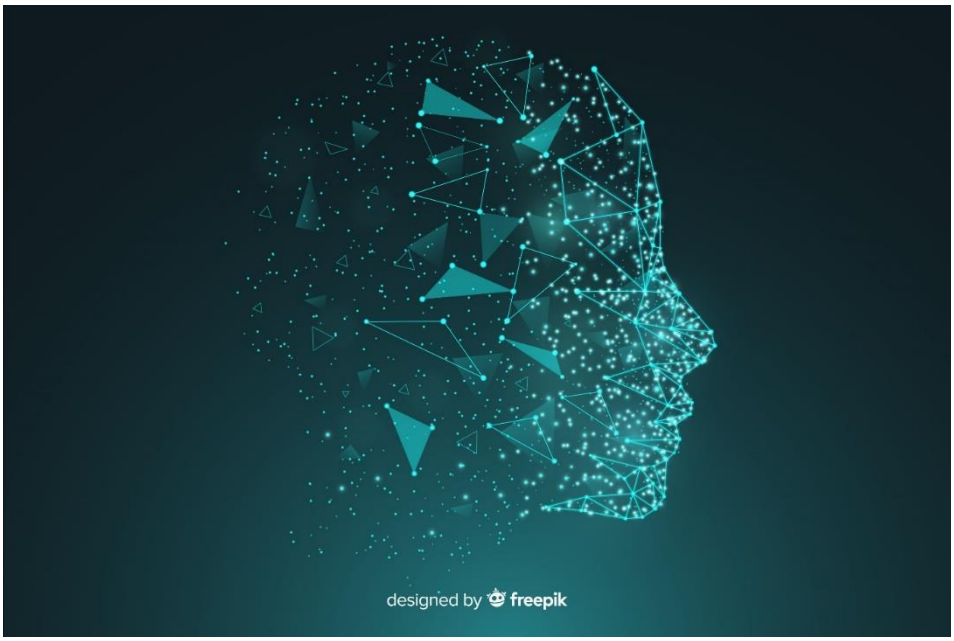

Figure 4, Source: https://pl.freepik.com/darmowe-wektory/tlo-twarzy-sztucznej-inteligencji_5513843.htm#page=1&query=Artificial%20Intelligence&position=1

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The benefits of implementing the Artificial Intelligence:

- Higher security - Artificial Intelligence enables analysis of historical data and current production data. One of the main problems that every company face is accidents in the workplace, which not only lead to damage to health but also involve high costs. By analysing the data, Artificial Intelligence is able to identify the sequence of incidents, warn of the risk of accidents and intervene.

- Production optimisation - Artificial Intelligence is able to identify the production element that is worth exploring and optimising. These can be costs related to energy consumption or less efficient machine operation for a specific activity.

- Prediction - Artificial Intelligence allows you to recognize the combination of conditions that cause failures and analyse actions that allow you to avoid them. Everything is done in real time, which allows to reduce the number of unplanned stoppages and breakdowns and to increase the production time of machines, thus increasing production.

- Introduction of new products and business solutions - Artificial Intelligence allows for the development of new solutions and the emergence of new applications that translate into increased business revenues.

- Better decision making – Systems using AI do not have their feelings, prejudices and interpretations, unlike people, so we can be sure that the decisions made by systems are not driven by emotions.

- Constant work - Artificially intelligent systems do not feel tired after work, unlike people who need rest for a certain period of time.

According to Harvard Business Review magazine, companies mainly use Artificial Intelligence to detect and prevent intrusion, solve technical problems, limit production management work and evaluate internal rules of cooperation with suppliers.

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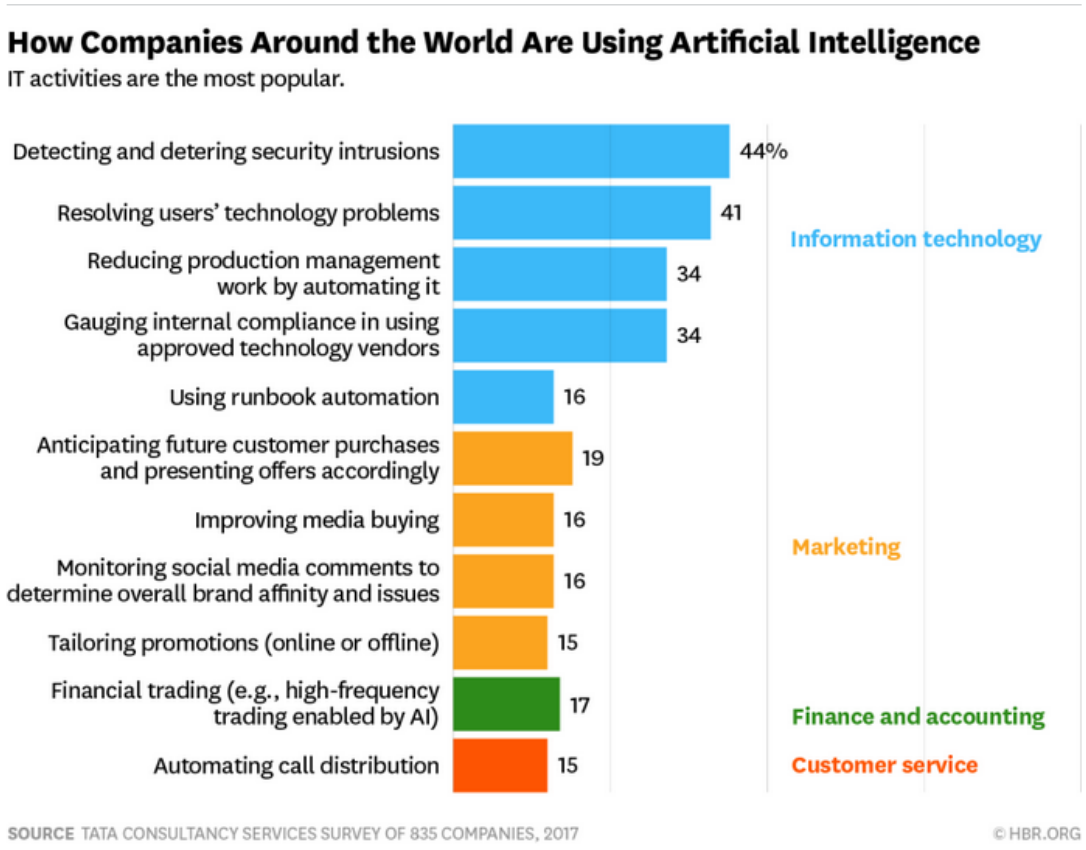

Figure 5. How companies around the word are using Artificial Intelligence

Source: https://hbr.org/2017/04/how-companies-are-already-using-ai

How we can use Artificial Intelligence in education?

