Green Deal Awareness through Augmented Reality in Primary School Education

2022-1-BG01-KA220-HED-000087414

Basic Principles on the Use of Augmented Reality in Primary School Education to Increase Awareness of the Green Deal

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1. GREEN DEAL AWARENESS

1.1. DEFINITION OF GREEN DEAL AWARENESS

One of the international issues that requires implementation action by all countries and regions is the climate crisis. Many national and international organisations have launched specific sustainability-based initiatives to counter the progress of climate change and environmental degradation. The aim of these initiatives, which integrate economic, social, and environmental aspects, is to ensure the survival of present and future generations. One of the most important concepts for implementing sustainable development is the ”green deal”.

The term "Green Deal" itself is derived from the US President's Franklin D. Roosevelt's reforms called "New Deal", which were created as a response to the economic problems of the time during the Great Depression in 1930s. The term "Green Deal" denotes a new approach to current environmental problems, including an approach from the economic side in the solutions, emphasising renewable energy and conservation of Earth's resources (Bloomfield & Steward, 2020). Many years later, towards the end of the 2000s, many environmental organisations around the world presented and developed the concepts of ”green deal”, “green new deal” and “global green new deal” (Lee et al., 2021). These concepts have in common the concern for climate protection actions along with finance and people’s lives.

The term "Green Deal" is not new and the program is implemented in several parts of the world as a response to current environmental problems. Before the world became familiar with the term "Green Deal", attention was already focused on environmental problems. As early as 1980, the UN paid attention to sustainable development, urging to link environmentalism with mainstream economic and social policy (Bloomfield & Steward, 2020). In 1997, however, the Kyoto Protocol was issued, which worked with the goal of reducing the emission of gases that contribute to global warming (Britannica, 2023). "Green Deal" was mentioned for the first time in 2007, when New York Times journalist Thomas Friedman tried to highlight the current climate change and global environmental crisis, saying that the world needs something like President Franklin D. Roosevelt's plan (Bloomfield & Steward, 2020). The term Green New Deal (GND) was popularised thanks to Thomas Friedman, that is world recognised Pulitzer Prize-winner (News, 2013) who defined it in January 2007 as „huge industrial project to create a whole new clean power industry to spur economy into the 21st century”. This green vision focused on changes in the very nature of the electricity grid and more it from high-carbon source of energy to renewables (Friedman, 2007).

The "green deal” could be defined as a strategy for mobilisation of whole community and enterprises to create clean and green economy through implementation of pro-environmental solutions in various sectors, which consider the three aspirations of sustainable development - the well-being of people, the environment and economic sustainability (Smol, 2022).

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The public is becoming increasingly aware of environmental issues, as a result of which several world countries or non-governmental organisations are building awareness through "Green Deal" programs, acting on a political level. One of the first “Green Deal” programs tika realizēta UK from 2012 to 2015 that encouraged people to make their homes more energy-efficient. It worked by letting homeowners, landlords, and tenants pay for the improvements using the money they'd save on energy bills. Although there were 45 types of improvements offered, there was no guarantee that the money saved on energy would cover the costs. A unique aspect of the program was that the responsibility for payments stayed with the house, not the person. The plan was for many homes to be improved, but only about 6000 households signed up, so the program was stopped to save public money (Rosenow & Eyre, 2016). A more successful program is currently being implemented in the USA under the name "Green New Deal". The Green New Deal aims to combat climate change and stimulate economic growth by transitioning to 100% renewable energy, investing in infrastructure and job creation, promoting social justice, supporting sustainable farming, and funding research and development (Friedman, 2019). Similar programs have been launched in different countries to address the ongoing climate and environment crisis. In Australia, the program has been known as "Green Plan" since 2009, in Canada it is called "Pact for a Green New Deal", in South Korea as "Green New Deal" and in Europe as "European Green Deal". The European Green Deal will be described more in the following sections. Although there is no single "Green Deal" program in the world, the goal of existing programs is similar, adapting the program and the policies it implements to the specifics of each country.

The European Union (EU), with the European Green Agreement announced on 11 December 2019, while setting out the goal of being the first climate-neutral continent in 2018; at the same time transforming the industry that will adopt a new growth strategy that requires announced that it would reshape. Relevant actions under the European Green Deal are energy, will reshape the EU economy, including transport, industry, finance, construction, agriculture, and forms the basis of a transformation that will gain momentum.

The three main tenets of the European Green Deal, which will help cut greenhouse gas emissions and improve the quality of life for our population, are (European Commission, 2023):

- putting greater emphasis on energy efficiency, enhancing the energy efficiency of our buildings,
- creating a power sector that mostly uses renewable energy sources,
- establishing a fully integrated, networked, and digitalized EU energy market; ensuring a secure and affordable EU energy supply

The Green Deal is the EU's growth strategy defined in such a way as to reach near-zero degrees in greenhouse gas production by 2050, to separate emissions from current resource use, which are its main goals, to separate economic growth from current resource use and to leave

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no person or place behind. Thus, the Agreement will create employment opportunities for people and increase living standards while reducing emissions.

Within the scope of the determined targets, the growth strategy has been established under 7 policy areas:

1. clean energy
2. sustainable industry
3. building and renovation
4. farm to fork
5. pollution elimination
6. sustainable mobility and biodiversity
7. sustainable development strategy.

These are;

- European Green Deal Investment Plan which acts as a framework to manage necessary investments for the Deal,
- Just Transition Mechanism which is constructed to prevent negative impact of the Deal on the zones and communities that have the risk of being socioeconomically harmed by the process (such as the ones in the fossil fuel value chains),
- European Climate Law which aims to eliminate the national differences of applications that might intercept with the goal of Europe being climate-neutral by 2050,
- European Industrial Strategy which aims to support industries and SMEs through green and digital transformation and
- Circular Economy Action Plan which aims the adaptation of sustainable production and consumption practices within the Union.

1.2. THE EUROPEAN GREEN DEAL AND INCREASING GREEN DEAL AWARENESS

Climate change and environmental degradation are a real threat to Europe and the world, with a significant negative impact on human life. That is why the European Commission presented a development strategy on December 11, 2019, called "European Green Deal" (EGD). The" European Green Deal" is a long-term strategy aimed at achieving carbon neutrality in Europe by 2050. The Green Deal is characterized by a holistic approach (Lamenta & Grzybowska, 2023), including the energy sectors but also other sectors of the countries of the European Union. All of the countries agreed to the agreement within a short period of time. The agreement focused primarily on the threats caused by the global climate crisis, but had a broader focus because this crisis affects the entire European economy.

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The European Commission (2019a) explained climate change with these words : “Climate change and environmental degradation, for Europe and the world the European Commission (2019a) described the concept as follows: “Climate change and environmental degradation are a serious threat to Europe and the world. To overcome these problems, Europe needs a new strategy that will transform the European Union (EU) into a modern, resource-efficient and competitive economy with no net greenhouse gas emissions by 2050.If he does not continue in this way, there will be no people or resources left."

The plan identified the necessary investment and available financial instruments. He explained exactly how a comprehensive transition will be achieved. The EU should also provide financial support and technical support to countries that are particularly affected by the transition to a green economy. The EU plans to become a climate-independent continent by 2050, which will require the adoption of appropriate measures in all sectors of the economy. The EU's plan was based on the existing universal development principles defined by 17 articles, the sustainable development goal (and 169 detailed sub-goals). All sub-goals are defined by about 240 quantitative indicators determined with universal global validity.

It is clear that this particular change affecting all EU citizens has a wide global overlap in successfully realizing the EU's role as a global sustainable development leader and providing the necessary tools to implement the necessary transitional steps and developing bilateral and multilateral instruments that will gradually ensure the EU's sustainable development.

The European Green Deal involves the implementation of numerous actions to transform Europe into a modern, resource-efficient economy characterized by the following (Lamenta & Grzybowska, 2023):

1. zero net greenhouse gas emissions in 2050;
2. decoupling economic growth from resource consumption;
3. an equal standard of living in all regions.

The European Green Deal not only commits to achieving zero net emissions of greenhouse gases, but also aims to improve the well being and health of citizens through a range of measures. These includes:

- providing clean air, water and healthy soil;
- renovating buildings for energy efficiency;
- promoting healthy and affordable food;
- expanding public transport;
- encourage cleaner energy and technological innovation;
- creating long-lasting recyclable products.

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The components of the European Green Deal are (UNIDO, 2020) (Figure 1):

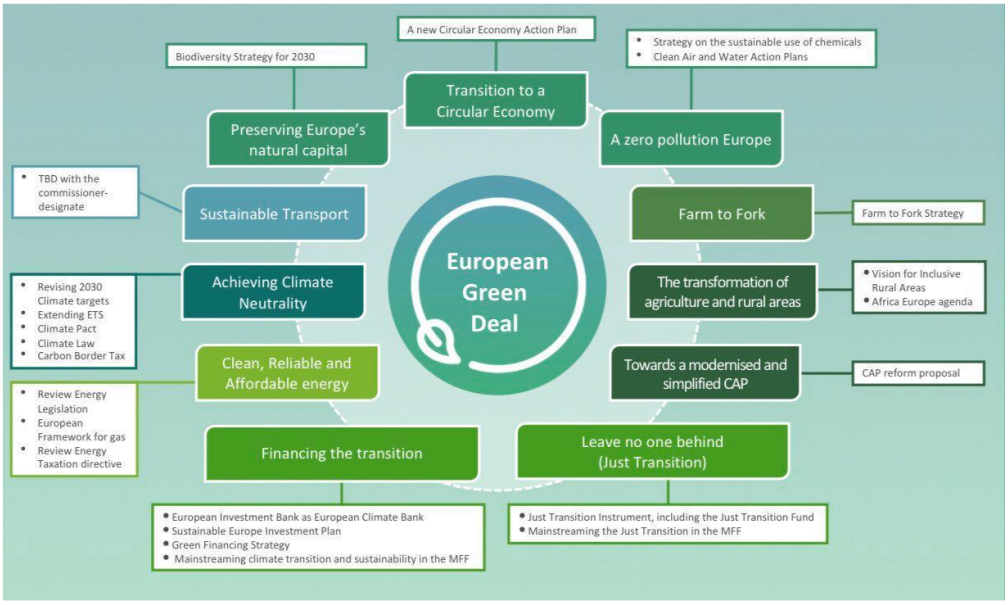

Figure 1. The components of the European Green Deal (UNIDO, 2020)

The external dimensions of the European Green Deal are an indivisible part of it as a whole. The EU needs to integrate the Green Deal into bilateral relations, in cooperation packages involving development cooperation, foreign policy, investment and knowledge cooperation (Koch & Keijzer, 2021) (Figure 2).

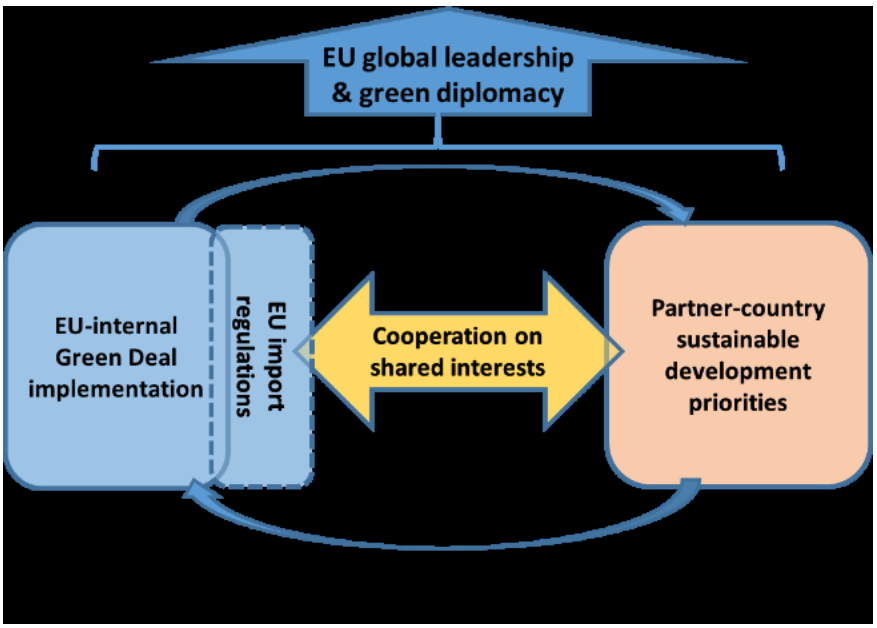

Figure 2. The external dimensions of the Green Deal (Koch & Keijzer, 2021)

The European Green Deal also expects to foster future-proof jobs and skills training while bolstering a globally competitive and resilient industry (European Commission, 2021). Implementation of the EGD also comes with some challenges. According to the 2023 European Green Deal Barometer by the Institute for European Environmental Policy (IEEP), the majority

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of sustainability experts remains cautiously optimistic about Green Deal resilience following the 2024 European elections. They identify insufficient commitment by member state governments as a primary barrier to realising the Green Deals aims (IEEP, 2023). Overall the EGD represents a comprehensive strategy to address environmental challenges and aims to transform the European Union into a sustainable and competitive economy. Its success will depend on the commitment and efforts of EU institutions, member state governments and other stakeholders in overcoming the implementation challenges and making the EGD visionary plan a reality.

One of the challenges found in the EGD barometer research is insufficient knowledge and understanding of the goals and tasks of EGD. 80 sustainable development experts participated in the study, of which 39 experts were from the European Union member states and 41 experts from non-European countries. When answering the question about familiarity of EGD, only a little more than half (59%) of experts from the EU were sure that they knew about the goals and tasks of EGD, while non-EU experts were able to answer affirmatively in 44% of cases (IEEP, 2023). Therefore, there are challenges to raise awareness of the goals and objectives of EGD. One way to increase awareness of EGD is the education sector. The sector of education is fundamental to guiding Europe's evolution towards a more sustainable model. Therefore, sustainability must include all aspects of education and training, starting from curricula development and training for educators to the operation of educational facilities (European Commision, 2022). Educational systems must adapt to the challenges of the 21st century, addressing learners' needs and assisting them in managing stress and anxiety experienced in the face of the global crisis (European Commision, 2022). As such, education should empower learners with the knowledge, skills, and attitudes necessary to champion sustainability and actively participate in the decision-making processes to reach some of EGD goals.

1.3. THE MOST DISCUSSED CONCEPTS AND PROBLEMS ON GREEN DEAL AWARENESS

The EGD is referred to as a "master plan" for the further development of the European Union, which foresees a development strategy with the aim of transforming Europe into a modern, sustainable, resource-efficient and competitive economy (European Commission, 2022). However, in order to achieve the set goal, it is necessary to make the main changes in the national policy, which in turn does not change as easily and quickly as the proposed strategy predicts. It also refers to the previously discussed study from the European Green Deal Barometer (IEEP, 2023) on the insufficient involvement of member states in the implementation of EGD. Changes are highly influenced by politics and power dynamics within energy systems. This includes looking at how using renewables and gas affects industry growth, analysing who gets to produce renewable energy and recognizing the significant role of political institutions in climate change (Samper, et al., 2021).

