

The Potential of Augmented Reality to Transform Education into Smart Education

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Abstract – Modern society strives to make its world smart. The role of education in this process is to meet the challenges of the changing world and prepare learners to become fully integrated members of society. Objects of research of the current work are innovative and effective tools and technologies that can transform education. They allow to create an environment where the training is consistent with the needs and characteristics of digital learners and present-day society. The specific purpose of the work is to reveal the potential of Augmented Reality to transform education into Smart education.

Keywords – Smart education, Digital natives, Augmented Reality, Smart things and technologies.

1. Introduction

The role and power of digital technologies in contemporary world is recognized. They provide comprehensive access to information and knowledge.

The education system must respond to the stage of society's development and be in line with its needs and characteristics to prepare adolescents to be fully integrated members of community. In the modern

information world, the role of ICT in education is very important since they create conditions for ubiquity and accessibility of education. The new technologies, combined with advanced pedagogical tools and practices, enable the creation of an innovative digital learning environment where collaborative work and interaction between learners are possible. Education becomes more engaging and interesting for students and provokes them to participate actively in the learning process. As a result, the quality and efficiency of training is improved.

Recently, there has been a widespread penetration of smart things and technologies. They can help society to use natural resources in the most effective way, ensure a sustainable lifestyle and sustainable business models. The ideas for building smart homes, smart cities, smart society are becoming more and more relevant. An important component of the idea of smart society is smart education.

The main goal of smart education is to harness the potential of smart things and intelligent technologies to create an environment where the training is consistent with the needs and characteristics of the new digital learners and modern society. Smart technologies change the learning and teaching processes. They support the development of skills and competences for critical thinking and evaluation of alternatives in decision making. Using smart technologies, students can learn how to make decisions based on available information and knowledge rather than to remember predetermined solutions [1].

Many technologies can be defined as smart. But is it possible to integrate them successfully into the learning process and define them as smart educational technologies? Each technology has the potential to be a smart educational technology and to support, facilitate and improve the learning process through interactivity and learners' engagement [2]. When these goals are achieved, the learning process will become a smart learning process.

Augmented Reality is among the fastest growing technologies in recent years. It allows users to see

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and perceive the surrounding real world in a new more engaging and interactive way using their smart devices.

The purpose of the current work is to reveal the potential of the Augmented Reality technology for innovative digital transformation of education and turning it into smart education. The change is based not only on using this smart technology but above all on a significant change in the way learners acquire knowledge, participate in learning activities and have a new positive attitude towards their own learning.

2. When does the education become smart?

Children, born in the information society, are often called a digital or net generation and have a number of distinctive features that make them significantly different from previous generations. Their characteristics make them extremely interesting objects, which should be taken into account by the whole education system. The education system is changing in technical and technological aspects (the rapid development of technologies and their widespread introduction in the training process) as well as in pedagogical (new pedagogical approaches and paradigms compliant with learners' traits).

2.1. Digital natives

There are many definitions that describe today's young people (born after 1980), as one of the most commonly used is digital natives. They have grown up in an environment full of devices and tools from the digital era and are in permanent contact with them. The everyday use of digital devices affects the way the young people perceive and process information, the process of thinking and learning, and their ability to work in multitasking mode [3].

Digital natives is a broad concept. It cannot be categorically determined that anyone born at that time belongs to digital generation. Crucial factors include access to the Internet, used ICT, the environment in which these technologies are applied - everyday activities, social contacts, or learning process. Many researchers report in their studies that not every young person can handle modern technology as high as expected [4]. Therefore, a distinction between digital natives and digital learners should be made [5].

The undeniable fact is that the new generation, no matter whether it belongs to the group of digital learners or not, cannot be trained in the traditional ways. Teachers should adapt pedagogical approaches and implement new tools and technologies in the learning process in order to keep the relationship and

communication between them and learners. Digital learners impose new requirements and have different expectations about the training. A digital learning environment that is enriched with a variety of technologies is appropriate for them. The role of educators is to create an authentic environment, using available innovative technologies that learners perceive as their own natural background.

