Augmented reality in process of studying astronomic concepts in primary school

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Abstract. The objective of the research is development a mobile application (on the Android platform) designed for visualization of the Solar System with the AR technology and the alphabet study, applying the astronomic definitions, which can be used by the teacher and the students for an effective training for studying the subjects of the astronomic cycle in primary school. Augmented Reality cards with the images of the Solar System planets and other celestial bodies were developed, as well as the "Space alphabet" was created. In the developed alphabet every letter of the alphabet becomes a certain celestial body or a different astronomic definition. Augmented Reality gives the opportunity to visualize images of the Solar System as much as possible, in other words to convert 2D images into 3D, as well as "make them alive". Applying this tool of ICT while studying new data gives the ability to develop and improve the pupils' spatial thinking, "to see" the invisible and to understand the perceived information in a deeper way, which will be beneficial for its better memorizing and development of computer skills. Studying the alphabet in the offered mobile app will definitely help nail the achieved knowledge and get interesting information about celestial bodies that are invisible and superior for kids; to make a journey into the space, prepare a project on "The Space Mysteries" subject; to stimulate the development of curiosity, cognitive motivation and learning activity; the development of imagination, creative initiative, including speaking out.

Keywords: augmented reality technology, mobile education, mobile application, astronomy, 3D-visualisation.

1 Introduction

1.1 The problem statement

Nowadays, the development of information and communication technologies gives the opportunity to upgrade the study process in general education establishments, using various trends of modern education. New methods of teaching natural sciences have to keep up with contemporary requirements for applying information technologies [9]. Applying information and communicative technologies (ICT) while studying natural sciences allows to intensify the educational process, accelerate the transfer of knowledge and skills, as well as raise the quality rate of study and education [9]. Applying multimedia presentations, Internet resources during the lessons, give the teacher the ability to explain the theory properly, increase the interest of students for study, keep their attention in a better way.

At the same time, natural sciences require high-quality demonstration data. An effective development of the knowledge of natural concepts in the primary school, and later on physics, chemistry, biology, geography and astronomy depends not only on the size of theory, but also on the methods of its presentation that require a decent theoretic training for the teacher.

In primary school, there is often lack of objective natural science knowledge of the primary school teachers. As far as they are not specialized in natural sciences (physics, chemistry, astronomy, biology, etc.), a good quality explanation of the study material in the natural science direction requires additional training [2]. Partially, these issues can be solved applying ICT within the study process. One of the most contemporary trends of ICT in education is the Augmented Reality (AR) together with mobile learning [11; 19; 21; 24].

1.2 The objective of the research

The objective of the research is development a mobile application (on the Android platform) designed for visualization of the Solar System with the AR technology and the alphabet study, applying the astronomic definitions, which can be used by the teacher and the students for an effective training for studying the subjects of the astronomic cycle in primary school.

2 Discussion and results

Modern ICT are parts of all the aspects of human lifestyle, especially in the education. The modern age requires new approaches to the teaching and learning, new methods, forms of presentation the learning information. Particularly, new approaches are necessary in the natural sciences training overall as well.

Using ICT in school education [1; 19; 21; 24] gives the opportunities of development a new learning environment, where the abilities of the ICT resources and new

generation learning materials are used along with the traditional materials and activity types.

During the natural sciences lessons ICT are used as an education resource and as a tool, designed not only for automation of the educational activity, but also for the development of critical thinking [18].

Critical thinking primary education receivers are notable for the following features: are able to find the necessary and important information easily; underline the key information and interprets it; ask questions in order to get more exact information or for investigation purposes; examine problems from different points of view and compare different opinions and approaches while solving these; bring out personal opinion, choose linguistic tools to develop own statements precisely; settle correlations between objects, processes, phenomena; generates new ideas; solve problematic situations easily; make sound decisions; understand that a mistake is an integral part of a successful study; consider every single option and make a personal choice; set up interpersonal relations with classmates without any issues; business-oriented; tolerant; realize the responsibility for their own lives; discover the environment curiously. This gives the ability to make it clear that all these features are genuine for a person, capable of critical thinking, are a must-have for carrying out investigation activities and developing experimental skills of primary pupils, particularly first-form pupils [8; 12; 16].

The contexts of natural, social and healthcare, civil and historical, technological, informational education branches in the New Ukrainian School come together with an integrated course “I discover the world” [23].

The nowadays level of computer technologies requires applying new approaches to the education process in the primary school, new methods, forms of presentation of the study data in order to activate the cognitive activities of the pupils [15]. Applying the ICT in primary school allows to intensify the education process, accelerate the transfer of knowledge and experience, enables the development of pupils’ critical thinking [9].