One of the first areas of application of artificial intelligence was medicine. Over the last decade, the implementation of artificial intelligence into education has been based on reasoning, planning and language processing. An example of AI in education is Intelligent Tutor Systems, which is a computer software designed to simulate the behaviour of lecturers and to give appropriate guidance. The software is able to track the stages of learning, diagnose misconceptions and estimate the user's understanding of the problem. Another advantage of this software is that the tasks are adapted to the learner at the appropriate level with appropriate content. Programmes that use this software include Tabtor or Carnegie Learning.

Using Artificial Intelligence in education:

Educational platforms

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Many educational platforms are increasingly investing in Artificial Intelligence to provide the most personalised courses for their students. These platforms allow you to create individual tests, instructions and feedback. With such platforms, students fill in their knowledge gaps.

Today's intelligence development also allows for scanning and analysing student facial expressions, based on which the platform can change the lesson/level according to students' needs.

Global Learning

By using Artificial Intelligence in education, students from all over the world have the opportunity to share their knowledge. This is possible thanks to courses and training programmes that are available on the platforms and have interactive learning materials from the best teachers.

Voice Assistants

Voice assistants allow you to use different learning materials without communicating with the teacher. They allow students to use the platform at any time and in any place. Examples: Apple Siri, Google Home.

Smart Content

Educational materials such as digital manuals or interfaces that are tailored to the user.

To sum up, there are many solutions based on artificial intelligence that improve the field of education. This industry is quite promising because of the incredible opportunities for development.

Some educational applications using AI:

Duolingo – one of the most popular language learning applications. It offers the possibility of text chatting with native speakers whose role has been taken on by artificial intelligence. Using language learning bots can be a much simpler and less stressful solution for students, because they do not talk to a real person. The Artificial Intelligence chat application is available on iOS smartphones. Chatting with boots is possible in three languages: Spanish, French and German.

Brainly – is an educational community for mutual Q&A learning. Students and teachers can ask questions on a topic that interests them and get answers.

iTalk2Learn - iTalk2Learn is an interdisciplinary project combining knowledge of machine learning, user modelling, intelligent learning systems, natural language processing, educational psychology and mathematical education.

What skills are needed to teach pupils with the use of Artificial Intelligence concept in the classroom?

The main competences that are needed to teach students with Artificial Intelligence are digital competences that relate to the conscious and critical use of digital technologies. These competences enable information acquisition, communication and basic problem solving in all aspects of life.

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Digital competences also mean the ability to use digital content, to use technology in a curious and open way, to filter digital content, to programme, to make it available and to take an ethical and responsible approach to using digital tools.

Many teachers are convinced that students have no problem with using new technologies, so they give up using ICT in their lessons, and this may also be due to routine and habituation to traditional teaching methods. Teachers who use modern technologies efficiently and apply them in class have significant benefits and are able to develop these competences among their students. Teachers who have difficulty implementing Artificial Intelligence in teaching can benefit from workshops or online training, which are now very popular. For example, the IBM team has developed the Edzia system, which provides teachers with proven information so that they do not have to search the Internet to find the answer to a question that interests them.

In the light of the current situation caused by the COVID-19 pandemic, it is very important that teachers continue to develop digital competences, which greatly facilitates their work with young people.

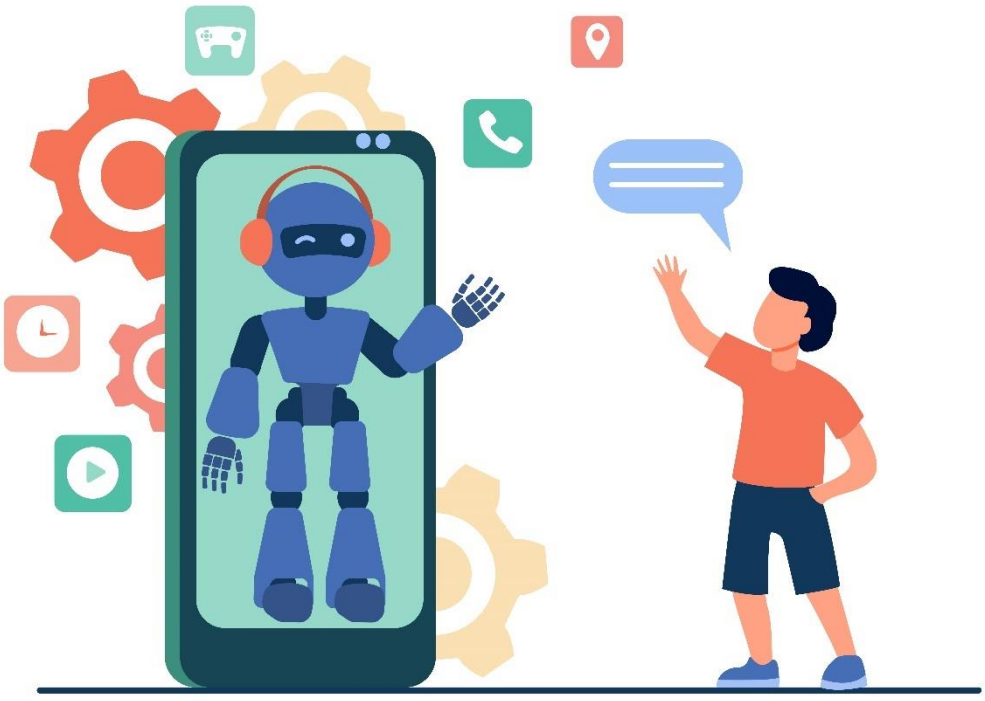

Figure 6. Source: https://pl.freepik.com/darmowe-wektory/chlopiec-macha-na-czesc-humanoida-na-ekranie-smartfona-czat-bot-wirtualny-asystent-ilustracja-wektorowa-plaski-telefon-komorkowy-technologia-dziecinstwo_10172418.htm#page=1&query=voice%20assistant&position=17