2.2. Smart things and technologies

Smart is an extremely popular term in recent years. Smart technologies, smart cities, smart homes are everyday words and how they can improve people's lives is the object of increasing interest. The term smart is most often associated with the concept Internet of Things (IoT).

Internet of Things is seen as a new stage in the evolution of the Internet. It is characterized by communication between devices, which results in huge amounts of data being generated. Collected data is processed, analyzed and transformed into information that can be disseminated [6]. All these processes are automated. A distinctive feature of the new stage in the development of the Internet is that the main and active players are the devices, which generate and use data [7].

According to Gartner IT Glossary [8] the Internet of Things is a concept for a network of physical objects that have embedded electronic devices that allow them to communicate, exchange data and interact with each other or with their surroundings. The physical devices react autonomously to the real world events. They can initiate processes that can run other actions with or without direct human intervention [9, 10].

The main advantages of the Internet of Things are communication, control and automation, less expense of financial resources and time, and productivity and they determine the widespread use of smart technologies in different spheres of life [11].

Most of smart things are ordinary things that perform new properties or behavior that are not normally available. These new qualities are manifested when the things are used in a given context or connected and utilized with other things. The word smart refers to additional functionality of the things, opportunity for interaction, reaction, or adaptation to given impact [12].

A distinction between smart things and smart technology is possible [12]. Smart things can change depending on the surrounding environment. Smart technologies can adapt to the surroundings and at the same time they can modify the environment that generated the changes.

2.3. Smart education

Modern society builds a digital world that aims to become a smart world. Society imposes new requirements on the education of adolescents so that they can fully integrate into it. The role of contemporary education is to equip learners with knowledge and skills as well as to prepare them to work with technologies inherent in digital era.

Modern training faces serious problems related to lack of interest and motivation of the learners and difficulties in retaining their attention [13]. The solutions require necessity of transition from the traditional approaches of memorizing learning content to opportunities for learners to analyze and evaluate information, stimulate their creativity and abilities for critical thinking and problem solving. There are many factors that distract learners and they can hardly focus on the content and activities that take place in the classroom. The main scattering agents are different smart devices and applications that are an integral part of the learners' daily lives.

An attractive, interesting and fun learning environment is needed, in order to keep students' attention on what happens in class, provide them with interactive, exciting and unforgettable experience and opportunities for active participation.

The question is: Is it possible all distracting factors to be turned into stimulating tools that actively engage learners in training? The answer is: Yes. Smart devices and technologies need to be integrated and become an integral part of the learning process since they are an integral part and accessory of the digital learners' life.

The education is among the domains that accept new technologies rapidly and develop and enrich by their integration. At the same time, the change of students' profiles raises the need for new pedagogical methods that integrate innovative ICT and modern approaches for their application.

There is an evolution in the terms that describe the role of integrated technologies in education: distance education, web-based education, e-learning, mobile, and so on. The combination "Smart education" has been increasingly used in recent years.

The pressing questions arise, such as: Is this combination of words possible?, What is the meaning of the combination "smart education"?, Is the formula: smart things and technologies + education = smart education possible?, Is it enough to use smart devices and technologies in the learning process to turn it into smart education?

There is no unambiguous definition of smart education in literary sources.

If the implemented technologies and tools predetermine the qualification of the training, the role of smart technologies is essential for transforming

education into smart education. Smart education can be defined as technically supported training by using connected devices and modern ICT [12]. The technologies create the environment where the learning process can be conducted. They provide: connectivity of people and devices and allow collaboration, interaction and communication; ubiquity, in terms of access to learning resources and learning environments for all, at any time and from any place; personalization of the learning experience for each learner [14].

Smart education is based on smart devices (IoT, artificial intelligence, wearable technology) and intelligent technologies such as cloud computing, big data and others. They allow the collection and analysis of data for learners' profiles, behavior and results, which are subsequently used to improve learning processes. Smart devices and intelligent technologies create learning environments that respond to each learner's profile and needs and offer conditions for realizing personalized and adaptive learning [15, 16].

On the other hand, smart education is not an education based on smart devices, it is a change of educational paradigms to the needs of the digital generation [17]. Smart devices and technologies are important prerequisites for creating a smart learning environment where the learning is directed to digital learners' needs and is designed according to their features.