It is a common fact that the natural science component requires illustration of the theory. Proper demonstration data helps understand various processes and phenomena in a better way, the structure of chemical compounds and mechanisms of physical correlations. While studying astronomic objects is not only appropriate, but crucial, because studying the definitions and objects that are impossible to be seen in the daily routine, makes learning more complicated. In this way, visualization of the study material makes its perception and memorizing easier. Unfortunately, usual 2D images of the traditional handbooks and textbooks do not give the ability to understand the mechanisms and the basics of physical and chemical phenomena, structure of the planets and other celestial objects etc. completely. That is why, for an effective learning of the study material of the natural science direction, in the modern era, there is an essential objective to apply numerous demonstrations in the learning process, that are impossible without using multimedia presentation, Internet resources, mobile applications and Augmented Reality programs.

Ronald T. Azuma et al. [2] defines the Augmented Reality as a system that: 1) combines the virtual and the real; 2) correlates in real-time; 3) operates in the 3D.

A new age implementation of this technologies in the most cases looks like the following: a special marker-image is placed in front of the web-camera, plugged into the computer [9; 20]. It can be a 2D image, printed on a regular sheet of paper. A special software is analyzing the image, scanned from the camera and augments it with virtual objects on the monitor screen (fig. 1).

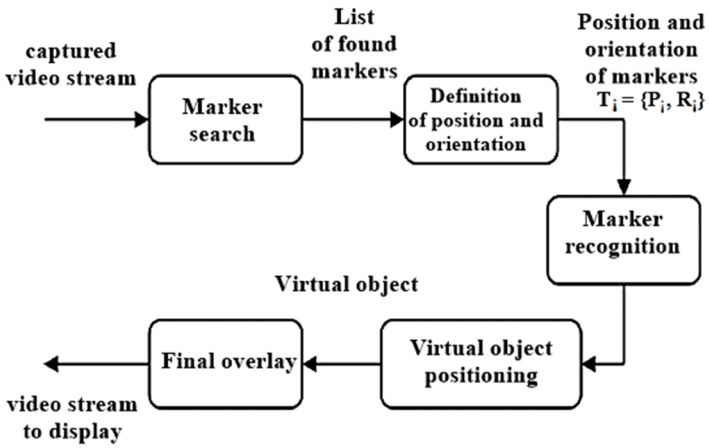

Fig. 1. Schematic algorithm of the augmented reality system.

The opportunity to use AR in education is obvious. The relevance of applying Augmented Reality into the education process is proved by the fact, that implementation of such a modern system will in fact increase the motivation of students, as well as raise the level of memorizing information by means of variety and interactivity of its visual presentation [4; 6; 10; 13; 14; 17; 20; 22].

With the development of AR there will also be changes to the set of manuals, because the necessity of bulky models will decrease. The teacher will only have to place a small image-marker in front of the camera and to project the augmented by the computer image on to the screen, which is beneficially different in the ability to be modified, turned around, zoomed in and out. There will be a possibility to view 3D objects, superior in the daily routine [7; 5; 10].

Implementation of these technologies is designed to reveal the individual personality of the pupil; to create situations for personal discovery of the world by the child; to ask problematic questions and questions, made for critical thinking; to learn pupils how to develop a question logically and correctly; to provide the ability to speak out and prove their opinion; to set up pupils conscious choice etc. [8; 12; 16].

This investigation is dedicated to studying “The Space Mysteries” subject in the first form (week 14) of the New Ukrainian School [3]. According to the program requirements of studying the subject above includes the following questions and tasks:

Approximate investigation / problematic questions:

– What is to be seen in space?
– Can the day “catch up with” the night?

– Is life on Earth possible without Sun?
– How do I imagine other planets?

Tasks for the fourteenth week:

1. To learn how to observe natural day and night changes.
2. To investigate the value of the Sun for the life on Earth.
3. To find out cause-and-effect connections between the Earth's rotation around its own axis and the change of the day part.
4. To form investigation skills, classify, summarize the achieved knowledge and use it in the daily routine.
5. To teach speaking out personal opinion, to listen actively with the conditions of verbal communication.

Results, expected at the end of the fourteenth week:

At the end of the week the pupils *will know:*

– the reasons of day and night change on Earth;
– the value of the Sunlight for the development of plants.

And they will be able to:

– observe the day and night changes and explain them;
– determine hours on the clock;
– set up the connection between the objects and phenomena of Nature;
– explain, why the Sun is necessary and what is its role in the life of mice and men.
– dream about life on other planets;
– prove their own point and listen to the others;
– follow the safe working methods;
– explain the advantages of healthy nutrition.

For the purpose of studying "The Space Mysteries" subject, the authors [3] recommend using the following types of work with pupils: creation of an associative "Space" bush, a fantastic journey into the space, creation of the layout "Space Mysteries" etc. At the same point, they found out, that a combination of the types of activities, named above and demonstration material in Augmented reality would be more effective and proper.