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As another problem in the implementation of EGD, the insufficient participation of society in achieving the goals is also emphasised (Samper, et al., 2021). This is related to social groups of society with different priorities - while one has to think about one's own and family finances, there is no capacity to think about society's needs for a sustainable future (Martin & Islar, 2021; Samper, et al., 2021). A similar problem of lack of involvement can also be observed in companies (Samper, et al., 2021). Considering that one of the goals of EGD is to reduce the consumption of resources in the profit-making sphere, or creating long-lasting recyclable products (European Commission, 2022), a special policy should be developed for this, however, currently, as mentioned above, policy development and implementation is a slow process. As long as the relevant policy instruments are not in place, companies will not always look for the most environmentally friendly solutions, but rather those to make a profit (Samper, et al., 2021). Although several important steps have already been taken to implement the relevant policy in the EGD member states, it is clear that a greater involvement and sense of responsibility is needed from society, companies and policy makers.

Climate action is the central part of the European Green Deal, an ambitious package of measures, with the aim of protecting Europe's natural environment. Climate change initiatives under the European Green Deal include:

- The European Climate Law.
- The European Climate Pact that aims to involve citizens and the whole society in the actions of combating climate change.
- The plan regarding the climate objectives for 2030 which provides for the reduction, until 2030 of emissions of greenhouse gases with at least 55%.

Combating climate change and making the transition to a climate-neutral society will require significant investment, research and innovation actions, new ways of production and consumption, as well as changes in the way we work, use transport, and live together.

The EU addresses this aspect by aligning actions in the following areas (European Commission, 2023):

- Energy
- Environment
- Mobility and transport
- Regional Policy and the Low Carbon Economy
- Sustainable financing
- Industrial policy
- Trade and sustainable development
- International cooperation and development
- Climate change research and innovation
- Sustainable development goals

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In conclusion, the "European Green Deal" proposed to make Europe climate neutral and sustainable for future generations. For this goal to become achievable and successful it is necessary to combine different external policies (such as trade, foreign and security policy) and to seek the involvement of Member States to actively contribute to their external and internal policies. Last but not least, the Green Deal needs to be a basis for dialogue with developing countries, but also a basis for joint cooperation for sustainable development.

2. AUGMENTED REALITY (AR)

2.1. DEFINITION OF AUGMENTED REALITY

There are several taxonomies to define and describe Augmented Reality. They are based on several criteria but the most important are the methods or applications used. There is now a wider development of Augmented Reality based applications based on the scheme proposed by Milgram et (Carmigniani et al., 2010). In the work of Milgram et al (Milgram & Kishino,1994; Milgram et al., 1994) there is a description of Augmented Reality (AR) based on continuous Virtual Reality (VR) (Figure 3). The described schemes show the combination of virtual reality with mixed reality, virtual augmentation or augmented reality, which led to the idea of those interested in Augmented Reality that they can define this notion and in particular classify types in several ways. (Norman et al., 2012).

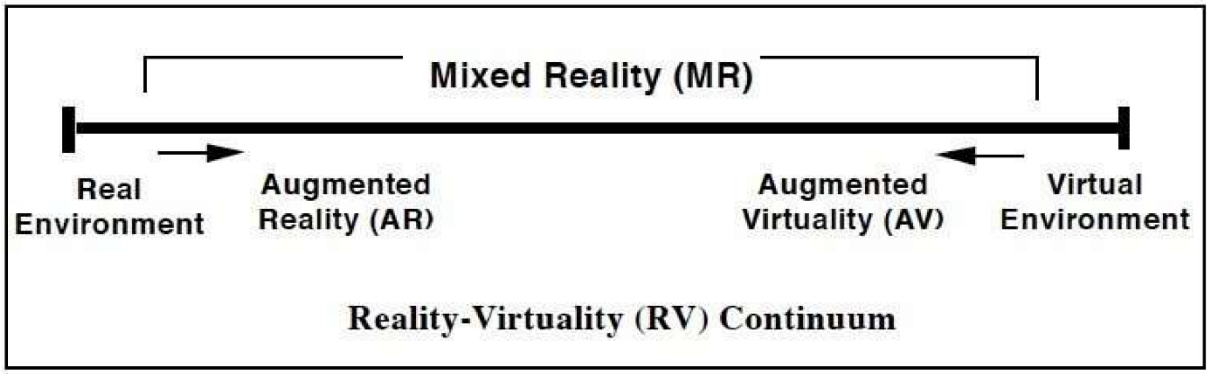

Figure 3. The mixed Reality by Milgram et al., 1994

When Figure 3 is examined, it is seen that the real environment is represented by the point on the far left of the continuum. By fusing digital models made in a computer environment with the real world, augmented reality is formed. Virtual worlds that try to mimic the real world are located at the far right end of the continuum. These environments, which are made up completely of virtual items, are given an enhanced virtuality by the addition of real objects. From the leftmost to the rightmost area of the figure, there are more virtual items, but there are less real-world connections. It is clear from the diagram that augmented reality is a component of mixed reality (Milgram & Kishino, 1994).

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Our environment is incredibly complicated, and it gives us a lot of information that can occasionally be challenging to comprehend or reconstruct. Even though Virtual Reality (VR) is a highly developed technology that is incredibly beneficial, the final applications are occasionally too basic and lack details about the environment that is supposed to be replicated. Augmented Reality (AR) technology has shown to be a more intriguing option for many applications. A view of reality is altered by a computer through augmented reality technology, which overlays virtual features over actual environmental factors (Zarzuela et al., 2013).

AR is a technology that was first developed over 60 years ago. It allows computer generated imagery to approximately overlay physical objects in real-time. In this review we adopt definition of AR proposed by Azuma: “Any system or technology that (a) combines real and virtual imagery, (b) is interactive in real-time, and (c) is registered in three dimensions (i.e., the real world).” Through the rapid development of technology AR has become available on a wide range of platforms. Initially developed on static computers with a display and camera, AR has now made its way onto smartphones, tablets and wearable glasses. These mobile devices allow the design of AR applications with mobility included as an integral part of the design. This mobility has resulted in applications of AR in construction, medicine, retail and, of course, education.

The AR technology is a computer-generated system that allowed user to see the objects in the real-world environment. According to Azuma, to limit AR to the use of certain external elements, such as the use of glasses or an AR suit, the concept of AR can be defined based on three common characteristics:

1. AR combines the virtual and the real world. That is, it allows us to interact in the real world with elements of the virtual world, allowing users of technology to have unique experiences that would not be possible without the use of AR.
2. AR is interactive in real-time. A user change or action has immediate repercussions on the scene created by the AR allowing the user to get a more realistic experience.
3. AR as elements captured in three dimensions (3D). Information is always shown in that perspective, giving you a sense of belonging to the real world. Thanks to the evolution of AR, you can interact directly with the physical abilities of the surroundings.

The increase in the processing capacities of new generation computers and smart mobile devices and the widespread use of these devices have brought new technologies such as Augmented Reality (AR) to our lives. Thus, today's learning environments have gained a different and innovative structure out of the ordinary. Augmented Reality (AR) is a technology that allows the simultaneous coexistence of three-dimensional virtual content produced with the help of computers with real-world objects (Azuma, 1997). With this feature, AR technology enriches physical learning environments with digital information. Digital AR content can be displayed on a tablet, computer, or with the help of head-mounted imaging devices.

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Three types of AR technology are common today: (1) image-based AR, (2) location-based AR, and (3) AR using surface sensing technology. In image-based AR, two- or three-dimensional digital content can be displayed in a real-world environment as a result of an AR camera detecting the marker. Users can observe this digital content from different angles with the help of a mobile screen or a head-mounted display device (Ibáñez, Di-Serio, Villarán-Molina, & Delgado-Kloos, 2016).

Figure 4. An example of an image-based Augmented Reality application. Source: https://www.pngegg.com

Location-based AR technology is generally preferred by the travel and tourism (e.g., wikitude) and gaming industries (e.g., Pokemon Go). Location-based AR allows us to follow the location information of that place while walking around with the help of accelerometer, compass, global (GPS) or WiFi-based positioning systems on our mobile devices (Özdemir and Baturay, 2020). This type of AR uses accelerometer, compass, global (GPS) or WiFi-based positioning systems. Wikitude (www.wikitude.com) is an example of location-based AR applications. With the help of this application, users can view descriptive information about the buildings or roads in their places on their mobile screens (Figure 5).

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Figure 5. Example of location-based AR application (Lee, Chung, & Jung, 2015).

The AR type, which uses surface sensing technology, allows placing digital contents on a flat surface without the need for any markers. With the help of this AR technology, virtual objects can be positioned on any surface in the real world. Thus, users can view and communicate with real world objects with the help of their mobile devices or glasses. An example of an AR application using surface sensing technology is given in Figure 6.

Figure 6. An image from the AR application named “My very hungry caterpillar AR” published by the Apple Store and developed by StoryToys Entertainment Limited.

Azuma (1997), who published a comprehensive research article on AR technology for the first time in the context of educational research, stated the three main features of AR as follows (Azuma, 1997; Azuma et al., 2001); (1) combines real and virtual objects in the real environment, (2) position (aligns) these objects to each other, and (3) is three-dimensional

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and offers real-time interaction (Özdemir and Baturay, 2020). Azuma's research is frequently cited in educational research on AR today.

For developing and using AR content, specific platforms and technologies need to be used. There are three core technologies for development of AR tools (Chen et al, 2019):

1. Intelligent display technology. As content in AR is mostly visual, quality of display plays an important role for using AR content. Such devices can be head-mounted displays designed for use in AR environments, touch-sensitive screens such as tablets or smartphones, and a computer if it is capable of providing the user with a camera that perceives the surrounding environment in the real world.

2. 3D registration technology. This is a vital component of augmented reality systems that allows for the precise overlay of virtual images onto the real world. The process involves two main steps. First the relationship between the virtual image, the model and the camera or display device's directional and positional information is established. Following that, the virtual image and model are precisely projected into the real environment, facilitating their integration with the real world.

3. Intelligent interaction technology. This technology in AR systems is influenced by various disciplines that facilitate diverse interactions such as hardware device, location, and information-based interactions. As this technology evolves, AR transcends overlaying virtual information on real scenes to enable interaction between people and virtual objects, enhancing user experience.

Developing systems for AR has become increasingly accessible and innovative thanks to the availability of several platforms and frameworks such as Unity3D, Vuforia, ClassVR, Blender, Unreal Engine and others (Ibáñez & Delgado-Kloos, 2018; Zālīte-Supe, 2022). These technological advancements have facilitated the application of AR in various fields including education, industry, marketing, and medicine (Yuen et al., 2011).

2.2. HISTORICAL DEVELOPMENT OF AUGMENTED REALITY

The first idea about augmented reality was introduced unintentionally by L. Frank Baum in1901. In the novel of The Master Key, he describes special eyeglasses. The person who wears them, sees everyone with a letter marked upon his or her forehead indicating his or her character. The good bears the letter ‘G,’ the evil the letter ‘E’, the foolish the letter ‘F’, etc. Thus, it is possible to determine the true natures of people by a single look. This usage is accepted to be the first idea of augmented reality (Woods, 2014).

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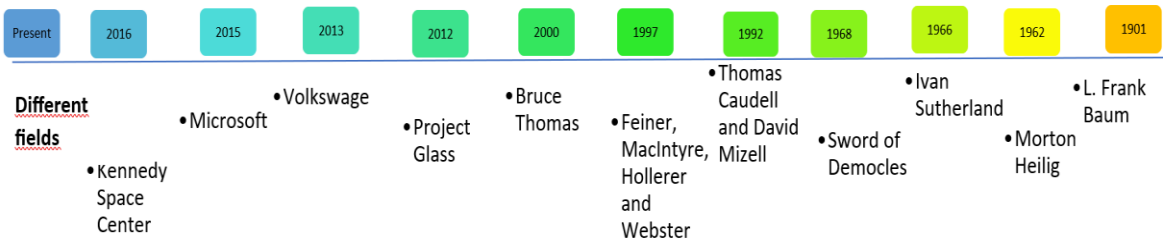

Figure 7. History of AR

One of the founders of AR is Morton Hayling, who developed the simulator "Sensorama" in 1950. It was a prototype for immersive technologies that provided information perception with multiple senses. Five short films were also created as part of the cinema-like prototype. The “Sensorama” is considered one of the first steps in the development of virtual and augmented reality technologies (Norman, n.d.). This simulator included features for sensory perception such as image, sound, wind, smell and vibration (Craig, Sherman, & Will, 2009).

Morton Heiling also patented the first head-mounted display in 1962, but it was never produced (Yuen et al., 2011). The next important step in the development of immersive technologies was taken by Ivan Sutherland, developing the first computer graphic user interface "Sketchpad" in 1962 and creating the "Ultimate display" with cathode ray tube screen in 1966. Both findings are significant for the graphically demanding environment of AR and have contributed to the further development of immersive technologies (Heather, 2022). They developed the first head-mounted display, which is technologically developed versions are still used today in virtual reality and augmented reality environments, an augmented reality system using a transparent optical head-mounted display (Carmigniani & Furht, 2011); Arth et al., 2015). This device was limited due to and lack of technologies that were still evolving. This limitation however did not stop the idea of giving birth to modern augmented reality applications. Sutherland constructed the first augmented reality system using his head-mounted display two years later, in 1968, with the help of his graduate students. With the head-mounted display connected to the sizable computers of the era as well as connections to the ceiling (it was a wired device), it was quite the contraption (Berryman, 2012).

Developed in 1975, Videoplace was an interactive virtual environment that responded to user movements without the use of glasses or gloves or the need for any mechanical device or sensor attached to the body (Krueger and Wilson, 1985). This developed system is accepted as one of the pioneers of virtual reality technology and interactive art (Kipper & Rampolla, 2012).

An important figure in the history of AR development is also Tom Caudell, who first introduced the term "augmented reality" in 1992. This has been an important step in the further development of this technology, given the similar path of development of virtual and augmented reality, which was initially unified.

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In 1996, Rekimoto (1996) introduced a shared AR system called TransVision. The TransVision system consisted of a small LCD screen with a camera mounted behind it. Two people sitting around a table could view AR content displayed on their phone screens in a shared manner (Haller, Billinghurst, & Thomas, 2006).

In 1998, a 2-dimensional marker in the form of a square barcode was developed by Rekimoto (1998), which allows camera tracking. With this method, for the first time, it was possible to establish a connection between a 2-dimensional printed material and digital information without the need for other 3-dimensional sensors. Today, these markers are gradually replaced by real images. AR systems can now easily identify real-world images and place virtual objects on these images without any problems. In 1999, Hirokazu Kato developed an AR software library called ARToolKit at the University of Washington's HIT Laboratory (Human Interface Technology Laboratory). Almost all AR applications that can be viewed through a web browser today are made using ARToolKit (Kipper and Rampolla, 2012). Professor Steve Mann, one ft he pioneers ft he field of digital glasses and working in the Department of Electrical and Computer Engineering at the University of Toronto, introduced the concept of „Mediated Reality ". In 2000, Thomas et al. (2000) developed a mobile AR version of a popular game called "AR-Quake".