The essence of smart education is the presence of an intelligent environment that uses intelligent technologies to facilitate intelligent pedagogy by providing personalized learning services to students [18]. An intelligent learning environment is a physical environment, enriched with digital, adaptive, context-sensitive devices, that is capable to promote more effective learning [19].

Smart learning environment is a technology-based medium that is capable to provide students' real-world learning, access and interaction with a variety of digital resources from all over the world at anytime and anywhere. The smart environment ensures the necessary learning tools, suggestions or help tips to the learners at the right time and place, in a form tailored to their individual needs [12, 15]. The adaptation of the environment is based on an analysis of learners' behavior and performance, as well as the context of the online and real situation [20].

An essential feature of a smart learning environment is its ability to adapt to the learner's needs. From this point of view, it is possible to make an analogy with adaptive learning environments where a learner profile is created and continually enriched and all his actions are recorded and tracked.

According to [20], three are the main features that define a learning environment as intelligent –

contextual-awareness, adaptive support and adaptive interface. The learning environment should be sensory and take into account both the context of the real world and the online status of the learners. [15] specifies that the location of learners in the real world is very important in order to allow the environment to adapt the learning content and situation to each of them. The environment should offer immediate and adaptive support to learners based on their individual needs and the virtual and real context in which they are located. The intelligent environment must be able to adapt the interface to the user – the form of learning content and the way it is delivered to learners depends on their preferences, style of learning, behavior and performance.

It is clear that the role of smart technologies is essential for transforming education into smart education. They lead to changes in the nature of the learning process, the roles, expectations and attitudes of all participants. New forms of learning, based on smart technologies, offer different roles to participants in training and relationships between them.

Smart technologies can not make the learning process easier, but they are able to make it more intriguing, interesting, attractive, stimulating the learners' strengths and provoking their abilities [12].

In conclusion, it can be summarized that smart education is a concept that describes training in the digital world, which is designed and adapted to the needs of the digital generation. Smart technologies and devices are the basis of smart education. They provide adaptability and personalization of the training and provoke learners' commitment, motivation and activity. The main goal of the integration of smart technologies and devices is to create a smart environment where training is consistent to the needs and characteristics of the new digital learners. Smart education can prepare the new generation to work with technologies inherent in the digital society and to be a part of the smart world that our society builds.

There are many technologies that help create a smart learning environment where smart education is possible. One of them is the promising Augmented Reality.

3. Augmented Reality – a tool for innovative digital transformation of education

Traditional methods for presenting and delivering learning content, such as lectures, lessons, seminars, can not spark an interest in today's digital learners. Standard pedagogical approaches consider learners as passive participants in the learning process, but for the digital generation this is an unacceptable position.

This is the reason for the negative results that traditional pedagogical approaches give.

In order to overcome the lack of interest and commitment to the training, modern technologies have to be integrated. They can transform the learning process by including elements of interaction, activities, entertainment, and etc.

Technologies always play a significant role in the education system, since they offer better opportunities for creating interactive, personalized learning materials and activities that are compliant with the specific needs and characteristics of learners. They can provoke motivation, learners' commitment to their own learning.

In recent years, Augmented Reality is considered to be one of the technologies able to change learning significantly.

3.1. Essence of Augmented Reality

Augmented Reality is a system with the following characteristics and features [21]:

- Combining real and virtual objects. The technology combines the virtual and real worlds by creating a common environment where the objects of both worlds coexist in the same place.
- Interactivity in real time. Users and virtual content are in an interaction mode. The virtual content responds to the users' actions.
- Virtual objects are registered in the physical 3D world. They are geometric aligned to the real-world objects.

Augmented Reality is an extension of the physical world that enriches it by adding layers of virtual content. Adding extra information to the real objects provides new opportunities for interaction between them and virtual objects. Augmented Reality does not replace the physical world, it complements and expands it.

Augmented Reality is the bridge between the physical and virtual worlds and removes the barrier between them. The technology blurs the boundaries between the real and digital worlds and as a result they mix and enrich each other. Augmented Reality improves the feeling of the real world and complements the reality with different sensory sensations.