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Possible benefits of use Artificial Intelligence in education

Over the last few years, attempts have been made to introduce modern technologies into education, including through the introduction of digital textbooks, iPad schools in the Netherlands and closed tablet systems in the United States. However, the potential of artificial intelligence in education has not yet been fully exploited.

Each student is different - they have different abilities, motivations, problems and learning styles. The problem of today's education is that the education system is not adapted to this diversity and often the potential of students is not used. Teachers who have limited class time are not able to personalize the learning process of every student in their class, so AI algorithms will be very helpful here.

Artificial intelligence can provide a better learning experience by adapting learning to each student's needs and ensuring universal access to students. It can also automate grading systems and provide additional support for students, depending on their needs.

Thanks to recent developments in the field of artificial intelligence, computers are able to perform complex tasks and their algorithm is developed through self-teaching. In education, the system is not able to replace the teacher, but it can improve their skills in the educational process.

Let us see how we can apply Artificial Intelligence in education, how Artificial Intelligence can improve the education process and what benefits will be gained by students and teachers who use it.

Algorithms personalising the learning process - These algorithms are used in many e-learning platforms and educational services. Teaching personalisation modules allow us to match educational materials to our interests, profile, format or previous training history. What is more, the algorithms are capable of analysing competence gaps and recommending actions to fill them.

Education anytime and anywhere - Students increasingly carry out their tasks using their smartphones. Applications based on Artificial Intelligence allow learning in their free time. In addition, thanks to some applications, students can get real-time feedback.

Virtual mentors – Virtual mentors have the ability to track students' progress in real time.

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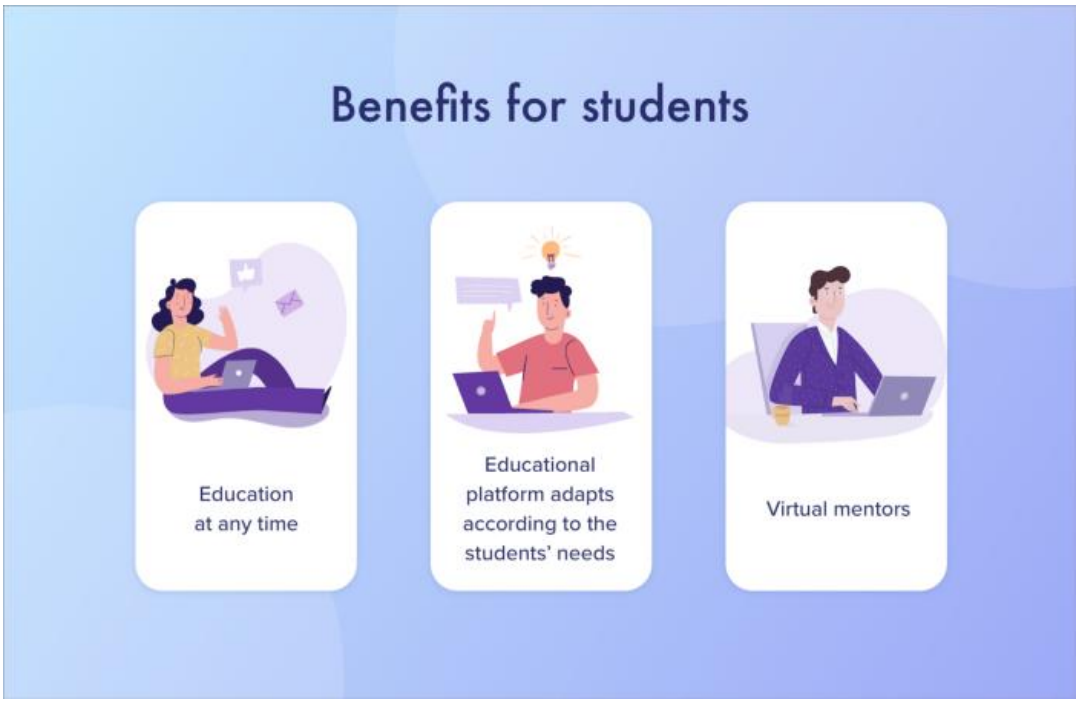

Figure 7. Benefits for students

Source: https://medium.com/towards-artificial-intelligence/artificial-intelligence-in-education-benefits-challenges-and-use-cases-db52d8921f7a

Automation of training processes - people involved in training know very well how much time it takes to report and analyse data for training. Intelligent algorithms can monitor users' reports and analyse the data they provide, so it is worth using them so that the person responsible for this task can do more creative things.

The use of authoring devices - tools appear on the market which, with a little human help, can create tests and even online training.

Ability to detect weaknesses - Training courses help to detect gaps in student knowledge.

Curriculum automatic creating - Teachers who use Artificial Intelligence in the teaching process do not need to create the curriculum from scratch.

Better engagement - Thanks to the interactive learning process, students are more involved in the classes.

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Figure 8. Benefits for schools and teachers.

Source: https://medium.com/towards-artificial-intelligence/artificial-intelligence-in-education-benefits-challenges-and-use-cases-db52d8921f7a

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3D Printing

Learning outcomes

After the teachers get acquainted with the theoretical part of the Module "3D printing", **they will**:

- learn more about 3D printing and FDM method
- learn about the 3D printing process
- learn about the advantages and disadvantages of using the above technologies
- be able to introduce elements of 3D printing in their didactic approaches.