In 2004, Möhring et al. (2004) developed the first prototype AR system that could work with smartphones, perform 3D pointer identification, and present images in the form of a video stream. This AR system was able to detect stationary paper markers and interactively integrate 2 or 3D graphics into video images. Wikitude AR Travel Guide was developed for Android phones in 2008 (Rabbi and Ullah, 2013). With this application, when users point their cameras at the places around them via mobile camera, internet and GPS, they can display descriptive information about those places (Perry, 2008). In 2011, Google X company developed Google Glass and in 2015 Microsoft company developed HoloLens. Google Glass and Hoolens offer its users the opportunity to display real world and virtual objects together in an interactive way. Smartphones are now equipped with GPS functions that allow users to find their own location, and accelerometers and compasses that allow them to determine directions (Arnaldi, Guitton, & Moreau, 2018). In the light of these developments, a location-based AR game called Pokémon Go was developed by Niantic in July 2016.

Today, AR technology; entertainment, marketing, military, automotive, tourism, etc. Although it continues to be used in many fields, it is still in the very early stages of its development process. Big technology companies such as Google and Apple continue to highlight the AR features of their mobile devices. However, AR systems have not reached the expected level of technological maturity today due to the lack of a consumer market, the low production of consumer-grade devices, and the limited amount of AR content that users can experience (Mealy, 2018). However, the technologies used to develop AR systems continue to develop more promisingly than before.

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2.3. USAGE AREAS OF AUGMENTED REALITY

Augmented Reality (AR) has a wide range of applications across various industries. The use of AR technologies is increasing day by day in many different fields such as marketing, real estate, cinema, decoration, tourism, logistics, gaming, military, shopping, construction, education, health and sports. Considering how much AR technology will make people's lives easier when used with mobile devices, it is thought that this technology should be used more in education (Boz, 2019).

1. AR in Education

According to the multimedia cognitive theory, people learn better, if multiple senses are targeted simultaneously. In this context, augmented reality has a great potential for better education because it can target multiple senses of people (Luckin and Fraser, 2011). Besides it is an interesting technology, and probably students find it enjoyable. Furthermore, it can be said that augmented reality provides new opportunities, that never existed before, for education (Wu, Lee, Chang and Liang, 2013).

Wu et al. (2013) performed a literature review study about augmented reality in education. They found that studies about augmented reality were based on the teaching or learning techniques like game-based learning, location-based learning, problem-based learning, simulation, role playing, jigsaw method. In another study, MagicBook application were created to show 3D images of the objects and cartoon characters in the book to children by markers and handheld devices. This study indicates that children liked to be a part of the story and were motivated by augmented reality application (Billinghurst, 2002)

In a comparison study, Di Serio, Ibáñez and Kloos (2013) found that attention and satisfaction level of students in a learning environment with augmented reality application were higher than the students who were in a lesson with slide-based presentation. Beside they also found that augmented reality in education increased the motivation of students.

An application based on radio frequency identification (RFID) and augmented reality technologies were developed for outdoor natural science learning in a study (Liu, Tan & Chu, 2009). Researchers used the application at the Guandu Nature Park in Taiwan to evaluate its effectiveness with elementary school students and teachers. They found that the used application they used improved student learning. Similarly, in another study in England, researchers compared a learning experience based on augmented reality with traditional education. They also found that augmented reality had positive effect on students' learning (Kerawalla, Luckin, Seljeflot, and Woolard, 2006).

AR has been used as a complement to a pre-established and standard curriculum, based mostly on a traditional methodology according to Ávila-Garzón et al. Text, 3D graphics, video, and audio can be overlaid in the student environment in real-time. There are other tools such

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as reading materials, textbooks, and reading cards that may contain markers or triggers scanned by a device that can support an AR application.

There are a number of benefits to using augmented reality (Garzón et al., 2017):

- Learning gain is the most commonly reported advantage. Studies have stated that when using augmented reality systems, students improve their academic performance.
- Motivation is the second most commonly reported benefit. Studies reported that students felt more motivated by using AR apps compared to other pedagogical methods and pedagogical tools.
- Memory retention was also reported as an advantage of using AR in educational settings. This technology not only helps in retaining knowledge but also gives the learner the opportunity to be able to retain it for longer periods of time compared to other pedagogical methodologies.
- Autonomy is another important advantage described in the selected studies. The combination of the real and virtual worlds enhances learner autonomy considering the natural abilities and motivation for the use of the technology devices.
- Collaboration was also reported as a major advantage. Augmented reality creates opportunities for collaborative learning around virtual content, which can facilitate learning as it allows learners to interact with their partners as well as with the educational content.
- Accessibility and creativity are other advantages described in selected studies. The advantages mentioned above may be an indicator of the many benefits that can be achieved when using augmented reality in educational contexts.

Yilmaz's review of the use of AR technology in education (2017)

a. AR in preschool education. Most research in this area focuses on observing student attitudes, enjoyment level, and comprehension. For this, researchers found that the main tool used was AR books to tell stories to children. The results show the use of AR in the preschool classroom improved their understanding and also concluded that there was significant evidence between the control and experimental groups regarding student interaction. Finally, the effectiveness of vocabulary acquisition related to colours in the art class was explored through the ColAR mobile application, used to perform activities related to the use of colours and their vocabulary. The study concluded with the statement that thanks to the use of AR enjoyment was superior and an improvement in the effectiveness of learning was observed. In conclusion, Yilmaz (2017) states that the inclusion of RA in several educational areas had, in general, acceptance and very positive results.

b. AR in primary education. Yilmaz analysed 11 studies including those of Joo- Nagata et al., Nadolny, Hsu, Cascales-Martínez and Laine stand out. These works focused on analyzing the improvement of the effectiveness of education through the use of RA and its influence on the

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educational process and the opinions of students and faculty regarding the application of this new tool in the curriculum of a primary school. For example, Nadolny studied patterns to observe the influence of marker use on math teaching. Their analysis showed that user interactions and cognitive exercises interested users and improved their understanding of mathematical language.

2. AR in Medicine and Health

The integration of AR into the medical field has revolutionised patient education, complex surgeries, and the overall healthcare experience. As AR technology offers real time experience that merges computer-generated information with human perception of reality, it is useful in enhancing medical procedures. Its effectiveness still relies on the skills and knowledge of healthcare professionals and the accuracy of its deployment, given its high cost compared to other medical methodologies (Parekh et al, 2020). AR technology potential extends from providing advanced preoperative imaging and 3D anatomical views to offering haptic feedback, enabling surgeons to “feel” conditions such as tumours without invasive surgery (Yuen et al., 2011). Thus, AR technology, when utilised carefully, may pave the way for future surgical innovations and more minimally invasive procedures.

3. AR in Engineering

A wide application of augmented reality is also in engineering and specifically in construction AR applications related to construction and simulation summaries will improve the construction management process by reducing the risk of injuries and with more safety in the work process, which will boost productivity and employee confidence in this field. Starting from the handler to the workers Augmented Reality can be applied so that they can understand the construction process and implementation (Trivedi & Tiwari, 2023).

4. AR in Entertainment

AR technology is ready to significantly reshape the entertainment industry. AR's interactive nature enhances user engagement across various entertainment domains, from gaming and multimedia presentations to music, travel, and live events. It offers personalised, immersive experiences, such as holographic concerts, AR-enhanced books with animated images and sound, virtual board games and innovative smartphone apps that blend virtual elements and models with the real-world landscape. This technology also facilitates complex AR projects like controlling drones via mobile interfaces for interactive approach (Yuen et al., 2011; Parekh et al, 2020). AR technologies stand to revolutionise the way we interact with and consume entertainment, broadening the scope of industries like electronic gaming and social media.

5. AR in Tourism

AR elevates navigation and exploration experiences not only in the tourism industry, but also in daily life, transforming mundane tasks into more engaging activities. GPS systems and

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search apps transcend traditional boundaries, morphing into interactive holographic signs and cues. This technology opens doors to more comprehensive interfaces, delivering real-time, location-specific information such as historical facts or nearby services (Yuen et al., 2011; Yung & Khoo-Lattimore, 2019; Cranmer et al., 2020). AR applications on smartphones continue to enrich user experience with various practical data, for example Google Lens offering real-time translation from pictures of text. Tourism is one sector that has seen a significant impact from AR, offering innovative ways to explore surroundings, altering travel behaviours, and affecting decision-making processes.

6. AR in Retail and Marketing

AR is significantly transforming the fields of advertising and marketing by providing immersive, interactive experiences. Large companies, like Coca-Cola, McDonald's, and General Electric, leverage AR for superior retail experiences and innovative marketing strategies, for example to visualise furniture placements in retail stores, displaying products virtually in real-world spaces, allowing consumers to virtually "try on" products, and create engaging games based on real-world objects (Yuen et al., 2011; Parekh et al, 2020). For example, McDonald's partnered with Trigger to develop an AR app featuring characters from DreamWorks movies, offering an interactive and engaging experience for children (Parekh et al, 2020). These innovative applications enhance customer engagement and drive direct purchases through the AR interface, revolutionising both physical and online shopping experiences.

7. AR in Architecture and Decoration

Designing a home and furnishing it with furniture and other decorations is another interesting and used trend of applying virtual reality. There are furniture companies applying augmented reality to the choice of desired furniture such as Ikeia (Sünger & Çankaya, 2019). Another example can be the arrangement of computers, servers and other devices needed for studies in a computer science or mechanics lab.

8. AR in Maintenance and Repair

AR can assist technicians and engineers in performing maintenance and repair tasks. By overlaying instructions, diARrams, and virtual markers onto real-world objects, AR can provide step-by-step guidance, helping to streamline complex procedures and reduce errors.

9. AR in Military and Defense

AR is utilized in military and defense applications for training simulations, battlefield visualization, and situational awareness. Soldiers can receive real-time information, identify targets, and access critical data through AR devices, improving decision-making and mission effectiveness.

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10. AR in Social Media and Communication

AR features are increasingly integrated into social media platforms, enabling users to add virtual filters, masks, and effects to their photos and videos. It adds a fun and creative element to online communication and self-expression.

These are just a few examples of the many usARe areas of augmented reality. As technology continues to advance, we can expect AR to find even more applications across various industries.

2.4 SOFTWARE USED IN AUGMENTED REALITY TECHNOLOGY

Content creation in augmented reality in any industry requires content creation software. Augmented reality content creation software usually works in a 3D environment, where content creators can insert their own 3D models or pick from those already available in the software library, supplementing them with interactivity or certain actions. Content creation platforms differ in their intended use (e.g. education, entertainment, marketing) and the digital skills required to create content on an AR creation platform (Herskovitz et.al, 2020).

Like any modern technology augmented reality needs special software and hardware applications. The main component connecting the real and augmented worlds is ARML (Augmented Reality Markup Language). It is the blocks that make the passage through cameras and tracking devices that pass into an XML-like file. So we break down the necessary technique of making augmented reality into hardware applications and software applications (Arena et al., 2022). The main devices for augmented reality are displays, input devices, tracking, and computers (Carmigniani et al., 2011).

A classification of softwre in dependence on the form of information processing and the link to the hardware part is given as follows (Sünger & Çankaya, 2019):

- Software involved directly in the AR application
- Software used to create the AR application
- Software used to create the content for the AR application
- Other software related to AR

Based on the software and hardware classification augmented reality depends on the devices used: tablet, computer or smartphone. There are several software tools and frameworks commonly used in the development of Augmented Reality (AR) applications. Here are some of the popular ones:

Unity: Unity is a widely used game development engine that supports AR development. It provides a comprehensive set of tools, including real-time rendering, physics simulation, and scripting capabilities, making it suitable for creating interactive AR experiences.

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ARCore: ARCore is Google's AR platform for Android devices. It enables developers to build AR applications that can detect and track the physical environment, place virtual objects, and integrate motion tracking and environmental understanding into their apps.

ARKit: ARKit is Apple's AR development platform for iOS devices. It provides a range of features, such as motion tracking, scene understanding, and light estimation, enabling developers to create immersive AR experiences for iPhones and iPads.

Vuforia: Vuforia is a popular AR development platform that offers marker-based and markerless tracking. It supports various platforms, including Android, iOS, and Unity, and provides tools for object recognition, virtual buttons, and extended tracking.

Wikitude: Wikitude is an AR software platform that supports marker-based and markerless tracking. It offers tools for imARe recognition, location-based AR, and 3D model rendering. It supports multiple platforms, including iOS, Android, and Windows.

OpenCV: OpenCV (Open Source Computer Vision Library) is a widely used open-source computer vision library. It provides a rich set of functions and algorithms for imARe and video processing, which can be utilized in AR applications for tasks like feature detection, tracking, and camera calibration.

Spark AR Studio: Spark AR Studio is a powerful tool provided by Facebook for creating AR effects on various platforms, including InstARram, Facebook, and Messenger. It offers a visual scripting interface and supports 3D modeling, animation, and face tracking.

MaxST: MaxST is an AR SDK (Software Development Kit) that provides features like markerless tracking, object recognition, and SLAM (Simultaneous Localization and Mapping). It supports both Android and iOS platforms.

EasyAR: EasyAR is a cross-platform AR development framework that offers marker-based and markerless tracking. It provides features like imARe recognition, cloud recognition, and 3D object tracking. It supports multiple programming languARes, including C++, Unity, and Java.

AR.js: AR.js is an open-source JavaScript library for creating AR experiences on the web. It utilizes WebAR technologies, such as WebRTC and WebGL, to enable marker-based and location-based AR on compatible browsers without the need for additional plugins.

AdobeAero: A content creation platform that offers the ability to create augmented reality experiences of varying levels of complexity. Offers blanks and 3D models for creating experiences.

ViewAR: A platform that offers the creation, management, testing and publishing of augmented reality programs. Thanks to the diverse capabilities of the platform, content can be created by both beginners and professionals.

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Sketch-up: It is regarded as one of the most well-known 3D modeling computer programs, which is used for creating models, preparing presentations and developing design solutions in various industries. It is possible to create your own 3D models or use what is offered by the software library. The created drawings can be viewed in the augmented reality environment - SketchUp Viewer.

Class VR: A content creation platform that offers the opportunity not only to create content, but also to create tasks to make the most of augmented reality technologies in education. The finished product can be viewed from both the teacher's and the student's side.

Unreal Engine: Offers the opportunity to develop content in augmented and virtual reality in various industries. High digital skills are not required to create simple content.

Blender: An open source program that is available for free. A content creation program used to create interactive 3D models with the ability to add various animations and additional visual effects.