Augmented Reality vs. Virtual Reality

Typically, the presentation and discussion of Augmented Reality is accompanied by its comparison with Virtual Reality.

The essence of Virtual Reality is the entirely replacement of the real world with a digitally recreated one. With Virtual Reality users immerse in a synthetic environment without the capability to interact with the physical world around them. Virtual Reality ensures that they are fully focused on the created environment, which turns the technology into a powerful digital content assimilation tool.

Augmented Reality also creates virtual objects, but in contrast to Virtual Reality, they do not aim to create a new reality and hide the physical world. Augmented Reality superimposes virtual objects on the real world and adds virtual details to the real objects. As a result, the technology expands and enriches the world around users, lets them stay connected with the surrounding world as well as interact with virtual content.

The most important advantage of Augmented Reality over Virtual Reality is the overcoming of the risk of social isolation and the lack of social skills and communication among users.

Types of Augmented Reality

Several criteria can be applied to the classification of Augmented Reality that reveals the rich capabilities of technology such as hardware and software.

The used hardware devices contribute to distinguish between the following types of Augmented Reality:

- **Stationary Augmented Reality Systems** – motionless systems equipped with more powerful cameras for accurately recognizing objects and scenes from the reality.
- **Spatial Augmented Reality Systems** – systems that project a virtual content directly on real-world objects in actual sizes and proportions.
- **Desktop Augmented Reality** – systems that use a computer camera to recognize objects from the reality and embed virtual objects or content to them.
- **Handheld Devices** – via their GPS capabilities the smart mobile devices are able to establish users' position and provide them up-to-date information in appropriate form like text, images, audio and video which is displayed and integrated into the real environment and directly related to their location.
- **Head-mounted Displays** – devices that visualize the combined image of real and virtual objects in front of the users' eyes.
- **Contact lenses** – the future of Augmented Reality. The process of development of contact lenses continues and they will allow users to

get a combined image of reality with embedded virtual content.

The way of identifying objects or scenes determines the following types of Augmented Reality:

- **Vision-based Augmented Reality.** Vision-based Augmented Reality can be marker-based and markerless. Augmented Reality is a marker-based when applications use the device camera to recognize and interpret markers. Usually, markers are black-and-white barcode images. The modern tools and applications allow to create color markers and integrate various shapes of their building elements. After analyzing the marker, the software creates virtual objects that are displayed on the device screen and integrated with the recognized real objects. The recognition of real-world objects (photographs, magazine covers, objects, faces, scenes, etc.) is known as a markerless Augmented Reality. The software recognizes the specific features of the real objects that distinguish them from the surrounding objects.
- **Location-based Augmented Reality.** Location-based Augmented Reality is a markerless Augmented Reality. Augmented Reality applications use GPS capabilities of the devices to determine the position of the device and its owner. After locating users, they provide up-to-date information about objects (hotels, restaurants, museums, etc.) near them.

Providing additional information about physical objects, which is not available at first glance, increases knowledge about the real world. Users become involved in a training process with access to a variety of information resources, including specially designed learning resources.

Augmented Reality has features that allow to be defined as a technology that helps transform education into smart education.

3.2. Augmented Reality – a tool for innovative digital transformation of education

Augmented Reality is a technology that allows the real and virtual world to mix and work in an integrated mode. Via Augmented Reality the gap between two worlds is filled up and a unified space is created – a mixed environment, where each real object is enriched with dynamically changing virtual content. Such a hybrid learning environment offers new ways of acquiring knowledge and skills [22]. Augmented Reality allows learners to interact with objects from both real and virtual world. Each new

interaction can cause a different response which is a source of new information and knowledge about them [23]. Learners can receive additional information that depends on their specific actions with the objects, so the delivered content is contextually dependent on the situation and the actions.