Introduction

3D printing is a technology that enters our everyday life. The implementation of both design and construction tasks, including the optimization of solutions and the aspect of quick presentation of the selected model, is applicable not only in workplaces but can also be largely used in school. The scope of the use of 3D printing is practically inorganic from the presentation of models on technical subjects, through the printing of models, for example, atoms on an object such as chemistry, models of geometric figures in mathematics.

What is missing in this field is the need to present and show the possibilities of 3D printing to help understand that mastering this technology is not impossible, and the potential it gives is something very helpful in education.

What is 3D printing?

3D printing is the general term for a set of technologies of incremental creation to make three-dimensional objects from a digital file. There are many printing methods available on the market. We can distinguish 6 types of technologies available on the market:

• FDM (3D printing from thermoplastics - deposition of molten material), in this method the working head spreads a fiber of thermoplastic material heated to a semi-liquid state on individual layers within the cross-section of the workpiece.

• light-curing resins (SLA, DLP, PolyJet / MJP, others), a very accurate method consisting in drawing a liquid polymer on the surface and hardening subsequent sections of the element using a beam of ultraviolet laser light.

• CJP (3D printing from gypsum powders in full color)

• SLS and MJF - 3D printing from powdered plastics that are point glued and welded, applied layer by layer on a given cross-section. The advantage is that there is no need for supports as their role is played by the powder.

• SLM, DMP, DMLS and EBM - 3D printing from powdered metals which are then laser welded

• LOM - 3D printing from foil or paper

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Most of the presented technologies are not possible to use in school settings due to their complexity and too high costs with special requirements. The technology that is currently suitable for use in school is FDM (Fused Deposition Modeling) printing, currently the most popular 3D printing method in the world. This technology is suitable for understanding 3D printing and entering the stage of presenting a computer model and then a real solid.

Methodology of work during 3D printing

Regardless of which printing technology you choose to use, some things are constant.

We include here:

• Necessity to use a computer,

• finding or creating a 3D model,

• having software to convert the model into a readable format for a given printer,

• having a 3D printer and raw materials on the basis of which we will make our model.

The 3D process itself can be divided into 6 stages:

1. Finding or making a 3D model

In order to make a design in the form of a 3D model, it is necessary to use specialized spatial modeling software. For this purpose, we can use professional software such as SolidWorks, Autodesk Inventor, open-source FreeCad, or even a free browser-based application, such as TINKERCAD (https://www.tinkercad.com/)

An overview of the various tools (including free tools) can be found on Shapeways - http://www.shapeways.com/creator/tools?li=nav. The only program criterion that must meet is the ability to save the model in * .STL format.

In addition to the aforementioned software and automatic model execution, we have two more options. One of them is the use of wizards to change 2D models to 3D. The second option is to use the pages where we can find libraries of models intended for 3D printing. On many of these sites, like Thingiverse, people share their projects. There are also quite substantial databases with free models ready for printing.

2. Translating the three-dimensional model into a model understandable for the printer (most often it is a file with the extension * .STL)

STL format - is a writing standard supported by most 3D design applications. In this format, the model is saved in the form of triangles in three-dimensional space. Models in STL format are solids whose surfaces are made of triangles. Its simplest form is a quadrilateral, which always consists of four triangles, each of them being an entire wall at the same time. Thanks to this, the file size does

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not depend on the size of the model but on the complicated form. This format is the basis for working with all types of 3D printers.

3. Cutting into layers

Before this task, having saved the model in the STL file, you should position and set the orientation of the 3D model on the work table, then you can use the slicer program (slice - in English). There are many programs on the market that allow you to do this. This type of tool is for example Slic3r but not only. The task of the software is to convert the object from the STL file to the format understood by the printer. This is done by converting the model into individual layers. The idea in each of the programs is similar, while the individual software will differ in the way it is used

4. Generating a G-code that will contain a tool path layer by layer with previously selected 3D printing parameters, such as material, temperature, cooling, speeds, layer thickness, etc.

G-cod is the result of writing instructions for the printer, allowing it to understand how our model should be made. It contains all the parameters in which the print is to be made along with paths for each layer.

Sample G-cod

```
G1 X17.274 Y82.376 E28.83269
G1 X17.669 Y76.785 E29.11232
G1 X17.748 Y71.136 E29.39418
G1 X17.509 Y65.544 E29.67342
G1 X16.953 Y59.952 E29.95378
G1 X16.081 Y54.396 E30.23436
G1 X15.572 Y51.811 E30.3658
G1 X15.561 Y51.693 E30.37172
G1 X15.562 Y36.324 E31.13848
G0 F1800 X15.962 Y36.324
G1 F900 X16.024 Y36.176 E31.14648
G1 X39.095 Y13.105 E32.77427
```

5. Launching G-code on a 3D printer

The generated G-cod is sent to the printer's memory via a USB cable, SD card or wireless connection, depending on the printer configuration.

6. After printing, the part is finished (cleaned, polished, painted).

In this operation, the supporting structures should be removed with, for example, a knife or pliers, and the edge of the model used to eliminate warping of the model should be removed. It is possible to fill the gaps in the printing with materials such as epoxy resin, body putty, ABS and acetone mixture, polish the surface of the part by grinding, and steam or chemical smoothing to melt the layer lines and give a shiny appearance to 3D printed objects. Acetone is often used for PLA and ABS printed objects.

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7. Finally, we can paint with a brush, airbrush or spray, and coat our model with epoxy resin or metal.