Augmented Reality cards with the images of the Solar System planets and other celestial bodies were developed, as well as the "Space alphabet" was created. In the developed alphabet every letter of the alphabet becomes a certain celestial body or a different astronomic definition. Every letter goes with an image of the applied celestial body or the other astronomic definition (fig. 2).

As a result, for the purpose of visualization the study material, a mobile application LiCo.SolarSystem was developed; it can be uploaded with the QR-code (fig. 3).

At the first stage, 3D-images of the Solar System planets and other celestial planets were developed.

Augmented Reality gives the opportunity to visualize these objects as much as possible, in other words to convert 2D images into 3D, as well as "make them alive".

Applying this tool of ICT while studying new data gives the ability to develop and improve the pupils' spatial thinking, "to see" the invisible and to understand the perceived information in a deeper way, which will be beneficial for its better memorizing and development of computer skills. This method has advantages above using computer applications, because it gives the ability to visualize images at any physical location of the pupil (in class, during a walking tour at the street, at home etc.) on a cellphone or tablet and does not require to be present in front of a computer or a laptop. In order to apply the AR technology, the Augmented Reality markers were developed [7] on the "Vuforia" platform; 3D-objects were realized with a multi-platform tool, designed for development of two- and three-dimensional mobile applications "Unity 3D".

Fig. 2. Images of celestial bodies and different astronomic definitions, used in the alphabet.

Fig. 3. QR-code to download the mobile app LiCo.SolarSystem.

When a mobile phone or tablet with the uploaded mobile app is pointed at the marker (Fig. 4), the picture becomes "alive", its three-dimensional model appears on the screen, it can be manipulated (rotating, zooming in, viewing from different angles, cross-section of the object) for better understanding of its structure.

At the second stage, the "Space Alphabet" was developed in the form of a mobile app and printed out cards, that will help to learn new letters and discover interesting facts about the Solar System objects and other celestial bodies. In order to boost pupils' curiosity and to set up decent contact with them, the explanation in the mobile app is provided by a virtual first-form pupil (fig. 5).

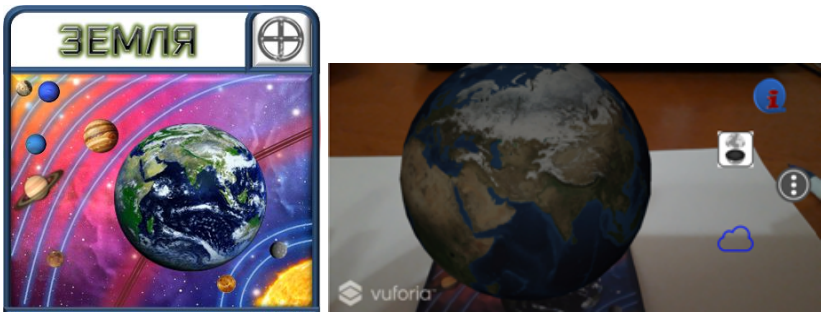

Fig. 4. Image-marker of the planet Earth, that is played with the AR technology in the mobile application LiCo.SolarSystem.

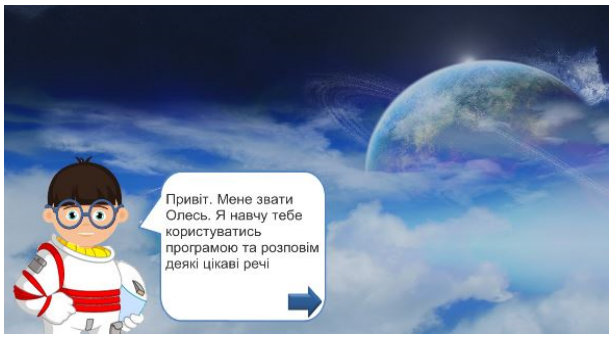

Fig. 5. Getting acquainted with the virtual first-form pupil.

In this way, the developed app works in two separate modes: studying the astronomic objects with the Augmented Reality and learning the alphabet (Fig. 6).

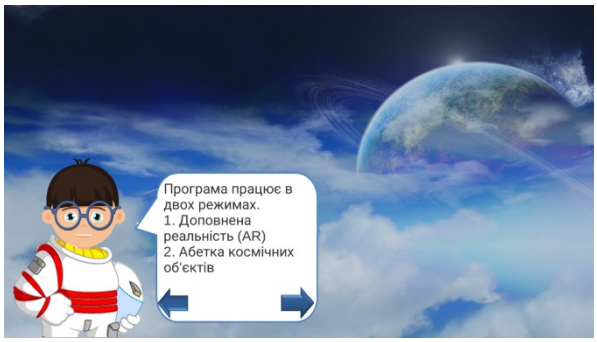

Fig. 6. LiCo.Solar System operating modes.