With Augmented Reality the printed materials can be enriched with digital multimedia information – audio, video, animation, 3D objects. Learning content becomes interactive, dynamic, contextually dependent, more interesting for learners, and easier to perceive and interpret. Augmented Reality offers opportunities to look at content from different perspectives, which is a prerequisite for deeper penetration into the essence of concepts and theories and their understanding. The technology overcomes the shortcomings of the static printed materials that do not involve interaction with readers and are based on passive knowledge transfer. Augmented Reality is a technology that is based on the two-way transfer of information and knowledge. The provided content is dynamic and there are opportunities for adding activities and tasks for learners. All these possibilities enhance students' interest in learning materials, which is a desirable effect in the era of the unwillingness of modern generation to read and use printed materials.

Augmented Reality allows the learning content to be adapted to learners' interests. Students interact with objects and receive timely additional information about them according to their choices and preferences. The learning environment can adapt not only the content of the learning materials but also the form of the delivered materials according to the students' needs and preferences – text messages, images, animations, 3D objects, etc.

Augmented Reality improves the perception of the real world with new sensations and perceptions, which is a prerequisite for a better understanding of the physical world and its processes [22]. Augmented Reality is an opportunity for learning in the real world that changes radically the way learners interact with the world around them. There are possibilities to manipulate and interact with objects, that is impossible in the physical world – for example, with molecules, atoms, planets, the globe, human organs and systems, and etc. With Augmented Reality students can actively participate in the learning process. They access learning materials through their own devices, actively explore nature, properties and behavior of the real and virtual objects and interact with them. The result is easier and quicker understanding of complex and abstract concepts [24].

Adding interactivity in the training strengthens students' interest, motivation and engagement to deepen knowledge.

The technology gives learners control over the actions of the objects (real and virtual) and over the process of interaction with them. Students can change position, size, shape, and other properties of virtual objects and their alignment with the real ones. Augmented Reality allows learners to experiment and discover properties and behavior of objects that cannot be achieved with traditional approaches. These options provoke learners' imagination, creative approach, reveal their cognitive and research abilities.

Augmented Reality is a technology that helps learners acquire practical skills through training in a mixed environment and simulations. Theoretical knowledge is the base but it is not enough for students to become experts in a given area. In order to be prepared for the real life and practice the learners have to develop their skills and to strive to reach the mastery. An innovative approach is to use Augmented Reality applications. They allow learners to work, manipulate and experiment with virtual object as well as with 3D models of real objects. Augmented Reality is a technology capable to recreate different situations and problems from the practice. Solving real tasks learners acquire practical skills and experience.

Augmented Reality increases the learners' motivation and engagement to educational process. Through technology students can master learning content easier and faster, deepen their knowledge by exploring objects from different perspectives. Augmented Reality has the potential to encourage learners to study content independently, follow their own research approach, and discover new properties, behaviors, and features of objects. The innovative technology attracts and inspires learners, stimulates their creativity and curiosity, provides the opportunity for interaction with abstract theories and concepts, experiments and deeply exploration of the objects, phenomena and processes that is not always possible or safe in the real research process [25].

Augmented Reality is an easy and intuitive to use technology that is essential to the learning process. Learners do not need to be trained how to use technology or its tools. They focus and concentrate on the content that is subject to observation and exploration. The result is an improved efficiency of the learning process.

It can be concluded that Augmented Reality is among the technologies that help creation of a smart learning environment. Table 1. summarizes the contribution of the technology for learners, learning environment, learning content and learning process.

Table 1. The advantages of Augmented Reality.

Advantages of Augmented Reality for:			
Learners	Learning Environment	Learning process	Learning content
Engagement to the learning process and responsibility for own learning	Hybrid environment that combines the virtual and real world	Learning by games, by doing, gamification, discovery-based learning	Integrated multimedia elements
Increased motivation and satisfaction from achievements	Stimulates creativity and curiosity	Engaging, connected to the real world	Interactive activities and tasks for learners
Positive attitude towards the learning process	Contextual awareness	Interactive learning approaches	Dynamic Contextually dependent
Easier perception of complex and abstract concepts	Collaboration between participants in the learning process	Active two-way transfer of knowledge	Adapted to learners' interests
Development of practical skills	Facilitated communication	Two-way interaction	
Usage of all senses in perception and understanding of information	Adapted to individual capabilities and needs		
	Multisensor		

Augmented Reality has some disadvantages since it requires latest smart devices, which can put the learners in unequal terms. Different technical problems may be caused, such as device camera malfunctions, the lack of fast Internet connection, or software issues – for example, inability to locate users. Sometimes Augmented Reality can be a distracting technology and divert students' attention from the learning materials.