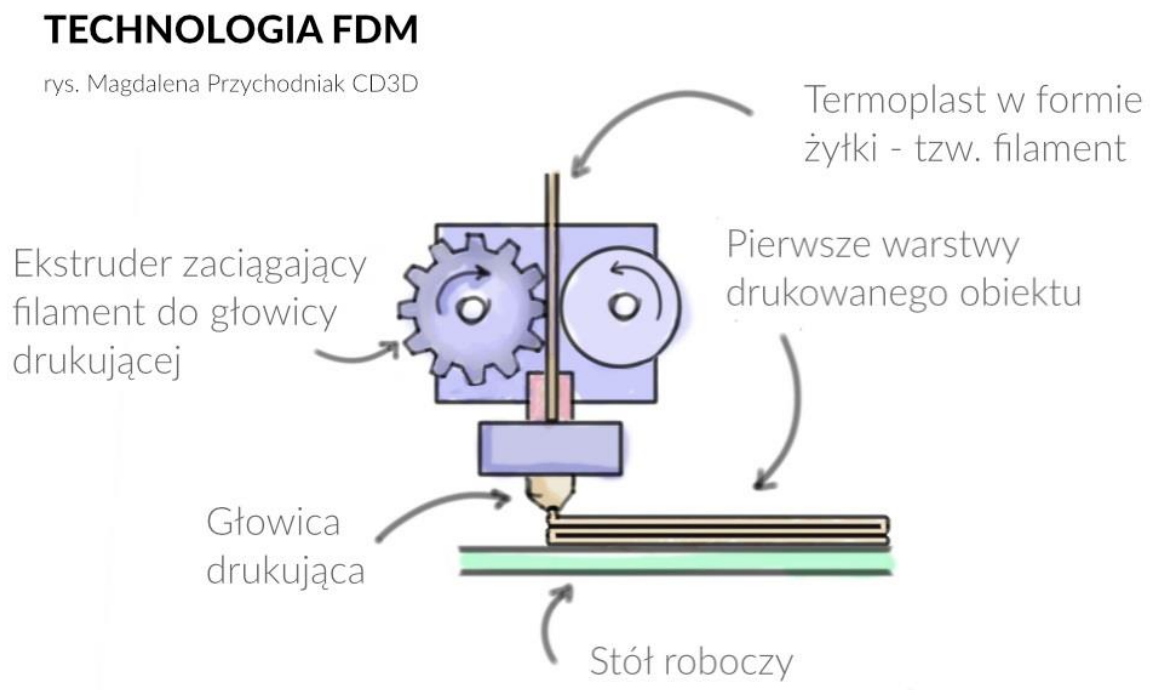
What is the FDM method?

The main reason for the creation of 3D printing and the association with it and the use of FDM technology in it was the rapid creation of prototypes at low-budget expenditures available to the average person. Thanks to this technology and making it available to a wide group of users, it began to be improved and used to produce final models.

FDM technology, i.e. one of the incremental printing techniques that uses thermoplastics in the printing process, the characteristic feature of which is the extrusion of material from the printing heads. Models created thanks to this technology are made of plastics (in the form of a line with a constant diameter), forming the geometry by heating the material to a semi-plastic state and then pushing it through the printer nozzle. The "filament" that is pushed out, as it is popularly called, has a diameter of 1.75mm to 2.85mm and is unwound from a spool suspended on the printer. Currently, FDM technology is the most widely used among all incremental methods in the world. It uses materials such as ABS, ASA, PC, PC-ABS and ULTEM. The first developers of the FDM technology is Stratasys®, as an alternative name FFF (Fused Filament Fabrication) was introduced.

The principle of operation of the FDM / FFF technology

The filament (the material used for printing) is introduced by an extruder consisting of a gear and a bearing. In between, the material line travels to the print head thanks to the stepper motor that moves the gear.



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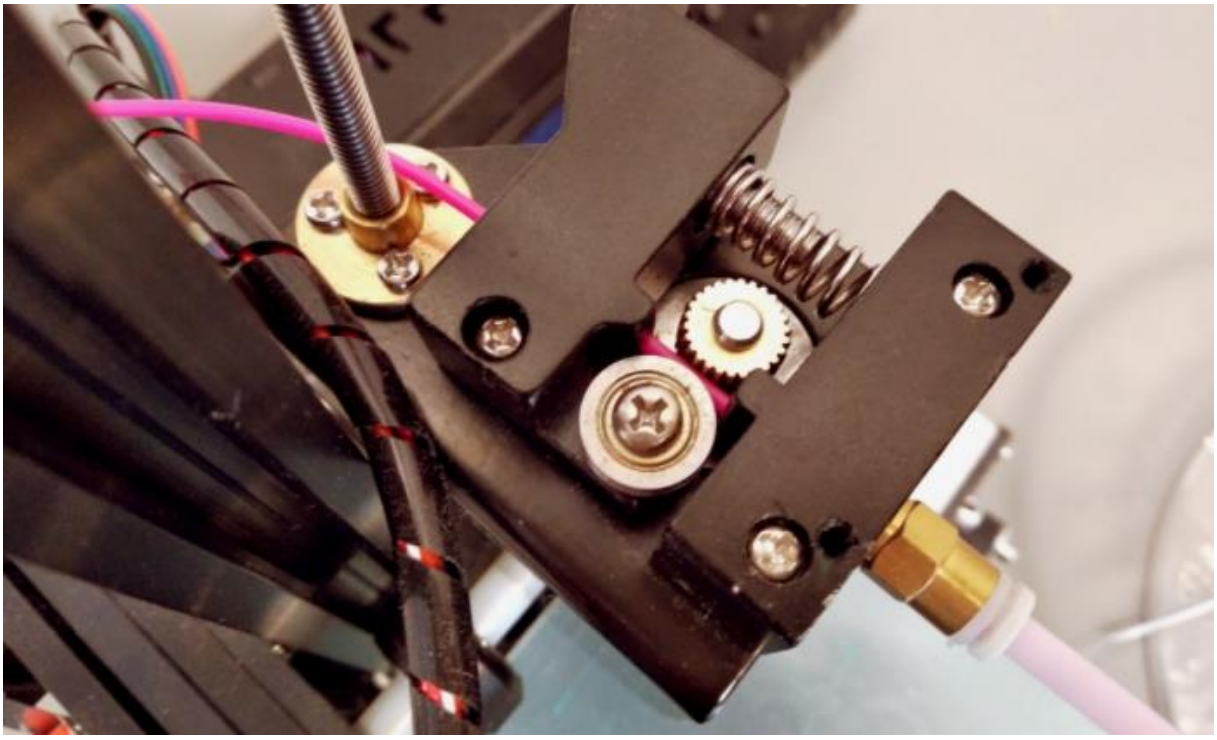
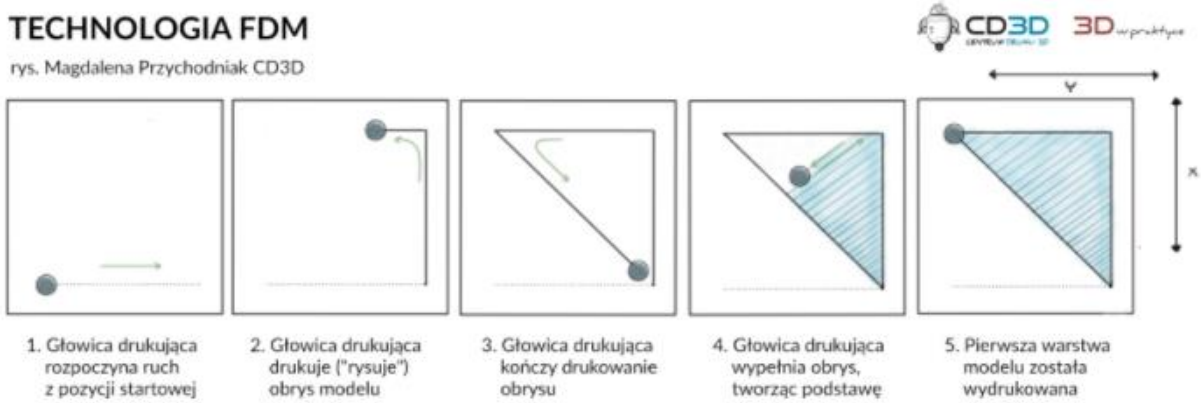