FactoryTalk: With FactoryTalk Software, you can design fantastic augmented reality (AR) experiences that seamlessly integrate for the user. It has been made to be simple to use, enabling anyone who are interested in this technology to start using it right away. This platform is among the best for ensuring that all requirements are met in terms of compliance and safety issues. It is feasible to develop interactive and user-friendly augmented reality applications with step-by-step job instructions.

These are just a few examples of the software tools and frameworks used in AR development. The choice of software depends on the specific requirements, target platforms, and developer preferences.

3. GREEN DEAL AWARENESS & AUGMENTED REALITY IN PRIMARY SCHOOL EDUCATION

3.1. BULGARIA

3.1.1. Green Deal Awareness in Primary School Education

In 2016 an ordinance, issued by the Minister of Education and Science established the state education standard in Bulgaria for civic, health, ecological and intercultural education. Ecological education is defined as a process for developing ecological culture, ecological consciousness and ecological behavior in their mutual interconnection leading to recognising ecological laws, protection, enhancement, management and rational usage of natural resources, as well as protection of environment and ecological equilibrium (Ordinance No13, 2016).

The key learning objectives defined in state standard can be summarised, as follows:

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- ensure students' knowledge and compliance with the norms of ecological culture and behavior with a view to nature conservation and creation of a sustainable environment; words) ensure knowledge of the mechanisms of public institutions and civil society for the implementation of shared responsibility for the protection of the environment and shows readiness to participate in them;
- build students' skills to make connections between different spheres of public life and to understand the causes of social inequalities, environmental and global challenges;
- build and maintain a positive psychological climate and opportunities for choices related to health, ecology, civic participation, intercultural tolerance, mutual understanding, respect and respect.

3.1.2. Use of Augmented Reality in Primary School Education

Shkolo

Shkolo (shkolo.bg) is an online platform and the leader in the process of digitalization of education in Bulgaria. In 2016 in close cooperation with the Ministry of Education, they built and introduced an electronic diary and the first version was officially launched in 2017. Its purpose is to completely replace the book diary. It has seen a rapid growth - 3 years after the start, more than 1700 out of 2400 schools in Bulgaria are using their software (Shkolo, 2020).

According to the creators of the platform, its three main goals are:

• Reducing bureaucracy in schools through and automating administrative processes. Their product replaces the need for paper diaries as well as the need for parent meetings by providing all the information online. They also introduce the possibility of electronic payments to the school (Shkolo, 2020).

• Engaging parents in the educational process by improving communication, real- time notification with applications for iOS and Android smartphones, etc. Parents have quick and convenient access to information about their children's performance. It is also possible to inform about extracurricular activities (Shkolo, 2020).

• Engaging students - educating technological culture among adolescents, adequate to modern trends in the modern world. Introduction of new teaching methods, such as playfulness of school tasks. It is possible for students to provide feedback to teachers and the tasks they set (Shkolo, 2020).

Ucha.se

Ucha.se is an online platform containing school lessons and striving to present them in an understandable language. The platform received more than 20 awards, including the award for the best educational site in Bulgaria for 3 consecutive years (2012 - 2014) (Ucha.se, 2020).

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The platform is extremely popular and up to this moment, more than 16 thousand video lessons are available, which have been viewed more than 70 million times (Ucha.se, 2020). According to their data, there are more than 900 thousand registered users. Android and iOS apps are also available for a better mobile experience.

Ucha.se contains a combination of video tutorials and tests. Video lessons present the material through situational examples and require simultaneous viewing, listening and writing - stimulation of the three main types of memory. The videos are short and entertaining, which makes learning more focused, fast and easy.

What you learn from the video lessons can be practiced and reinforced with the available tests after the lesson. In case of a wrong answer, the platform automatically offers the exact excerpt from the lesson to make up for the omission.

A game element has also been added to the platform - each student on the site develops his virtual character in real time, as in a game. When the student watches videos, solves tests and participates in discussions under the lessons, his character goes to different levels, gets better and better and collects badges.

Knigovishte

Knigovishte is an educational internet platform that strengthens children's ability to make sense of the text they read - its purpose is to be an innovative "reader's diary" with questionnaires for children's and adolescent books. The start of the project was set in May 2019. The platform includes over 1000 questionnaires for books for children from 6 to 14 years old, and in the future, it is planned to expand to older children (Knigovishte, 2020).

The children choose the title of the read book on the site, answer the questions to it and earn points. Using techniques developed in electronic games (so-called gamification), the platform aims to make reading a fashionable and popular activity among children. As in any electronic game, in Knigovishte, users compete with the computer and with themselves, as well as with their classmates, by reading more and understanding reading better. It gives children topics to talk to classmates and ideas for new books that others like them like.

Smart Classroom

Smart Classroom is a platform consisting of several separate modules that are interconnected. It is part of the Smart Classroom project of Samsung Bulgaria, developed in collaboration with Bulgarian teachers and authors of teaching materials. The modules include a basic module for creating content, a communication module meant to facilitate communication between students and teachers; module for creating exercises with augmented reality (AR), which are performed in the mobile application Smart Classroom AR (for Android) and a teacher and student portfolio (Smart Classroom, 2020).

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Together, these modules create a digital classroom that can be used by teachers and students. This virtual classroom also has several types of boards that the teacher uses, but can also give students access. The main board is graphical and loads by default. The others are a math board that allows the use of special symbols, a media board on which the teacher can upload video from his computer, and also a link board on which he can upload a link to material from the Internet. Depending on the subject, boards can be added and several can be worked on at the same time, with the teacher choosing which one to visualize.

Project "Digital Competencies and Media Education at Pre-school and Primary School Age"

The purpose of the fundamental project "Digital Competencies and Media Education at Pre-school and Primary School Age" (DN 05/8; funded by the Bulgarian Science Fund) is to study and explore the conditions, methods, and approaches that need to be applied for the propaedeutic acquisition and formation of digital competences. To accomplish the aim, there are specific objectives. Dr. Parijkova is a leader of the project's Working Group „Research of the connection between Reading and Digital literacy". The main purpose of the study in this Working Group is to seek the correlation between the formation of digital literacy in children up to 11 years and the development of their reading skills. In the first stage of the project /2017- 2018/ there are made three types of surveys – for students (priority from fourth grade), for parents and for teachers. The greatest responsibility for the formation of digital literacy in early childhood has parents (Parijkova, 2019).

STEM programme of the government of Bulgaria

The national program 'Building a School STEM Environment' is a large-scale STEM programme of the government of Bulgaria. Its primary focus is to create new school 'centers' - an integrated set of specially created and equipped learning spaces with a focus on the study and application of competencies in the field of natural sciences and mathematics in state and municipal schools in the country. The centres will support a range of education innovations, including new teaching methods, teaching environments and educational content.

The national program 'Building a School STEM Environment' aims to create new school centers - an integrated set of specially created and equipped learning spaces with a focus on the study and application of competencies in the field of natural sciences and mathematics in state and municipal schools in the country. Each school center will include the following elements:

- physical environment (improvement of the interior architecture and furnishing of existing spaces)
- technology (equipment)
- learning content,
- teaching methods
- management of the educational process**.**

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The main objective of the programme is to create an integrated learning environment for a new generation in Bulgarian schools, which will encourage and support educational innovations in teaching and learning in the field of STEM, creativity and research. The investments will support the introduction of new teaching methods, raising the qualification of pedagogical specialists and creating new educational content in the direction of integrating the subject areas of STEM. The Program is in line with Bulgaria's Digital transformation Policy and National Science Strategy 2017-2030.

To achieve this, the programme is aimed at schools with (already) innovative practices and those with the potential to develop innovations in science, digital technology, engineering thinking and mathematics (STEM). The national program will create "models" in some Bulgarian schools for successfully investing in a comprehensive idea, including learning environment, technology, management, integrated content, qualifications and teaching methods. The 'Education of Bulgarians Abroad and School Network'-directorate is responsible for the implementation of the programme.

3.1.3. What Titles, Subjects and Concepts Can Be Taught Through AR in Primary School Education

Primary school education in other word, the place for student development and playing, activities, experience and social interaction practiced. Learning experience is very important part in the process of teaching and learning for primary school education because of student in this age need to get more attention in order to increase their motivation and satisfaction in classroom [3]. Today, primary school teachers face challenges when dealing with digital natives. As a result of the explosion and rapid growth in information technologies that can be used in education, there are increasing demands to adopt technology in education, in order to influence students to learn actively and motivate them to gain an effective learning process.

The most applicable subject presented through AR are “man a nature “; “ambient world” and math. Actually, first two subjects are mainly element of biology and ecology.

The ate one of the most suitable study subjects for realization of the AR teaching. They take an intermediate position as it realizes the connection of the natural and human being and have the powerful impact of ethical and aesthetic norms and ideals. The experience and development of man and environment is based on a synthesis of knowledge and modes of activity by relation to the unique features of the biosphere and to the unique characteristics of life itself. It is not by chance that V. I. Vernadsky (cited according to Pressman, 1976) defines the biosphere as a planetary organization of life subordinate to the cosmic organization and thus reveals the unity of the natural sciences in its study.

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Via AR student activities are related to visualizing the studied objects and processes and the methods used for this purpose and experimental productions. Thus, help students to penetrate into the essence of the phenomena and reveal the interrelationships.

3.2. GERMANY

3.2.1. Green Deal Awareness in Primary School Education

It may appear to anyone looking at Germany from the outside that this country is well ahead of the rest of the world as far as the environment is concerned. Not only that hundreds of thousands of people here are involved in a Green Deal Awareness, the most of them carefully separates its waste and Germany is the world's number one with having low-resource of technology for the environment . Germany is also the first country in which gives the most care on environmental protection party has taken on responsibility in government.

Environmental awareness, Green deal awareness training, learning from nature illustrates the complexity of the subject. Green Deal Awareness education is a multifaceted experimentation field. It reflects the search for educational responses to a crisis, the dimensions of which have emerged only slowly. Green deal awareness is made up like a reconciliation many independent creative ideas.

The first United Nations Environment Conference in Stockholm in 1972 not only made the terms environment" and "environmental protection and awareness " into political vogue words , but the representatives also suggested an international programme on environmental education and awareness. These programmes were taken up by the Conference of Education Ministers in Germany and formulated into a "Programme of Action to Promote Environmental Awareness". The first generation of environmental education built upon the tradition of nature awareness conservation education that had already been developed by dedicated natural history and biology teachers at the turn of the century.

In the new "Green deal awareness training" the emphasis was on the science subjects: chemistry, physics and geography. Although the first textbooks that appeared on the subject of environmental protection dealt with the multi-layered structure of nature with its countless mutual dependencies, they hardly took account of the role of man.

"Think globally, act locally"are the key words in Germany. For a school this means that it has to see itself as a first step within the natural cycle for the first time: how much energy is needed to bring the teachers and the pupils to the school, what energy is used to create the optimum learning conditions, how is the heating energy used and where is it being wasted? What is the state of the heat insulation, where is electricity being wasted, what happens with the chemical residues from chemistry lessons and the darkroom, how is waste separated?

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Environmental awareness and its scientific methodology was at the heart of Green deal awareness training; this was mostly conveyed in a warning tone and stressed the responsibility of each individual for his own conduct.

3.2.2. Use of Augmented Reality in Primary School Education

Augmented Reality (AR) has emerged as a powerful tool in primary school education in Germany, enhancing the learning experience for students and providing new opportunities for interactive and immersive learning. Here is some ways AR is being used in primary schools in Germany:

Interactive Learning Experiences: AR applications allow students to interact with virtual objects and characters, bringing abstract concepts to life. For example, students can explore the solar system, witness historical events, or dissect virtual animals, all within the confines of their classroom. By combining physical and virtual learning materials, AR encourages students to participate in an interactive learning environment that makes learning fun and engaging (Lu et al., 2015). Educators must address a variety of challenges inherent to the teaching of scientific disciplines—such as physics — expensive or inadequate laboratory equipment, equipment failure, difficulty simulating certain experimental conditions. Augmented reality (AR) could be a promising approach to tackling these challenges (Cai et al., 2017).

Virtual Field Trips: AR enables students to take virtual field trips without leaving the school premises. They can visit famous landmarks, explore different ecosystems, or even travel through time to experience historical periods, providing a rich and engaging learning experience. In parallel with the developments in instructional technologies, new and innovative teaching methods and techniques that can increase the mental and physical development of children are proposed (Gecu-Parmaksiz et al., 2020). Especially for early children, the development of spatial abilities that require spatial visualization and mental rotation is an important issue (Gecu-Parmaksiz et al., 2020).

Language Learning: The potential to use augmented reality (AR) to create constructive learning opportunities in second language classrooms has been widely recognized. This understanding is based on the claim that ubiquitous learning paradigms, such as AR-based teaching, motivate students to engage in second language learning (Ji & Shin 2019). AR can enhance language learning by providing real-time translations, pronunciation guides, and interactive vocabulary exercises. Students can point their device at an object, and AR overlays will display the corresponding word in their chosen language, helping them develop their vocabulary and language skills. AR allows students to complete the game collaboratively in classrooms and can build a deep understanding of linguistic knowledge in the process (Wen 2019).

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Science and STEM Education: Augmented reality technology has recently become one of the primary technologies for science education (Baran et al., 2020) . AR can transform science lessons by allowing students to visualize complex scientific concepts. For instance, they can examine and manipulate 3D models of molecules, explore human anatomy, or conduct virtual experiments, fostering a deeper understanding of scientific principles. AR applications are effective in the motivation of students to work collaboratively, especially in science teaching (Beyoğlu et al., 2020).

Collaborative Learning: AR facilitates collaborative learning experiences where students can work together on projects and simulations. They can share information, solve problems, and collaborate on virtual tasks, promoting teamwork and communication skills. Beyoğlu et al. (2020), stated that AR applications positively affect students' motivation to work collaboratively.

Gamification of Learning: AR-based educational games make learning more enjoyable and engaging. By incorporating game-like elements, such as challenges, rewards, and interactive quizzes, AR motivates students to actively participate in their learning process. Compared to traditional teaching, educational games can help offer more engaging learning environments (Wen 2018).

Cultural Education: AR can bring cultural heritage to life by overlaying digital information on physical artifacts, monuments, or historical sites. Students can explore ancient civilizations, learn about famous artists, or study local culture through interactive AR experiences. In this context, a large number of digital technologies that are popular among children can increase their cultural awareness and motivation to learn (Chen et al., 2023). Experiential AR blended learning tools, in particular, provide a more meaningful experience that motivates children to appreciate the value of cultural/historical assets (Lee et al., 2021)

Special Needs Education: AR can cater to the individual needs of students with disabilities or learning difficulties. By offering personalized and adaptive learning experiences, AR can help students with visual impairments, attention disorders, or other special needs, fostering inclusivity in the classroom. It has been shown that the use of AR technology can increase learning motivation and tolerance for disability in children with special needs (Lin et al., 2016).