On the other side, the development of appropriate Augmented Reality educational applications is a difficult and time-consuming process. It requires teachers to have an innovative approach both to the presentation of the content and to the means and approaches for accessing and interacting with it.

Comparing positive and negative features of the technology, it can be concluded that Augmented Reality is among the few technologies that achieve a combination of attractiveness and effectiveness of education.

In conclusion, it can be summarized that Augmented Reality is a technology that combines the

real world context with digital resources to situate learners in an authentic learning environment and provide them an authentic real world experience [15, 20]. Augmented Reality guarantees the creation of a blended learning medium where learning resources and activities are in accordance with the context of learners' situations. The technology enriches the real world with additional layers of virtual interactive content and facilitates the perception of complex theories.

3.3. Educational Augmented Reality applications

Augmented Reality can be applied in different educational stages – from small children using magic books to university courses where abstract concepts are studied.

There are a lot of Augmented Reality applications that are specially designed for use in the educational process. Some of them (many are free) could be used not only by tutors to develop their own Augmented Reality applications, but also by students when solving learning tasks.

Augmented textbooks

The process of developing Augmented Reality applications, suitable for the education, is time consuming and difficult. The first step that can be taken to implement technology in education is to create interactive textbooks. Sometimes, books that contain elements with Augmented Reality are called "magic books". They can be used in various subjects.

Augmented Reality can transform the traditional textbooks that most digital natives consider to be "boring", into interactive tools that engage and motivate learners to read and study as well as entertain them. Textbooks with Augmented Reality include much more learning content than traditional ones. In addition to the standard content, they provide digital content, which is accessible to anyone who has the need or desire to deepen his knowledge. One more advantage of augmented textbooks is that the virtual learning materials can be delivered to students in multilingual mode.

An example of an interactive textbook is the Statistics textbook, developed by the authors. Statistical concepts are abstract and difficult to comprehend. Augmented Reality can facilitate their understanding by learners. Marker-based and markerless technology is used to prepare examples that reveal the importance of an appropriate choice of statistical method as well as the interpretation of the results. In addition, via Augmented Reality learners can interactively compare some of the most popular statistical software packages by viewing videos with data analysis. The technology has also contributed to

the perception of statistics by learners as a fun method to explore and understand the real world and its regularities.

Other examples are Animal Kingdom Education Book, iStorm: Wild Weather and Other Forces of Nature, Augmented reality book – 3D Solar System, Planets 3D Popar Augmented Reality Book, Planets 4D Augmented Reality Book and many others.

Augmented Reality in Medicine and veterinary medicine

The first applications of Augmented Reality in medical practice were developed with particular attention being paid to the diagnosis of diseases. There are a number of applications in the field of medicine and veterinary medicine that allow 3D visualization of the anatomy of humans and animals. The training is practically oriented and learners can easily remember the structure of the human or animals bodies, the functioning of the various systems or organs, etc.

Augmented Reality applications are an effective tool for acquiring practical skills. Learners can perform various manipulations in a controlled and protected mode, and patients' safety is ensured even in cases of mistakes. Practicing in the hybrid learning environment allows students to gain experience and confidence in their own capabilities and learn from mistakes.

Among the popular Augmented Reality applications in medical education are Anatomy 4D, VR Dentist, Human 3D Heart, Reality of AFib, 3D Brain, Brain AR App, AR Liver Viewer, Desktop Bessie (3-D cow app) and more.

Augmented chemistry

Augmented Reality can greatly facilitate the chemistry education. With applications the studying the structure of atoms, molecules or complex compounds and the essence of chemical reactions is interesting, engaging and easier. Most experiments have to be performed in chemical laboratories. They require the use of specialized safety equipment. There is no need for expensive equipment to conduct different experiments with Augmented Reality applications. All experiments are authentic and, at the same time, absolutely safe for learners. Chemical reactions can be considered in detail without any risk to learners. Augmented Reality based applications in chemistry education are Elements 4D, Augmented Chemical Reactions, Arloon Chemistry.