The first mode is the Augmented Reality mode and it has a particular symbol 

(fig. 7).

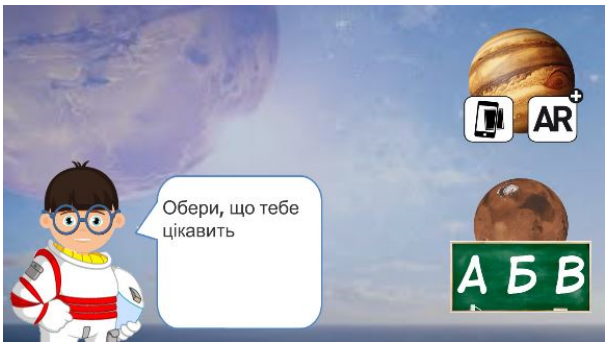

Fig. 7. Marking the operating modes of the LiCo.SolarSystem app.

While using this mode (AR), the pupils can view the external picture of the planets in 3D in details, do their cross-cut section (fig. 8), find out about the structure of the internal beds, “hold” the investigated celestial bodies in hand.

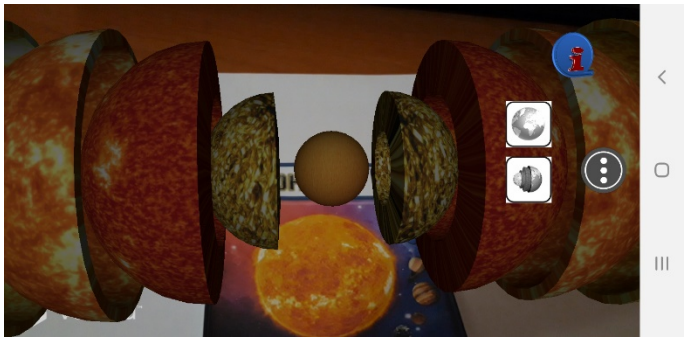

Fig. 8. Studying the internal structure of the Sun using LiCo.SolarSystem.

The information button, that appears while playing the 3D-object, helps receive additional text information about it (fig. 9).

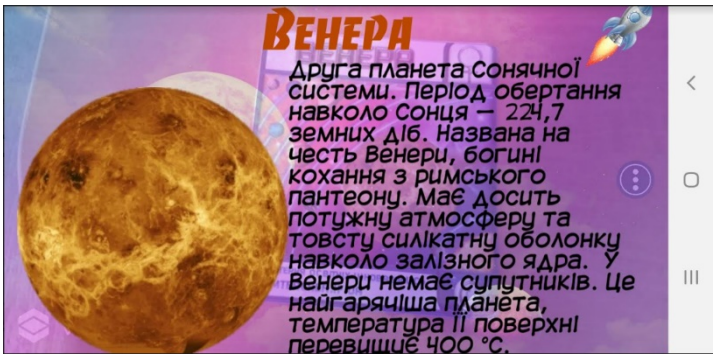

Fig. 9. Displaying text information about the investigated celestial body.

The second mode, which is the alphabet study mode, involves the choice of the letter (fig. 10).

Fig. 10. Work through the alphabet study mode in LiCo.SolarSystem.

After the letter choice is made, the virtual first-form pupil narrates about the celestial body, the name of which is connected with the chosen letter (fig. 11). During the narration, an image of this astronomic object appears. A detailed picture can be reviewed on the printed-out cards, as well as sentences can be made out with these.

Fig. 11. Learning alphabet in LiCo.SolarSystem.

Taking into consideration the age-related specifics of the first form pupils, the information is provided in a short form. The navigator in the offered application is an image of a space rocket that helps the pupil to switch the modes back and forth and return to the main menu (fig. 12).

Fig. 12. Navigation in LiCo.SolarSystem and in the Augmented Reality mode.

3 Conclusions

A mobile application (on the Android platform) has been developed for visualization of the Solar System with the AR technology and the alphabet study, applying the astronomic definitions, which can be used by the teacher and the students for an effective training for studying the subjects of the astronomic cycle in primary school.

Applying the augmented reality objects gives the teacher an opportunity to explain a huge volume of new theory quickly and understandably, with a good quality demonstration material, and the pupils to memorize it effectively, it develops critical thinking, the ability to ask problematic questions and boosts motivation for study.

Studying the alphabet in the offered mobile app will definitely help nail the achieved knowledge and, at the same time, get interesting information about celestial bodies that are invisible and superior for kids; to make a journey into the space, prepare a project on “The Space Mysteries” subject etc.; to stimulate the development of curiosity,

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