The use of AR in primary school education in Germany is growing, and educators and developers are continuously exploring innovative ways to integrate AR technology into the curriculum. By leveraging the immersive and interactive nature of AR, primary schools in Germany are creating dynamic learning environments that enhance student engagement, foster creativity, and promote a deeper understanding of various subjects.

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3.2.3. What Titles, Subjects and Concepts Can Be Taught Through AR in Primary School Education

AR can be used to teach various titles, subjects, and concepts in primary school education in Germany. Here are some examples:

German Language: The potential to use augmented reality (AR) to create constructive learning opportunities in second language classrooms has been widely recognized(Ji & Shin 2019. AR can support language learning by providing interactive vocabulary exercises, pronunciation guides, and real-time translations. Students can point their devices at objects, and AR overlays will display the corresponding words, helping them develop their language skills (Demir et al., 2022). In his studies, he used Augmented Reality (AR)-based cards for teaching vocabulary in the German language and found that voiced animation-based AR cards increased students' knowledge of German vocabulary. AR allows students to complete the game collaboratively in classrooms and can build a deep understanding of linguistic knowledge in the process (Wen 2019).

Mathematics: AR can enhance the teaching of mathematical concepts, such as geometry, arithmetic, measurement, and problem-solving. Students can interact with virtual objects, visualize mathematical operations, and engage in hands-on activities to deepen their understanding of mathematical principles. In math disciplines such as geometry, learning is often difficult for children, and it is normal for them to encounter some problems while learning these subjects (Gecu-Parmaksiz & Delialioğlu 2020). Parmaksız at al. (2020), in their study, they compared the impact of Augmented Reality (AR)-based virtual manipulatives to physical manipulatives to teach geometric shapes to improve children's spatial skills. The results showed that there was a statistically significant difference in the children's spatial ability test scores in favor of the experimental group.

Natural Sciences: AR can bring science subjects to life by allowing students to explore topics such as the solar system, ecosystems, plants, animals, and the human body. They can interact with 3D models, conduct virtual experiments, and observe scientific phenomena in a more engaging and immersive manner. A study conducted by Beyoğlu at al. (2020) investigated the effect of AR applications on students' motivation to learn science. The study also aims to determine students' attitudes towards augmented reality applications and also to investigate students' opinions about mixed reality applications. The results of the research show that AR applications are effective in students' motivation to work collaboratively in science teaching. In the research, it was concluded that students were willing to use augmented reality applications in science teaching and their anxiety levels decreased. The results revealed that students are pleased to use augmented reality applications in science teaching.

History and Social Studies: AR can provide interactive experiences for teaching history and social studies topics. Students can virtually visit historical sites, witness significant events, and interact with virtual characters from different time periods, fostering a deeper understanding

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of the past and promoting cultural awareness. A study by Utami et al. (2019) focuses on the effectiveness of AR as a history-learning environment. As a result of the research, it was found that AR is effective as a history learning environment.

Geography: AR can help students explore geography by allowing them to virtually visit different countries, landmarks, and natural wonders. They can examine maps, learn about geographical features, and understand spatial relationships in an interactive and immersive way. Augmented Reality, in the context of Geography, can enhance the learning process and user experience through the visualization of content and a better understanding of abstract concepts (Volioti et al., 2022). Volioti et al. (2022) found in their study that AR technology is accepted by all participants learning geography and are willing to be incorporated into the teaching process

Art and Design: AR can support artistic and design education by enabling students to visualize and manipulate virtual art pieces. They can create digital artworks, experiment with different artistic techniques, and explore the works of famous artists through augmented reality exhibitions. Huang et al. (2016) designed a series of art education activities using AR and implemented them in the classroom. The results of the research showed that all children can design, control and interact with the animated objects created by the AR app.

Music: AR can enhance music education by providing interactive experiences with virtual instruments, musical notation, and composition. Students can learn to play virtual instruments, read sheet music, and compose their own music in a dynamic and engaging manner. Güçlü et al. (2021) found in their studies that the interest and motivation of the student who experienced music education for the first time with the application of R increased. In the content analysis study conducted by Apaydınlı (2023), it was determined that AR applications have advantages such as increasing and facilitating the music learning performance of the students, making learning exciting and fun and providing motivation.

Environmental Education: AR can help raise awareness about environmental issues by allowing students to explore ecosystems, learn about sustainable practices, and witness the effects of human activities on the environment. They can engage in virtual conservation activities and understand the importance of environmental stewardship. Theodorou et al. (2018) have addressed the application of AR technology as a means of communicating environmental problems to primary school students and increasing environmental education. The results showed that AR applications for environmental education concepts have a significant complementary learning effect as a mobile-assisted learning tool.

These are just a few examples of how AR can be utilized to teach various titles, subjects, and concepts in primary school education in Germany. The versatility of AR technology allows for creative and innovative applications across a wide range of subjects, promoting interactive and immersive learning experiences for students.

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3.3. LATVIA

3.3.1. Green Deal Awareness in Primary School Education

The content related to EGD goals is included in the Latvian educational standard, which was last published in a new version in 2018 (for the primary school level) and in 2019 (for the secondary school level). Learning related content begins in preschool education and continues at any other level of education. In pre-school education, the content related to EGD goals can be observed most in the field of natural sciences and in the field of social and civic studies. In them, the main learning outcomes related to the goals of EGD are related to getting to know natural resources, teaching about saving natural resources, sustainable waste management and recycling, as well as creating an understanding of the individual's participation in the processes taking place in society (Republic of Latvia Cabinet Regulation No. 716, 2018).

The content to be learned is presented in a complex way, linking knowledge and skills with competences and values that are necessary for any person. Therefore, the goals of EGD are integrated not only in the content to be learned, but also in the cross-cutting competencies to be learned, creating an understanding of sustainable development and one's role in it. In the pre-school stage, it is essential to learn by doing, so the educational standard and the educational program also define a couple of practical approaches to help pre-school children acquire specific knowledge and skills. However, it should be taken into account that ultimately the teacher is responsible for the form of implementation of the content.

The primary school stage, which is from the 1st to the 9th grade, is designed similarly and the EGD goals are integrated both in the learning content and in the competences and values to be learned. The learning outcomes of the primary school stage standard are defined in more detail than in the pre-school education standard, but contain the same learning areas, creating an organic transition from one educational stage to the next. The achievable results of basic education are divided into three main parts - what the student must learn at the end of the 3rd, 6th and 9th grade. The achievable results and their groups are similar, however, each subsequent stage requires more complex knowledge and skills.

The learning outcomes related to the EGD goals can be seen intermediately in any of the cross-cutting skills, as they require the student to develop critical thinking, cooperation, creativity and entrepreneurship, self-directed learning, civil participation and digital skills. The goals of EGD are more clearly visible in the field of natural sciences. Within the field, the student learns the elements of the environment and the types of pollution that can affect them, learns about natural resources and their sustainable use, learns to act responsibly for their own and others' health, including observing a healthy diet, and learns to conduct research to explain processes occurring in nature (Republic of Latvia Cabinet Regulation No. 747, 2018).

The goals set by EGD can also be seen in the field of social and civil education. Within the field, they are taught in connection with sustainable economic and production development, they

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are taught about non-governmental organisations and their set goals, as well as cooperation agreements concluded with Latvia and the European Union (Republic of Latvia Cabinet Regulation No. 747, 2018).

It is important to emphasise that the Latvian education standard and the learning areas defined in it are guidelines for the result to be achieved, which the student must acquire upon completing a certain stage of education. In order to divide the learning outcomes in more detail, study programs have been created for each subject, as well as each teacher defines the learning outcomes within the lesson. Therefore, it is also the educator's responsibility to introduce the student to the goals of EGD. Although the education standard provides for learning topics about sustainable development and other goals related to EGD, it is observed that non-governmental or non-profit organisations, as well as private companies (for example, landfills) or state companies (for example, Latvian State Forests) are more actively developing learning tools on environmental topics.

3.3.2. Use of Augmented Reality in Primary School Education

A unified platform or tool for learning content using AR has not been developed in Latvia. In Latvia, AR solutions in the field of education are more widely used in museum pedagogy or informal education, the use of AR in primary school education is a relatively new concept. If previously the necessary technology was not available in educational institutions, now, along with the implementation of the European Regional Development Fund and the Recovery Fund, schools are supplied with laptop computers to ensure a technology enhanced learning process. In the near future it could also contribute to the use of augmented reality in the classroom.

Although there is no unified platform for the use of augmented reality in Latvia, it is possible to use it within the framework of any topic, if it helps to achieve the learning outcomes defined in the education standard and ensures the meaningful use of technology. One of the examples is the educational content on sustainable development and smart use of resources created by the nature and technology park "Urda" of the company "ZAAO" (area of waste management). The learning materials also include augmented reality solutions (Urda, n.d.). These study materials are available free of charge. Similarly, in Latvia, a repository of digital learning tools "DigiKlase" has been created, where the teacher can familiarise himself with meaningful, outcome-based digital teaching aids with different degrees of interactivity (DigiKlase, n.d.). It also provides an opportunity to add augmented reality learning tools to make them more accessible to both educators and students.

Currently, there is a risk that educators in primary school education are not ready to use augmented reality technologies if they are not available in the national language. There is also a risk that augmented reality tools are not used to ensure a meaningful learning process.

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Therefore, in order to promote the use of augmented reality in education, it is necessary to create such tools that would meaningfully direct the student to the learning outcomes, without creating an unnecessary burden for either the student or the teacher.

3.3.3. What Titles, Subjects and Concepts Can Be Taught Through AR in Primary School Education

The Latvian education standard defines the main guidelines for the knowledge, skills and competences that a student needs to learn any of the stages of education, so the teacher has a relatively free choice with which methods to ensure the learning process. This means that any topic can be learned using augmented reality, as long as appropriate learning materials are developed and the educational institution is technically equipped to implement a technology-enriched learning process.

Considering that children learn by doing in preschool and elementary school, the gamification method and practical activities are used in the learning process. This means that augmented reality is only a small part of a single lesson. At the moment, the most applications in the availability of augmented reality teaching materials are directly in the field of natural sciences, so it is most likely the field in which augmented reality will be used the most.

3.4. ROMANIA

3.4.1. Green Deal Awareness in Primary School Education in Romania

At the beginning of 2023, Romania adopted the "National Strategy on Education for Environment and Climate Change 2023 – 2030". The document sets out clear actions to increase education and awareness among children and young people on sustainable development and environmental responsibility. The objectives and measures foreseen target several levels (formal and non-formal education, human resources, including teacher training, investments, open resources, partnerships, etc.), through four directions of action (Ministerul Educatiei, 2023):

- implementation of a National Education Program for Environment and Climate;
- identifying, promoting and facilitating solutions for the creation and use of educational resources;
- creating, developing and supporting the rehabilitation of infrastructure for sustainable schools;
- training of human resources involved in environmental and climate change education in order to promote a culture of sustainability at the level of educational institutions.

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Environmental and climate change education aims at education for social change through public awareness and concrete actions in order to create a sustainable future.

The implementation of a Climate and Environment Education Programme is a key objective to be achieved by introducing in the national curriculum a week dedicated to environment and climate change, "Green Week". According to the published methodology, the "*Green Week*" program has a duration of 5 consecutive working days, during the school year and is carried out based on a plan, at the decision of each school. The program contributes to the development of the competences of preschoolers/pupils for inter- and transdisciplinary investigation of the surrounding reality and the formation of responsible behaviors towards the environment (Ministerul Educaţiei, 2023). Teachers have access to a platform dedicated to climate change and environmental education, which includes a digital library with educational resources on environmental and climate topics, examples and offers of activities, an interactive map of free accommodation in protected natural areas, as well as examples on the schedule and design of activities (Ministerul Educaţiei, 2023).

The implementation of the Education Program for Climate and Environment is also achieved by introducing, in the national curriculum offer at school decision (CDS), subjects dedicated to education on adaptation to climate change and environmental protection. Schools in Romania have the opportunity to choose their electives within the curriculum at the school's decision, the educational offer proposed by the school must be in accordance with the needs and learning interests of students, with the specifics of the school, with the needs of the local community. In 2023, curriculum at the school's decision in primary classes means 0-1 optional hour in the 20 hours in the common core. Basically, students in a primary school class can choose to study any optional subjects. (Ministerul Educaţiei, 2022)

Through the implementation of the National Recovery and Resilience Plan, in the programmatic period 2021-2026 - Component C 15: Education), the Ministry of Education proposed a series of projects:

1. a project "Building and developing a pilot network of green schools" where Romania aims by the end of 2025 to operationalize a network of "green schools", distributed equitably at territorial level, including on the criterion of representation in rural-urban areas (Ministerul Educaţiei, 2022). According to the published methodology, the concept of "Green School" designates the profile of a school that creates a healthy environment and favors learning, while saving resources, generating its own electricity and using technologies that reduce greenhouse gas emissions (heat pumps, electric buses charged with electricity produced from photovoltaic solar panels, etc. (Ministerul Educaţiei, 2022)
2. a project "Electric minibuses for pupils" where Romania aims to facilitate children's access to education, by protecting the environment, while also contributing to the European Union's objective of reducing net greenhouse gas emissions by at least 55% by 2030. According to the methodology published by this project, the aim is to improve

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transport conditions for pupils, especially for pupils in remote areas, with low population, by providing electric, environmentally friendly school minibuses with low energy consumption (Ministerul educaţiei, 2023).

3. a project "Endowment of schools with special equipment and provision of various educational software". The Ministry of European Investments and Projects aims to renovate, equip with ICT equipment, furniture and educational and sports materials worth 1 billion euros by March 31, 2025. About 3,000 schools (out of about 31,000 school institutions in Romania) from this project target 3 types of investments (Ministerul Educatiei, 2022):

- Digitization of learning environments in pre-university education **(**equipped IT laboratories; 3,600 schools with primary, secondary and high school classes equipped with IT equipment for digitizing learning resources; 909 IT laboratories in vocational education and training schools)
- School infrastructure **(**75,000 classrooms/rooms for extracurricular or sports activities, equipped with furniture; 10,000 laboratories/cabinets in the pre-university education system, including psycho-pedagogical assistance offices)
- Endowment with equipment, including digital, of practical workshops in the vocational education and training network (Ministerul Educatiei, 2022)**.**

Green Deal's awareness in Romania at primary school is also done through various environmental NGOs. More than 155 NGOs are registered in Romania (Catalogul organizațiilor din România) two examples are provided below:

- Nature Talks, which develops education programs for pupils aged 7–12. Nature Talks organized between March and June 2023 environmental workshops for over 6,000 students from over 20 cities in the country, where they attended outdoor classes and learned about air pollution, food waste, separate collection and energy efficiency. (Asociația Nature Talks, 2021)
- Another example of an environmental NGO is the Viitor Plus Association, a non-profit organization that develops social entrepreneurship programs, environmental education, volunteering and environmental infrastructure. The main programs are: Adopt a tree, Recicleta, Recycling Map, Eco Challenge and Eco Office. (Asociatia Viitor Plus, 2008)

3.4.2. Use of Augmented Reality in Primary School Education in Romania

In Romania, the pandemic period was extremely difficult for teachers, with many challenges. Regarding the positive aspects of the pandemic in education, we can say that the number of educational platforms with interface in the Romanian language has greatly increased (Malureanu, 2022) which made available many online educational resources (tools,

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applications and teaching materials) to both teachers and students. Even though some of them were available before the pandemic, many teachers did not know about their existence and did not use them in the classroom. During the pandemic, but also today, they are frequently accessed and used in the classroom.