The print head reaches the temperature needed to make the material semi-plastic. For most 3D printers, the temperatures range from 190 ° C to 220 ° C - however, it depends on the type of filament used. The semi-fluid material does not drip as it could be in a liquid state and allows you to "draw" a given shape on the work table. Depending on the printer model, the print head moves in the XY plane and the heatbed moves in the Z axis or the printhead moves in the Z plane and the heatbed moves in the XY axes. When drawing on the plotter principle, the first layer of our model is created.

The method of creating layers depends on the needs of the model and is determined by the user.



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Performing the first layer completely lowers the model along the Z axis or raises the head along the Z axis. Thanks to this, by applying layer by layer, a three-dimensional model is created. After printing is finished, we remove our solid from the heatbed.

What materials are used in the FDM method?

The big advantage of FDM / FFF printing is the possibility of using a wide range of filaments depending on what we need to get and what our budget is. It is the materials that largely determine the properties of the printed model. One of the most popular materials used in the 3D printing method is ABS and PLA (material based on organic compounds). Equally popular are nylon used for the production of ropes, PETG used in the production of plastic bottles or TPU which is a material resembling rubber.

Due to the fact that the materials of the same type are used in mass production on industrial injection molding machines, FDM printing has the ability to obtain similar physical and chemical properties to the final product. However, its advantage is the ability to create individual pieces, which in the case of injection molding machines is unprofitable.

Filaments available on the market are offered in different colors, so it depends on our choice and the printer's capabilities (one or two heads or making a pause while printing and replacing the filament), how many colors and what our model will be built

Below is a brief description of the most popular materials used in FDM printing technology:

Material	**Properities**
ABS	- good strength properties - good thermal resistance - deformability
Nylon (PA)	- very good strength properties - high resistance to abrasive wear and chemicals - low resistance to moisture
PC	- high accuracy - very good strength properties - rigid and abrasion-resistant components after printing
ABS-ESD7	- dissipates charges (antistatic) - ideal for electronics housings
ULTEM	- very good strength properties - fire resistance and resistance to chemicals - High price

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Advantages and disadvantages of FDM technology:

Advantages	Disadvantages
+ a very economical method of production from thermoplastic elements, the additional advantage of which is the fast pace of construction and low material losses **+ possibility of making prototypes from a wide range of plastics in various colors** **+ very economical construction of elements made of thermoplastics** **+ short time of making a model, both a functional prototype and creating a conceptual model** **+ possibility of printing the model in office conditions** **+ exploitation of high dimensional accuracy + - 0.15 to + -0.3mm**	- the need to avoid large flat surfaces and thin elements due to susceptibility to deformation, - although the elements are characterized by high strength in the Z axis, they are fragile in the XY axis, which means that this technology is rarely used for mechanically heavily loaded components, - lower dimensional accuracy for elements with complex and geometrically complex shapes compared to other machining methods - in order to remove the visible lines of printing of subsequent layers of material, additional processing of the model is necessary

Classes of FDM 3D printers

Currently, the market is dominated by FDM printers, which meant that this type has become synonymous with 3D printing, despite the fact that there are many more types of incremental methods on the market.

The number of FDM printers on the market is currently countless, which causes considerable problems for an ordinary user with the choice of a model. Printers can be divided into classes that we can buy from 100 Euro to even several hundred thousand Euro. The simplest division is into categories:

- amateur
- desktop
- professional
- production

Each is suitable for a different element, is designated for a different thing, has a different functionality and potentiality.

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Amateur 3D printers are designed to print using PLA, ABS materials and used at home, school and in small business. They cost from 100 to 1300 euro. They are used by hobbyists, pupils, students or entrepreneurs with a low budget. They are also suitable for schools to be presented while gaining knowledge by students. They are on the market to be self-assembled , but the quality is rather poor. It is worth checking whether there is possibility to print out using filament from different producers or only dedicated filament.

Summarising, thanks to such printers the users can enter the world of 3D printing.

Desktop Printers are mainly designed for schools, universities and business, used by students and entrepreteurs. The price is from 1000 to 10000 euro. You can print using PLA, ABS, PETG, HIPS materials, nylon and other materials.