Augmented astronomy

Astronomy is a science where the study of concepts is theoretical and the opportunities for experiments are minimized. Augmented Reality can support the exploration and study of the objects and planets in the Universe and the interaction between them. Students can work, manipulate and interact with 3D objects. Examples of educational applications in astronomy are Google SkyMap, BuildAR Viewer, Planets, Star Chart, Amazing Space Journey – 3D Solar System, Star Walk, Sky View, Spacecraft 3D and more.

Augmented mathematics

Augmented Reality has the potential to be effectively used in mathematics training (geometry) both in the classroom and in creating materials for self-preparation. Complex geometric shapes can be represented by their 3D models, which would make it easier for learners to develop their spatial thinking. Among the popular applications are Arlon Geometry, Geometry – Augmented Reality, CleverBooks, Cyberchase 3D Builder, Math Ninja AR, etc.

Augmented agriculture

Potential opportunities for the use of Augmented Reality in agriculture and livestock farming have not been fully revealed yet. Augmented Reality, farming systems support current and future farmers in the treatment of crops with different preparations, advise them when deciding on upcoming farming processes and activities according to weather conditions [26]. An interesting example for beginner gardeners is presented in the Smart Garden project. Fiducial marker provides instructions for soil preparation, sowing and growing of vegetables. The ability to record agricultural activities helps to increase the efficiency of the process [27].

Augmented history

Augmented Reality in history education can recreate past events or show how historical people, artifacts, buildings, and entire cities have looked. Some museums successfully implement the technology into their exposures to provide a different experience to their visitors, which can also be transferred to classrooms. Traditional history education can be enriched with Augmented Reality applications. Students are able to immerse themselves in the past world and become witnesses and participants in significant events. History education acquires new dimensions and allows learners to feel the atmosphere of the past. PIVOT, Shakespeare's Globe 360, the Bulgarian Iwalk Guide, are examples of applications with Augmented Reality suitable for history education.

There is a variety of Augmented Reality applications that can be successfully used in training physics, geography, architecture, engineering, business and others.

The market for Augmented Reality applications for education is constantly expanding. There is a requisite for developing applications that can be adapted to the needs of learners. The options for customization will result in enrichment and improvement of digital content.

There are many internet sources (blogs, sites, etc.) that evaluate applications for Augmented Reality and recommend the best of them to be used in education. However, there are no researches on pedagogical performance and outcomes of using Augmented Reality and its impact on learners.

4. Conclusions

The modern society is characterized by a digital transformation that is possible due to the variety of innovative technologies and the comprehensive Internet access.

Education is constantly changing in order to follow the trends in the development of society. Nevertheless, the main reasons for the shifts in the field of education are not the new technologies, but the new learners with their new needs and requirements. Technologies are a means that allows the necessary learning environment to be created where the learning process can be realized in the most effective way.

Via innovative ICT, learning space transcends the boundaries of traditional classrooms. The training becomes accessible to all people – learning content and activities are reachable from all over the world and there are opportunities for lifelong learning. Modern technologies enable each learner to show his best qualities and advance in the learning process in the most appropriate way.

A major advantage of smart technologies is that they make learning interactive. Knowledge and skills acquisition is more effective, learning experience is improving when learners are actively engaged in the learning process. Smart devices are just a tool that changes the essence of the process of learning and acquiring skills. They offer students a new approach for interaction with the learning content as well as with the other participants in training.

The goal of this study was to present the advantages of Augmented Reality as one of the technologies that can create an environment that combines reality and virtuality. The hybrid medium reveals opportunities to apply new pedagogical methods in education. In such an environment, learners can work and interact with virtual objects integrated into the real world. They explore and learn

abstract theories and concepts much faster and easier with aspiration and motivation for deepening knowledge.

The technology offers an innovative way of learning and helps transform education into smart education. Learners acquire key skills, knowledge and competences that enable them to take adequate and creative solutions of real problems.

Augmented Reality is able to bring significant and innovative changes in education to be in line with new needs and requirements of learners, teachers and society.

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