In Romania, there are no studies showing that primary school teachers use augmented reality (AR) in the classroom and what platforms allow its integration in the classroom.

The augmented reality technique is quite new in schools in Romania, but its use in teaching and learning is easily presented in lessons and primary school and this aspect is noticed on forums for primary school teachers. Another argument that augmented reality is beginning to be known to primary school teachers would be that university professors who teach future teachers/educators through Pedagogy of Primary and Preschool Education programs have begun to include courses on virtual reality and augmented reality in education in their subject records.

Below there are 4 educational platforms frequently used in the classroom by primary school teachers and providing users with 3D and augmented reality (AR) models.

1. Twinkl is the most used online educational platform in Romania by educators and teachers due to its very affordable prices and the quality of educational resources provided. More than 10,000 resources are available in Romanian and over 900,000 in English, German and other languages.

Twinkl ultimate subscribers have access to a growing library of more than 400 3D and augmented reality models (AR) (Resurse educaționale Twinkl, 2023)

- To view the 3D Models, you need a subscription on the platform and they can be accessed from any computer, mobile device or interactive whiteboard and can be rotated, enlarged or reduced, many details can be seen from various angles.
- To view 3D Twinkl models in AR, it is needed an Apple device (iPad, iPhone or computer with updated iOS). Augmented reality (AR) adds an extra element by combining a 3D model with the real environment, this allows for some unique opportunities, such as sitting next to the observed object/being or holding it in the palm of your hand.

The platform explains the concept of augmented reality starting from a brief evolutionary history, the difference between augmented reality (AR) and virtual reality (VR), how augmented reality can be understood in education and what are the benefits of using it in the classroom (Realitatea Augmentată, 2023)**:**

- lessons become much more attractive and interactive;
- Improved learning environment, much more motivating, stimulating learning
- allows a more in-depth approach to some topics, which are often only addressed theoretically

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- a much better understanding of the subjects;
- introduces students to the world of technology and helps them understand what augmented reality means;
- students have the opportunity to learn new knowledge at their own pace;
- encourages visual storytelling;
- turn the educational experience into a much more fun activity;
- Students can explore topics in a practical way and what will prepare them much better for the future;

2. The Mozaweb educational platform is among the first educational platforms with an interface in Romanian language and widely used by primary school teachers on the free version. To access the mosAR application, a paid subscription is required, and the cost for a licence is 80 euro/year, allowing a teacher to use mozaBook and mozaWeb from several devices (Mozaweb, 2023). With the mozAR app, images from Mozaik textbooks come to life, reality being augmented with the camera of an Android or iOS device.

3. According to the website of the Ministry of Education until 2026, Romanian students will have smart boards in class, through the PNRR program "Endowment of schools with special equipment and provision of various educational software". I did not find information about schools in Romania equipped with interactive whiteboards, but teachers who have them have access to the 3D models that come with the installation of the interactive whiteboard software.

4. At the time of writing, over 5028 schools in almost 2500 localities (about 80% of the total) use the educational tools provided and developed by Google (Google, 2022). Every year the company makes improvements to all of Google's educational tools, including an augmented reality platform (Google AR&VR).

3.4.3. What Titles, Subjects and Concepts Can Be Taught Through AR in Primary School Education in Romania

Analyzing the curricula related to the disciplines taught in primary school, a blackboard was made in which we specified the class, the disciplines with the number of hours allocated per week to study in class.

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Table 1. Subjects that can be taught with RA

Class	**Discipline**	**Number of hours/week**
Preparatory class	Mathematics and environmental exploration	**4 hours/week**
Class I	Mathematics and environmental exploration	**4 hours/week**
Class II	Mathematics and environmental exploration	**5 hours/week**
Class III	Mathematics	4 hours/week
	Natural sciences	1 hour/week
Fourth grade	Mathematics	4 hours/week
	Natural sciences	1 hour/week
	History	1 hour/week
	Geography	1 hour/week

The learning contents where augmented reality can be introduced to several primary school disciplines. are presented by class in Table 2, Table 3 and Table 4.

Table 2. Learning contents in the preparatory class, First Class and Second Class - Mathematics and Environmental Exploration (Ministerul Educaţiei, 2014)

Learning contents	**Preparatory class**	**Class I**	**Class II**
Geometric figures and bodies	Bodies/ 3D Cube, cuboid, sphere: name	Geometric figures and bodies: Cube, cuboid, cylinder, sphere: description (faces – shape, number)	Cube, cuboid, cylinder, sphere, cone: construction by given development
Life Sciences	The human body. Component parts and their role	The human body. Skeleton and major organs of the body	The human body. Viruses and their impact on human health

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Life Sciences	Plants and animals. Component parts. Living conditions (water, air, light, heat)	Plants and animals. Skeleton and major animal organs (brain, heart, lungs, stomach, kidneys); Location and roles	Plants and animals. Common characteristics of living (reproduction, growth, basic needs: air, food, water) Living environments: lake/ river, forest
Earth Sciences	Intuitive elements regarding: Earth. The presence of water in nature Natural phenomena: rain, snow, wind, lightning, thunder. Universe Earth, Sun and Moon	Intuitive elements on: Earth Water transformations: solidification, melting, evaporation, boiling, condensation. Sun Universe	Intuitive elements on: Earth Composition: land, water and atmosphere Landforms: mountains, hills, plains. Universe Planets

Table 3. Learning contents in the preparatory class, Class I and Class II - Personal Development (Ministerul Educaţiei, 2014)

Learning contents	**Preparatory class**	**Class I**	**Class II**
Exploring trades	Favorite hobbies and activities	Known trades: Main activities, tools and tools	What are trades used for?

Table 4. Third grade learning contents (Ministerul Educaţiei, 2014)

Matter	**Learning contents**
Mathematics	Locating objects in space and representations in familiar situations Exploring the simple features of geometric figures and bodies in familiar contexts Geometric bodies - cube, parallelepiped, cylinder, sphere, cone (recognition, identification of specific elements)
Natural Sciences	Identification of characteristics of living and non-living bodies Features of the living world Earth - living environment

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	Bodies - properties Transformation of matter

Table 5. Learning contents in the fourth grade (Ministerul Educaţiei, 2014)

Matter	**Learning contents**
Mathematics	Locating objects in space and symbols in various representations Exploring the characteristics, relationships and properties of geometric figures and bodies identified in different contexts Geometric bodies - cube, parallelepiped, pyramid, cylinder, sphere, cone (identification, unfolding, construction using patterns or various materials) - volume of cube and parallelepiped
Natural Sciences	Observation of relationships between bodies within phenomena and processes Life cycles in the living world Earth in the Solar System Testimonies of past life. Fossils Bodies – properties Changes in the characteristics of bodies and materials Energy - sources and effects Electricity. Light
History	Historical places in the community Places of historical importance for Romania Monuments and places included in the UNESCO heritage
Geography	Climate, water, vegetation, animals and soils Relief: general features and relief steps Earth – our planet Earth – a planet of the solar system

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3.5. TURKEY

3.5.1. Green Deal Awareness in Primary School Education

In Turkey, no training is provided to raise awareness about the green agreement, but environmental education achievements for environmental awareness are included in primary school programs.

The Turkish Ministry of Environment and Forestry emphasized the importance of environmental education in the “Turkish Environmental Atlas” published in 2004 and determined what to do in this regard. The aim to be achieved in the subjects related to social and natural sciences, human and environmental relations, natural resources and their use included in the curriculum; is to train individuals have attained environmental awareness and gained environmental awareness and positive behaviors rather than being burdened with knowledge (ÇOB, 2004).

Due to the rapid increase in the importance of the environment today, the Ministry of Environment and the Ministry of National Education, Cooperation Protocol on Studies” was signed and put into effect with the thought that starting from the kindergartens and continuing the environmental education in a systematic and regular way in primary and secondary education institutions, will bring important results. The following items are included in the protocol (ÇOB, 2004):

- Giving importance to applied activities in environmental education of preschool and primary school children,
- Providing training to teachers to improve environmental awareness,
- Allocating one hour a week to environmental education within the scope of Environment Lesson within the framework of the program deemed appropriate in secondary education institutions,
- Giving importance to environmental issues in apprenticeship training programs,
- It is in the form of in-service training courses on environmental education so that teachers and students all over the country can have environmental awareness.

Primary and secondary school is the basic education level for children aged 6-14. In this period, environmental gains are given in various courses (Life Science, Science, Turkish, Social Studies, etc.). In the Life Science curriculum updated in 2018, the subject related to environmental education is included in the "Life in Nature" unit in the 1st, 2nd and 3rd grades (MEB, 2018a). In the unit in this curriculum;

- Getting to know nature and living things,
- Keeping the environment clean and being aware of recycling,

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- Knowing natural events and taking precautions,
- There are basic gains such as being aware of the world and those who travel.

In the social studies curriculum taken in the 4th grade of primary school, environmental issues were included in the unit of People, Places and Environments. In the unit; Gains such as making inferences about the location of any place around it, drawing a sketch of the spaces used in his daily life, distinguishing the natural and human elements in his environment, observing the weather events occurring around him, and making the necessary preparations for natural disasters are included (MEB, 2018b). In the primary school 3rd grade science curriculum, the subjects related to environmental education; It is included in the unit named “Journey to the world of living things”. If we look at the achievements of this unit, gains such as recognizing the assets in our environment, understanding and knowing the natural and artificial environment, and protecting the natural environment come to the fore. When we look at the 4th grade level of the same curriculum; In the “lighting and sound technologies” unit: while sound, light and noise pollution are at the forefront; In the “human and environment” unit: resource use, being economical, being a conscious consumer, the importance of resources and recycling are emphasized (MEB, 2018c).

3.5.2. Use of Augmented Reality in Primary School Education

An augmented reality application named mebar has been developed by the Ministry of National Education, which takes into account the positive outputs created by the use of augmented reality in education. “MEBAR Augmented Reality Application" was developed by Istanbul Teacher Academies Technology Unit of Istanbul Provincial Directorate of National Education. The MEBAR Augmented Reality Application, which is aimed to be used free of charge by teachers and students in all areas of life, was developed as a mobile application that can be used during make-up training and activities. Equipped with 3D content prepared for different disciplines, MEBAR has been designed to raise awareness in the field of augmented reality and increase productivity in education and training environments and in all areas of life by using the information needed by teachers and students. In addition, MEBAR is Turkey's largest and first corporate augmented reality platform and application developed entirely by teachers by our Provincial Directorate of National Education. The augmented reality box contents prepared for MEBAR have been developed to be used via phones as well.

In addition, many studies investigating the use of augmented reality in education have been carried out in Turkey, some of which are at primary school level. Examples of these studies are presented below. In the research conducted by Boz (2019), it is seen that teachers mostly use AR applications in their lessons as complementary or supportive to the curriculum. Another use is for “Practice/Practice (practice with simulation in different environments, etc.)”. The

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teachers who participated in the research stated their other purposes of using AR applications in their answers to the open-ended question as follows:

- Enriching the lecture with visuals and videos,
- To draw students' attention to the lesson,
- To translate, to help students understand abstract subjects better,
- To compete,
- To enrich the activities they organize for certain days and weeks.

In addition, according to the teachers, "Concrete concretization of abstract concepts" (12%) comes first among the fields of use of AR applications in education. “Visualizing concepts and spatial relations” (10%) is in the second place and “Giving a third dimension to two-dimensional books” (8%). Teachers think that AR applications facilitate students' interest in the lesson (17%), increase student participation in the lesson (14%) and facilitate student learning (12%).

Between 2012 and 2013, a group of 100 people used the "augmented reality 3D geometry software" application in the 6th grade of Aksaray. The aim of the study was to show students' perspectives on mathematics, AR technologies and academic achievement. The study showed that both groups had a positive view of mathematics and AR technology, and there was a significant difference in academic achievement in one of the groups (İbili, 2013).

In the research conducted by Gün (2014), 88 6th grade students were allowed to examine the 3-dimensional state of solid objects in the mathematics lesson by using the BuildAR application. As a result of the study, it was observed that while there was no significant difference in the academic success of the students, they developed a positive attitude towards AR applications.

Yılmaz (2014) enabled secondary school students to construct stories using AR technology. At the end of the application, according to the students who fictionalized a story with AR technology; story they are more successful in terms of editing, creativity in the story, the length of the story, the number of adjectives used; In the comparison between the sexes, it was seen that there was no difference. In the study by Yılmaz (2015), educational magic toys (EMT) were created using augmented reality technology. This study found that EMT activities were enjoyed by both teachers and students. Average 5–6 age children in Early Childhood Education with these toys, but their cognitive development was not very advanced. Yıldırım (2019)’s research it has been determined that the teaching enriched with AR applications is more effective on the language and concept development of preschool students than traditional teaching. As a result of the Ekiçi ve Yeşilbursa (2021)’s research, students' AR applications easy to use, interesting, surprising, and the application creates a feeling of flow; Social Studies course In terms of academic achievement, it increases the interest and motivation in the course and also provides permanent learning opinions have been expressed.

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3.5.3. What Titles, Subjects and Concepts Can Be Taught Through AR in Primary School Education

Nowadays, the use of AR is increasing in education, as in many other fields. AR can be used at many levels of education, including primary school. AR has the potential to transform education and training by providing interactive and immersive experiences. It can enhance traditional learning methods by overlaying additional information, 3D models, and simulations onto real-world objects. AR can be used for interactive textbooks, virtual science experiments, language learning, and more. Students will be able to conduct experiments without harming the environment by utilizing augmented reality to solve issues, fix, and maintain experimental equipment. The use of augmented reality in the classroom and the chance to learn about a topic in its natural setting attract students. A study's object, such as an atomic structure that may be studied in a convenient representation, can now be represented by both virtual and real-world items existing side by side thanks to augmented reality, which also allows for the expansion of space and time (Popel & Shyshkina, 2018).

Many subjects in primary school education can be taught through AR. AR can enhance the teaching of mathematical concepts, such as geometry, arithmetic, measurement, and problem-solving. AR can bring science subjects to life by allowing students to explore topics such as the solar system, ecosystems, plants, animals, and the human body. AR can help students explore geography by allowing them to virtually visit different countries, landmarks, and natural wonders. AR can support artistic and design education by enabling students to visualize and manipulate virtual art pieces. AR can help raise awareness about environmental issues by allowing students to explore ecosystems, learn about sustainable practices, and witness the effects of human activities on the environment.