Such devices are suitable for education. They often have their own software. The main advantage of these printers is more automated process of 3D printing less human's work with the settings. Thanks to it and more advanced parameters the quality of printing is higher in comparison with amateur devices.

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Professional 3D printers are devices to be used for professional purpose, especially at universities, for big business in an industrial area. Scientists, engineers in factories use them. You can print using PLA, ABS, PETG, HIPS materials, nylon and high-temperature materials (e.g. PEEK). Their main advantages are closed and heated beds, two heads which are suitable for working several dozen hours non-stop. The price is over 10000 euro.

3D production printer desinged for big business and industrial area. Tha main users are engineers i factories. The material used are PLA, ABS, PETG, HIPS, nylon as well as high-temperature such as PEEK and ULTEM. They cost from 50 000 euro.

Despite unnoticed differences between the described production printers, they are especially designed for the heavy industry, mainly aviation as it has certificates and meets the standards.

Parts of an amateur and desktop 3D FDM type

Depending on the class and price the design of the printers can differ. However, some elements are common:

the frame is the chassis of the 3D printer. It holds the other components together and is directly responsible for the stability and durability of the machine. It can be divided into closed or open.

Claw for the filament – the part with consumable material, it is not so important but the access to this place must be easy.

extruder – a mechanism pushing the filament into the hot end.

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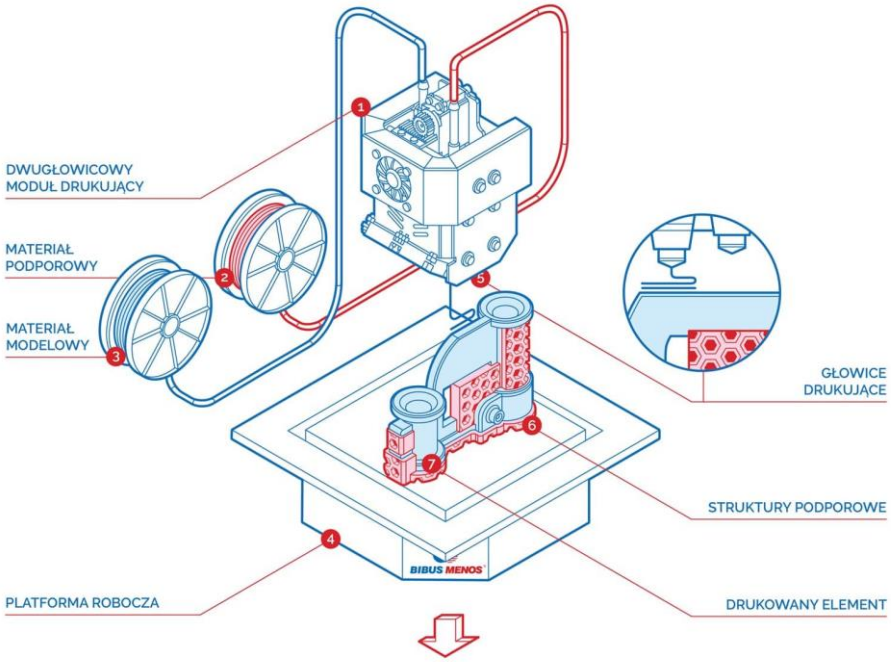
nozzle – it is located at the end of the hot end. It is where the melted filament comes out. It comes in different sizes, the smaller the nozzle, the higher the print detail.

the print bed – it helps the object being printed stick to the platform and allows for easier removal of completed objects.



3D printing in education

3D printing can be used in many areas, at home, in education, industry, throughout the whole production chain starting with prototypes and ending with the management of spare parts. FDM printing technology is becoming more and more popular among hobbyists and in education as well as it is used for professional purpose. Its popularity and fast development can be owed to affordable technology.

More and more frequent 3D printing implementation in school curriculum, using it in university libraries, in schools for adults makes it crucial to educate teachers about the technology and help them use the 3D printing during lessons. Lack of teachers' knowledge about 3D printing may result in difficulties to integrate educational system with 3D printing.

Teaching about 3D printing to students allows gaining the knowledge freely and in a more realistic way as well as it helps them to look at the model more spatially. Getting the students interested in

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3D printing technology will help to acknowledge them with 3D design, learn about the 3D software processes, and encourage them to further self-development.

Thanks to this technology, students can learn problem solving techniques, team work and look for theoretical solutions in practice.

This technology allows to understand different subjects in an easier way starting with the structure of the atom, biological particles, geometry, material properties, element construction technology, elements of machines.

We can show our students didactic materials connected with anatomy, physics, science, geography and other fields. By printing out model before or during a lesson, we are able to see for example elements of our national heritage. Getting models of the atom or a different thing is also cheaper than the models available on the market and they can be made immediately.

Schools start implementing this technology to their curriculum and will still do it because it allows to get the students ready for future lessons. It helps us to show the topic in a more accessible way, also to students with special needs.

Teachers have access to a lot of free educational platforms with ready model to be used during lessons. It is an opportunity to make lessons more interesting and help students gain knowledge.

3D printing has a great potential in education. It makes the teaching process easier, it develops students' skills, their creativity, it helps them understand science subjects. If we increase teachers' involvement, students'' interest and engagement increases as well.

Any difficult topics become easier to be presented which involves the students in a particular field of study. If a students is makes something with his/her hands, he/she can create something, touch it, it is easier to explain the results of his/her efforts.

This technology allows an interaction with the process of learning which is opposed to a passive way of teaching. Students may experiment, design things and use their senses. They can discover their talents, develop critical thinking and problem solving. In this way they perceive mistakes not as a failure but as a way to overcome difficulties and improve. It also a good way to understand the topic and remember new information.

Doing experiments allows them to solve problems using a trial and error method and it builds innovation and creativity. It also facilitates remembering facts and drawing conclusions. It is a way of teaching that encourages thinking.