4. CONCLUSION

4.1. BULGARIA

4.1.1. Why the EU Underlines the Green Deal Awareness?

In light of this, UNESCO proposed the 2030 Action Plan for Education in 2015, which provides country-specific implementation guidelines for Sustainable Development Goals (SDGs) (UNESCO, 2015a,b, 2016). Among the expectations and challenges for quality learning, teachers are highlighted as the key to enhancing quality learning, and a variety of organizations (including profit-making businesses, civic

groups, social enterprises, etc.) are expected to participate in educational innovation and investment (Naidoo, 2017). The aim of environmental education is not only what children should learn about the environment, but also to build children’s correct attitudes and positive relationships toward the environment, so designing the appropriate curriculum is important

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to achieve the learning goals (Surjanti et al., 2018). Based on a growing body of research highlighting the complexities of behavior, environmental education is no longer a linear pathway from developing attitudes toward the environment to learning about protecting it and then to taking action to improve it, and now emphasizes the dynamic, complex relational ecosystems that influence behavior (Marcinkowski and Reid, 2019).

4.1.2. Reasons for Using Augmented Reality in Primary Education

Therefore, the requirement to enhance education with the latest technologies continues to increase to the point where it is becoming an essential part of good teaching. In fact, teachers are required to spend a good deal of personal time familiarizing themselves with innovative and emerging technologies to gain a high level of confidence for integrating them in lessons, as these could really enhance student learning and engagement (Pierson, 2001).

In fact, AR offers an efficient way to visualize abstract concepts and support stu- dents' interaction and engagement (Cook, 2006, Di Serio, Ibáñez,Kloos, 2013, Martin, Diaz, Sancristobal, Gil, Castro and Peire, J. 2011, Singhal, Bagga, Goyal, Saxena, 2012, Wu, Krajcik, Soloway 2001).

For instance, AR could support seamless interaction between real and virtual environments and facilitate the use of a tangible interface metaphor for object manipulation. AR could also enable learning outside class hours and outside school limits by creating a learning experience that is linked to the formal classroom (Burton, Frazier, Annetta, LambCheng. and Chmiel, 2011).

Although a lot of research has been conducted on AR and it has been proved to have potential application in education, limited studies have been conducted in regarding adopting AR in education field (Kesim, and Ozarslan, 2012).

Due to the promising features and a results of the enhancement in computer and information technology, AR in education is considered to play a more efficient role with wider user adoption than ever before (Lee, 2012).

Wu et al. (2013) explain that the "learning activities associated with AR usually involve innovative approaches such as participatory simulations and studio-based pedagogy".

Lindgren, Tscholl, Wang, & Johnson (2016) also reported high levels of engagement among middle school students studying the gravity and planetary motion. In this study, the AR provided an immersive environment with a whole-body interactive simulation of an outer space field that was projected onto the floor and walls. Students used their body to load virtual asteroids onto a spring and predict their movement in and around the planets in the AR projection.

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Educators must be consider to bring this emerging technology to support and enhance learning by integrated with the use of computers, multimedia materials, internet, simulations game and immersive technology such as 3D virtual world and Augmented Reality (Di Serio, Ibanez and Kloos, 2012). The creative strategies should be implemented as such as organize sets of activities to support learning and at the same time to meet pedagogical practice (Kreijns, Acker, Vermeulen and Buuren, 2013).

If AR technology can be properly used in teaching, it can be beneficial in solving educational problems such as lack of classroom time, crowded classrooms, and inexperienced teachers (Akçayır and Akçayır, 2017).

One could argue that the adoption of AR into instruction in schools is very early in the adoption process and that those educators who are using it or advocating for its use fall into the Innovators or Early Adopters categories (Cavanagh, 2019). In education, the adoption of any technology tool is not necessarily bound to its newness and innovation alone, but to ist effectiveness in engaging and motivating students and creating an enjoyable learning environment.

4.1.3. Suggestions to "How Augmented Reality Can Be Used to Increasing Green Deal Awareness in Primary School Education"

Environmental topics being studied in the classroom should influence the way the whole school operates. What the children study should enhance the environmental actions being undertaken by the school. This will provide greater relevance for the students. Opportunities exist within Green Education to make curriculum links into a range of subjects at many levels.

Global environmental change touches upon every aspect of human existence such as health, diet, leisure, quality of life, every day practices; production, consumption, education, research, politics, and societal values. All students deserve the opportunity to be educated in healthy environments that are conducive to learning and support their dreams for a brighter future.

Accordingly, in 2002, the UN established the Decade of Education for Sustainable Development (DESD) for the period 2005 to 2014 and appointed UNESCO (UNESCO, 2005) to integrate sustainability development into all academic subjects, via a holistic inter- and trans-disciplinary approach with a clear focus on values and ethics (UNESCO, 2007). The term Education for Sustainability (EfS) is used interchangeably with Education for Sustainable Development (ESD) and where sustain- ability is interpreted as "both a process and a broad direction" (Sidiropoulos, 2014). Sustainability is a value, a space, a skillset and a mindset and EfS is focussed on providing individuals with "knowledge, skills and understanding necessary to make decisions based upon their full environmental, social and economic implications" and to create sustainable alternatives as individuals (Schelly, Cross, Franzen, Hall, & Reeve, 2012).

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There is a tremendous opportunity and a grand teachable moment for children to learn about ecological sustainability, environmental health, nutrition, personal responsibility, and leadership through their hands–on participation in making their own schools healthier, more efficient, sustainable, and pleasant centers for learning (Xiong et al., 2013).

Benefits

1. Conserves energy and natural resources

2. Saves taxpayer money

3. Improves indoor air quality

4. Removes toxic materials from buildings

5. Employs daylighting strategies and improves classroom acoustics

6. Employs sustainable purchasing and green cleaning practices

7. Improves environmental literacy in students

8. Encourages recycling

9. Promotes habitat protection

10. Reduces demand on local landfills

Three issues arise from these implications: first, that sustainability programs should incorporate a course or series of courses that expose students to a wide variety of scholarly approaches to sustainability early in the curriculum; second, within courses deeply entrenched in disciplinary silos, sustainability should be presented in a way in which disciplinary focus is situated within that larger frame; and third, greater attention should be paid within programs that are fully integrated with an emphasis on typical descriptors of effective sustainability education as holistic systems, ability to make connection, interdisciplinarity and lateral rigor (Weissman, 2012).

Green education endeavours to extend learning beyond the classroom and develop responsible attitudes and commitment. Schools consume enormous quantities of paper and energy, produce tons of waste and carbon emissions, and rarely purchase environmentally friendly products. Schools use cleaners and pesticides with neurological and reproductive toxins, which are dangerous.

This knowledge should be adopted to ensure a more ecologically literate and environmentally sensitive generation will follow and ultimately the environmental problems that threaten our existence will be solved. The development of a green education curriculum tailor made for the school system will contribute to the body of knowledge for environmental conservation and sustainability development.

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School greening is quickly becoming more than a trend. It is now the method of choice for providing healthy, comfortable and productive learning environments while saving energy, resources and money (Watson, 2012). School greening is also playing a very important role in preparing the youth of today for the green jobs of tomorrow by teaching children to become environmental citizens (Gadotti, 2010). Environmental education is critical to a Green Education initiative and future generations. Programs of study that focus on the environment and sustainability should involve the children in greening their school (Cole, 2014). Promoting environmental education through hands-on projects, with measurable results will help students' develop strong civic skills, environmental stewardship and workforce preparedness (Fisher & McAdams, 2015).

4.2. GERMANY

4.2.1. Why the EU Underlines the Green Deal Awareness?

This Communication display a European Green Deal for the European Union and its citizens. It resets the Commission's commitment to struggle with the climate and environmental-challenges that is this generation's defining task. The atmosphere is warming and the climate is changing year by year . Two million of the nine million species on the planet are at risk of being lost. Forests and oceans are being polluted by the people.

Together with the industrial strategy, a new circular economy action plan will help modernise the EU's economy and take advantage of the opportunities of circular economy domestically and globally. The action will focus in particular on resource sectors such as textiles, construction, electronics and plastics. A sustainable product policy also has the potential to reduce waste immediately.

Therefore, by diversifying the supply from both primary and secondary sources, ensuring the supply of sustainable raw materials, especially raw materials needed for new clean technologies, digital, space and defense applications, is one of the prerequisites for this transition to take place.

4.2.2. Reasons for Using Augmented Reality in Primary Education

There are several reasons for using augmented reality (AR) in primary education. Here are some of the key benefits:

Engagement and Motivation: With the Mobile learning system through AR, it can appeal to students at a greater staff level and encourage both engagement and motivation among its users (Hanafi 2017). AR creates a highly engaging and interactive learning environment for students. The immersive and interactive nature of AR captivates students' attention and motivates them to actively participate in their learning. This increased engagement leads to

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better retention of knowledge and a more positive attitude towards learning. Studies using AR as a teaching tool have also reported high levels of engagement (Mundy et al., 2019).

Visual and Experiential Learning: The development of more personalized educational offerings that incorporate different methods of auditory, visual, and experiential learning could lead to a better-educated population that is better able to cope with the complexities of the modern world (Gillpatrick, 2020). AR provides visual representations and hands-on experiences that enhance the learning process. Students can interact with virtual objects and 3D models, making abstract and complex concepts more understandable and tangible. This visual and experiential approach fosters a deeper understanding of the subject matter (Mudaly & Singh 2018).

Personalized Learning: The term personalized learning has proliferated especially in recent years with the advancement of various educational technologies, conceptual frameworks, and mobile and wireless internet technologies (Nandigam et al., 2014) AR can be tailored to individual students' needs and learning styles. It allows for adaptive learning experiences, where content and difficulty levels can be adjusted based on the student's progress and abilities. This personalization helps students learn at their own pace and promotes a sense of ownership over their learning journey. AR applications that use emerging technologies for personalized education have tremendous potential for efficient training (Gurieva et al., 2019).

Multisensory Learning: One of the most important features of multimedia is its ability to stimulate perceptions and information processing in different formats, which allows for the inclusion of multisensory modalities (Vedadiet al., 2019). AR combines visual, auditory, and sometimes haptic (touch-based) stimuli, creating a multisensory learning experience. This multisensory approach enhances memory retention and comprehension by stimulating different senses simultaneously. It accommodates diverse learning preferences and provides a more comprehensive learning experience.

Collaboration and Social Learning: AR systems can be used to create unique collaborative experiences. For example, users in the same location can see shared 3D virtual objects with which they are interacting, or a user can annotate a live video image of a remote employee so they can collaborate remotely. The overall goal is to enhance the face-to-face collaborative experience, or to make remote people feel like they're virtually in the same place (Lukosch et al., 2015). AR can facilitate collaborative learning experiences, allowing students to work together on projects and simulations. They can share information, solve problems, and communicate effectively, fostering teamwork and social skills development. AR-based collaborative activities promote peer interaction and cooperative learning.

Real-World Connections: Relevance to the real world requires relating abstract scientific concepts to the real world. This can be done by embedding learning processes into real-world contexts and bridging the gap between virtual content and the real world with augmented reality (AR) (Laine et al., 2016). AR bridges the gap between the classroom and the real world

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by overlaying virtual information on the physical environment. Students can explore real-world applications of concepts, make connections to their daily lives, and develop a deeper appreciation for the relevance and practicality of what they learn in school.

Inclusivity and Accessibility: Because immersive experiences can add variety to the daily routine and thus improve quality of life, VR and AR content can be particularly appealing for individuals with disabilities and older people who are often tied to home because of limited mobility (Yin et al., 2023). AR can cater to the needs of students with different learning styles, abilities, and special needs. It provides alternative modes of representation and interaction, enabling students with disabilities to access and participate in the learning process. AR promotes inclusivity in the classroom and ensures that all students have equal opportunities to learn and succeed.

Future Skills Development: By using AR in education, students gain exposure to emerging technologies and develop skills that are increasingly valuable in the digital age. They acquire critical thinking, problem-solving, creativity, and technological literacy skills, preparing them for the challenges of the future.

These reasons demonstrate the significant advantages of incorporating augmented reality in primary education, offering a dynamic and innovative approach to teaching and learning that benefits students, educators, and the overall learning experience.

4.2.3. Suggestions to "How Augmented Reality Can Be Used to Increasing Green Deal Awareness in Primary School Education"

Using augmented reality (AR) to increase Green Deal awareness in primary school education can be an effective way to engage students in environmental issues and promote sustainability. Here are some suggestions on how AR can be utilized for this purpose:

Virtual Tours of Sustainable Energy Sources: Create AR experiences that allow students to virtually visit renewable energy sites, such as solar farms, wind turbines, or hydroelectric plants. They can explore how these sources work, understand their benefits, and learn about their role in achieving sustainability goals.

Interactive Recycling and Waste Management: Develop AR applications that educate students about proper recycling techniques and waste management practices. Students can use AR to scan different items and learn how to sort them correctly, helping them develop environmentally conscious habits.

Virtual Green Spaces and Gardens: Use AR to transform school grounds into virtual green spaces or gardens. Students can interact with virtual plants, learn about their importance for biodiversity, and understand the benefits of urban greening in mitigating climate change.

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Carbon Footprint Calculators: Create AR tools that enable students to calculate their carbon footprints. By inputting their daily activities and habits, students can visualize the environmental impact of their actions and explore ways to reduce their carbon emissions.

Interactive Climate Change Simulations: Develop AR simulations that allow students to witness the effects of climate change on different environments, such as melting glaciers or changing weather patterns. This immersive experience can help students understand the urgency of addressing climate issues.

Sustainable City Planning: Use AR to engage students in urban planning and sustainable city design. They can create virtual models of eco-friendly cities, incorporating renewable energy sources, green spaces, and efficient transportation systems. This activity promotes critical thinking and problem-solving skills while fostering an understanding of sustainable urban development.

Wildlife Conservation Experiences: Develop AR applications that showcase endangered species and their habitats. Students can interact with virtual animals, learn about their conservation status, and explore the importance of protecting biodiversity for a sustainable future.

Interactive Sustainability Challenges: Design AR-based challenges that encourage students to make sustainable choices and take actions that support the Green Deal objectives. For example, they can complete virtual quests to reduce energy consumption, conserve water, or promote eco-friendly practices within their communities.

Virtual Environmental Campaigns: Empower students to create their virtual environmental campaigns using AR. They can design posters, videos, or interactive presentations that raise awareness about specific environmental issues and propose solutions for a greener future.

Collaborative AR Projects: Foster collaboration among students by assigning group projects that involve designing and implementing AR experiences related to the Green Deal. This collaborative approach promotes teamwork, creativity, and shared responsibility towards environmental sustainability.

By incorporating these suggestions, AR can be a powerful tool to increase Green Deal awareness in primary school education. It can spark students' curiosity, inspire action, and empower them to become environmental advocates, contributing to a more sustainable future.