For teachers it as a new tool which gives a lot of opportunities and makes course books much more interesting. Students are aware and understand better the link between real objects with those presented in books or publications.

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It provides opportunities to practise and getting to know new learning styles. It helps to understand such things as 'learning through action', 'learning through experiencing and making mistakes' and 'having fun while learning'.

It is worth mentioning that 3D can inspire the next generations of engineers, architects and designers. It can also help students who struggle with traditional learning theories and topics shown in books. Students become smarter and effective while working with physical objects.

3D printers can bridge the gap between public research and art, improving the way of learning and students' productivity.

This technology gives new opportunities of learning, allows students to see how their concepts become reality. It allows a proper interaction between a student and a teacher.

It is part of our future, not only in our personal but also professional lives, that is why it is crucial to implement it in school and education.

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5. Focus groups

Project Teacher 4.0 assumptions are based on the results from a survey carried out within a specially selected Focus Group. Focus Group is a qualitative study method that is used to collect in-depth data for small sample studies. In case of an international project like this one, interviews were conducted in all the countries partnering in the creation of the program. Participants of the Focus Group in the Project Teacher 4.0 were representatives of important educational occupations like school founders, supervisors, internal and external school evaluation conductors, scientists, university teachers, initial and in-service teacher training providers and participants from associated partners. Focus Groups took part in a survey during the workshops, where they could all share their experiences, suggest changes in the program and give their opinions on the matter. Afterwards, from every participating country there was a report developed. Reports included findings of the workshops and summarization of conclusions.

Workshop for the Focus Group method in the Project pertained to seven questions that were discussed and analysed under the supervision of the meeting moderator and moderator's assistant. These are the questions mentioned:
Q1: Is Industry 4.0 included in the core curricula of primary schools and secondary schools in your country? What is your opinion on this?
Q2: Is augmented reality the right direction for extending the didactic approach that school can offer? Please justify your opinion.
Q3:Do you use cloud computing within the structures of your institution as the main source of information? How is cloud computing (data storage, sharing or making available information via online channels, including clouds) beneficial in the education sector?
Q4: How do you in general assess the level of cybersecurity regarding school websites/platforms? What improvements could be introduced in this respect?
Q5: How much do you know about the concept of a Digital Twin? With the knowledge/skills/competence you possess, could you recommend this way of digital prototyping to your peers?
Q6: How is the concept of robotics addressed in the sector of education in your country? Do schools in your country use collaborative robots in education?
Q7: In which sense can artificial intelligence take a role of a classmate?

Summarized results from the workshops and survey are the following:

Q1: Industry 4.0 is included in the schools curricula in secondary schools. Usually in a form of a partnership between the school and companies that use modern technologies. Through that partnerships it is more likely to educate qualified industry workers. This cooperation seems a natural

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step towards modernization of the educational systems. Although this model of training already exist, there is room for improvement and development.

Q2: Augmented reality aids in presentation and enables to show almost everything via modern technologies available to most people. Therefore it is considered to be a future of education in most fields. Education could easily use all the advantages offered by AR – the emotional ant technical ones at the same time.

Q3: Participants usually use cloud computing but it is not the main source of information for them. Advantages from using it are mainly: easy access to the data from different devices, eliminating the need to collect data on personal equipment, easing sharing and accessing data with co-workers, preventing from loosing the data in case of equipment malfunction, backup in case of deleting the important data.

Q4: The level of cybersecurity of the school websites is considered good. Access to the important personal data is protected by passwords. Generally there no major problems with the functioning of the system.

Q5: A Digital Twin is a dynamic model of a real object, system or process. It could be a product, technical installation or even a whole factory. Data from a Digital Twin can assist the decision making proses and through this help immensely the operators. Since it expedites production and at the same time lowers its costs, it seems to be a good idea to incorporate it in education also.

Q6: Usually this takes form of training courses, school projects, workshops for children, additional classes in schools organized by the teachers. The source of information for the teachers are mainly websites that offer schooling for the educational stuff and pre-prepared lesson plans. Schools use collaborative robots, there are platforms in existence, offering robotic courses for teachers.

Q7: Artificial intelligence is not considered to be a classmate, rather an assistant. It matches educational materials to the interest of the user, his or hers preferences or level of education. There is a big potential in combination of human skills and possibilities of artificial intelligence. Because this collaboration is widely used by the industry, it should also be incorporated in education. This way pupils – future workers can be prepared for the demands of the labour market.

6. The impact of the project on the Teachers involved.

Project Teacher 4.0 involves the targeted teachers at every stage of development of its results (specific objectives and intellectual outputs). Simultaneously it greatly enhance their competences related to the concept of industry 4.0. This will certainly contribute to strengthening of the profile of

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non-IT teachers profession, and make teachers career more attractive to peruse. Shifting from traditional teaching methods towards more innovative ones is unavoidable. It is very important that teachers feel secure and unhampered while the educational system changes. Project Teacher 4.0 enables them to learn about the aspect of IT innovations that most probably are or will consider them in the near future.

Education through modern means is much more effective, simply because it is more attractive for the students. They grew up surrounded by technology and expect to learn more about it. By letting the educators feel natural in that kind of surrounding, Project 4.0 helps them work more efficiently and educate better.

7. Justification

Teacher 4.0 is the only Erasmus + project that corresponds with the Industry 4.0 and non-IT subject teachers. It will contribute to solving one of the main problems in primary and secondary school education: the shortage of teachers' competences by integrating innovative ICT into the teaching process. Through this it will also resolve problems like low motivation of pupils to learn, under-achievement in science subjects, lack of good practices dealing with diverse groups of pupils using modern technologies in classroom and much more.

The project also corresponds with the horizontal priority related to open and innovative practises in a digital area by promoting innovative methods, technologies and pedagogies. Exemplary result for this statement is developing models and lesson plans that incorporate concept of Industry 4.0.

The need for Project 4.0 and others alike is noticeable. Benefits of the project will be seen in not so distant future. It is crucial to learn and draw conclusions from ideas like that and build better modern education for future generations in Europe.

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