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4.3. LATVIA

4.3.1. Why the EU Underlines the Green Deal Awareness?

EGD is not the only project that advocates the goals of sustainable development. On a much broader scale, the United Nations Educational, Scientific and Cultural Organization (UNESCO) sets the Sustainable Development Goals, which also include the goals that the EGD have identified as their project priorities. Also at the level of UNESCO, the strategy of education development and how to communicate the goals of sustainable development with students and society is being thought of (*UNESCO*, n.d.). EGD, on the other hand, has the opportunity to look in a narrower context, looking at the immediate environment. In this way, each individual has the opportunity to associate himself with the processes taking place around him, he will feel a greater responsibility and impact for the importance of sustainable development. Achieving the goals of EGD is also gradually moving towards the priorities of sustainable development set by UNESCO.

4.3.2. Reasons for Using Augmented Reality in Primary Education

As mentioned in the previous chapters, it is essential for a student to learn by doing in preschool and primary school. The interactive environment of augmented reality gives the student the opportunity to explore on his own. Interest and the desire to learn is also one of the skills that the student must develop as a competence, and augmented reality provides the opportunity to learn independently if the learning outcome is clearly known. Another reason can be the ability of augmented reality to represent complex phenomena or models that the student cannot see in real life (Fotaris et al., 2017). An example is the operation of the Solar system or the structure of a planet. With the help of augmented reality, it is possible to teach students about abstract topics, creating not only an understanding of the topic, but also motivation to learn (Fotaris et al., 2017; Chen et al., 2019). The third important factor is the relatively easy availability of augmented reality technology. While virtual reality requires a special device to create a virtual environment, augmented reality can be used from various devices, including phones, tablets, individual laptops, which are more accessible technologies such as head-mounted displays (Alalwan et al., 2020). Augmented reality content can be integrated into textbooks and the student can easily access it with the help of their phone.

4.3.3. Suggestions to "How Augmented Reality Can Be Used to Increasing Green Deal Awareness in Primary School Education"

In order to use augmented reality in the learning process, there are several important things to consider. A significant role is played by the meaningful use of technology in the provision

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of the learning process. Augmented reality learning tools should guide the student towards learning outcomes. It is not important whether the learning outcomes to be achieved is defined in formal or informal education - without a certain result to be achieved, the learning process is not effective and technologies are not used meaningfully. The second essential role is to understand the characteristics of a student's age. It is essential for students in preschool and elementary school to learn by doing, including game elements in the learning process, so augmented reality is a good tool to ensure this. However, the use of augmented reality cannot be the only method with which the student is employed - it must be integrated into the learning process, best by offering teachers ready-made lesson plans that integrate an activity with the use of augmented reality, also mentioning specific tools that will help guide students to the achievable result, creating a technology enhanced learning process. It is also important to prepare the educators themselves for a technology enhanced learning process. If the educator feels that the use of augmented reality creates a burden rather than facilitating the learning process, the use of augmented reality may not achieve the originally intended goals. Therefore, it will be necessary to describe the methodology for using augmented reality for educators in the learning process.

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4.4. ROMANIA

4.4.1. Why the EU Underlines the Green Deal Awareness?

The European Union has placed significant emphasis on the importance of the Green Deal, a comprehensive policy framework aimed at achieving sustainable development and addressing climate change. The Green Deal, presented in 2019, builds upon the principles of the United Nations' Sustainable Development Goals. These goals provide a clear and transparent framework for sustainable development while setting specific targets to aim for. Additionally, the Green Deal outlines measures to promote ecosystem services related to land use. Furthermore, the EU recognizes that its actions in reducing greenhouse gas emissions go beyond its obligations under global climate agreements. With a vision of achieving climate neutrality by 2050 (Cengiz & Kutlu, 2021).

The EU sees the Green Deal as an essential tool for tackling the climate-environment relationship and ensuring a sustainable future for its member states. The EU's emphasis on the Green Deal is based on its recognition of the urgent need to address environmental challenges and transition towards a sustainable society. One of the key reasons why the EU underlines the importance of the Green Deal is because it aligns with and supports their commitment to achieving the Sustainable Development Goals set by the United Nations. The SDGs provide a comprehensive framework for addressing social, economic, and environmental challenges globally. By incorporating these goals into its policies, such as reducing air, water, and soil pollution, promoting biodiversity conservation, and ensuring sustainable energy use and resource management, the EU aims to contribute towards global sustainability efforts (Cayirağasi & Sakici, 2021).

In addition to aligning with the UN's SDGs, the EU also recognizes that the Green Deal is crucial for addressing pressing environmental concerns within its own borders. The EU acknowledges the need to reduce greenhouse gas emissions and mitigate climate change, as well as the importance of protecting ecosystems and biodiversity. By implementing the Green Deal, the EU aims to achieve these goals while also promoting societal well-being and economic growth.

The Green Deal serves as a roadmap for the EU to achieve its sustainability objectives and address the interconnected challenges of climate change, environmental degradation, and social inequality. It presents a comprehensive strategy that encompasses various aspects of sustainability, such as reducing pollution, improving resource efficiency, promoting circular economy principles, and investing in renewable energy sources. Moreover, the Green Deal emphasizes the importance of sustainable land use and recognizes that ecosystems and their services are closely tied to the well-being of both humans and the planet. Therefore, the EU sees the Green Deal as a crucial tool in achieving a climate-neutral EU by 2050 and ensuring the long-term well-being of its citizens.

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The Green Deal is not only a key element of the EU's strategy for implementing the UN Sustainable Development Goals but also a reflection of the EU's commitment to creating a sustainable society. It aims to promote the transition towards a greener and more sustainable economy while also addressing social inequalities and improving the quality of life for all EU citizens. Furthermore, the EU recognizes that achieving a toxic-free environment is essential for sustainable development. To this end, the EU has committed to presenting a chemicals strategy for sustainability as part of the Green Deal. This strategy will focus on minimizing exposure to hazardous chemicals and promoting the use of safer alternatives, thereby safeguarding human health, and protecting ecosystems. The Green Deal also recognizes the important role of the financial system in driving sustainable investments and innovative projects.

The Green Deal seeks to change how the financial system allocates capital and manages investments for innovative projects and businesses. It aims to encourage investment strategies that internalize environmental costs as financial risks, rather than externalize these risks, which is the standard approach for most financing strategies (Long & Blok, 2021).

4.4.2. Reasons for Using Augmented Reality in Primary Education

Augmented reality technology has gained significant attention in recent years for its potential applications in various fields, including education. One area where augmented reality has shown great promise is in primary education. There are several reasons why augmented reality is being increasingly embraced as a valuable tool in primary education.

First and foremost, augmented reality can greatly enhance the learning experience for young children. By integrating digital information into the real-world environment, augmented reality creates a more immersive and interactive learning experience. This can help to capture and maintain the attention of young students, making the learning process more engaging and enjoyable. Research has shown that when students are actively engaged in their learning, they are more likely to retain information and develop a deeper understanding of the concepts being taught. Furthermore, augmented reality can support learning while playing in primary school education (Zuniari et al., 2022).

Incorporating augmented reality into play-based learning activities can allow children to apply their knowledge and skills in a meaningful and engaging way. In addition to enhancing the learning experience, augmented reality in primary education can also have positive effects on students' motivation. Learning gains and increased motivation are among the reported advantages of using augmented reality systems in education (Wang et al., 2011).

The use of augmented reality in primary education can also promote the development of critical thinking and problem-solving skills. Through interactive simulations and virtual scenarios, augmented reality can provide students with opportunities to apply their

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knowledge and skills in real-world contexts. This can help them develop their problem-solving abilities and encourage creative thinking (Papoutsi et al., 2021). Moreover, augmented reality can also support the acquisition of both procedural-practical knowledge, such as completing tasks or following instructions, and declarative knowledge, which refers to factual information and concepts. Research has shown that students who engage with augmented reality in their learning process demonstrate improved analytical and problem-solving skills, as well as a better understanding of theoretical concepts (Karadavut & Çimen, 2021). Furthermore, augmented reality has the potential to bridge the learning gap among students from different socioeconomic backgrounds. Due to the alarming statistics that show a significant number of students performing below proficient levels in math and reading, particularly among children from low-income families, there is a pressing need for innovative approaches to education that can address these disparities. Augmented reality technology could play a crucial role in closing this learning gap. By providing interactive and engaging visualizations, augmented reality can make learning more accessible and enjoyable for students, regardless of their socioeconomic status. In the domain of learning, augmented reality has been shown to have measurable benefits over traditional approaches when experienced by K-12 students and adults. Furthermore, research has shown that the use of augmented reality in education can improve student achievement (Sirakaya & Sirakaya, 2018). This is evident from the findings that augmented reality increases student participation and motivation, making classes more enjoyable (Sirakaya & Sirakaya, 2018).

Additionally, augmented reality can enhance the learning experience by making it more immersive and interactive. Using augmented reality in education can create a more engaging and immersive learning experience for students (Sirakaya & Sirakaya, 2018).

4.4.3. Suggestions to “How Augmented Reality Can Be Used to Increasing Green Deal Awareness in Primary School Education”

In today's rapidly changing world, the significance of accurate and timely weather forecasts cannot be overstated. With the increasing focus on environmental issues such as climate change and sustainability, it is essential for young people to be aware of and engaged in initiatives like the Green Deal.

The Green Deal is a comprehensive plan proposed to address environmental challenges and promote sustainable development. One innovative approach to increasing awareness of the Green Deal in primary school education is by utilizing augmented reality technology. This emerging technology has already been successfully implemented in various educational contexts, including preschool, elementary school, middle school, and high school. According to research, augmented reality has been found to have a positive impact on the quality of education and student learning outcomes (Kyaw et al., 2019). Specifically, a study conducted by South American researchers in primary school education found that the use of augmented

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reality improved the efficiency of the educational process, enhanced students' mastery of the material, and resulted in higher levels of academic performance. Augmented reality can be a valuable tool in increasing Green Deal awareness in primary school education due to its interactive and immersive nature. By incorporating augmented reality elements into educational programs, students can engage in interactive experiences that bring the concepts of sustainability and environmental conservation to life (Szymczak, 2019). For example, students can use a mobile navigation application with augmented reality elements to explore different environmental settings and learn about the impact of human activities on ecosystems.

Through augmented reality, students can visualize the consequences of their actions and make connections between their daily lives and broader environmental issues. Furthermore, augmented reality can also facilitate hands-on learning experiences by allowing students to interact with virtual objects and simulations related to the Green Deal. This can help students develop a deeper understanding of concepts and enhance their problem-solving skills.

By utilizing augmented reality, primary school students can become actively involved in their own learning process and develop a sense of agency when it comes to addressing environmental challenges and promoting sustainable development. Augmented reality technology can also enhance the effectiveness of teaching procedural-practical knowledge, declarative knowledge, analytical/problem-solving skills, theoretical concepts, and soft skills (Chen & Xia, 2022). Additionally, augmented reality simulations can be used to immerse students in the roles of scientists conducting investigations (Akin & Göktürk, 2019).

This hands-on approach can foster a sense of curiosity and inquiry, as well as develop their scientific thinking and investigation skills. Moreover, the use of augmented reality in primary school education can also enhance motivation and engagement among students. Research has shown that augmented reality systems in education can increase motivation and engagement among students (Abutayeh et al., 2022).

This is due to the interactive and immersive nature of augmented reality, which captures students' attention and encourages active participation in the learning process. Overall, the integration of augmented reality into primary school education can greatly increase awareness and understanding of environmental issues related to the Green Deal.

By bringing abstract concepts to life and providing interactive learning experiences, augmented reality can engage students in a way that traditional teaching methods cannot. According to research from South America, using augmented reality in primary school education has a positive effect on educational quality. In an experiment on primary school geography instruction, South American researchers discovered that using a mobile navigation app with augmented reality components improved student mastery of the subject matter and increased academic performance (Lazo-Amado et al., 2022).

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Overall, the use of augmented reality in primary school education can increase Green Deal awareness by enhancing students' problem-solving skills, fostering curiosity and inquiry, developing scientific thinking and investigation skills, and promoting motivation and engagement.

4.5. TURKEY

4.5.1. Why the EU Underlines the Green Deal Awareness?

EU sets out a European Green Deal to tackling climate and environmental-related challenges that is this generation's defining task. The atmosphere is warming and the climate is changing with each passing year. Forests and oceans are being polluted and destroyed. The European Green Deal is a response to these challenges. It is a new growth strategy that aims to transform the EU into a fair and prosperous society, with a modern, resource-efficient and competitive economy where there are no net emissions of greenhouse gases in 2050. It also aims to protect and enhance protect the health and well-being of citizens from environment-related risks and impacts.

4.5.2. Reasons for Using Augmented Reality in Primary Education

The teaching and use of AR applications will contribute to the increase of students' digital skills. At the same time, the use of innovative technologies in learning and teaching activities will be ensured. In recent years, it has become inevitable to use digital tools and equipment as course materials in classroom environments. One of these innovative digital technologies used in classroom environments is AR technology and applications, whose educational value is increasingly recognized. AR is expressed as the interactive display of virtual objects together with the real environment, thanks to the use of technological tools. In addition, it is stated in the studies carried out that AR technologies make the learning content three-dimensional, provide visuality, enable learning regardless of time and place.

When the literature is examined, the benefits of using augmented reality applications in primary school education are determined as listed below (Dunleavy, Dede ve Mitchell, 2009; Johnson ve diğerleri, 2010; Behzadan, Iqbal ve Kamat, 2011; Lee, 2012; Singhal ve diğerleri, 2012; Wojciechowski ve Cellary, 2013 Wu ve diğerleri, 2013 Rambli, Matcha ve Sulaiman, 2013 Di Serio, Ibanez ve Kloos, 2013; Radu, 2014; Bacca ve diğerleri, 2014; Danish ve DeLiema, 2015; Hwang ve diğerleri, 2016; Yılmaz ve Batdı, 2016; Ibanez, Di Serio, Villaran ve Kloos, 2016)

Offers an engaging learning opportunity

- Makes learning permanent

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- Embody abstract concepts
- Makes lessons more fun and enjoyable
- Ensures that students' attitudes towards the course are high
- Ensures that students' motivation towards the leaning are high
- Ensures that students' attitudes and motivation towards the course are high
- It allows students to collaborate in the learning process and allows for social interaction.

4.5.3. Suggestions to "How Augmented Reality Can Be Used to Increasing Green Deal Awareness in Primary School Education"

Augmented reality can be used to animate three-dimensional pictures to increase students' perceptions of Green Deal Awareness.

The results of the activities planned with green deal can be examined by the students in a concrete way with the augmented reality application.

In-service training can be given to primary school teachers in order to use R applications in the learning and teaching process about green deal awareness.

Pre-service training can be given to primary school pre-service teachers in order to use R applications in the learning and teaching process about green deal awareness.

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