Augmented reality technology within studying natural subjects in primary school

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Abstract. The purpose of the research is creation of mobile app (supported by Android) for visualization of chemical structure of water and to display video-data of laboratory experiments that can be used by the teacher and pupils for an effective background for learning natural cycle subjects and performance of laboratory experiments in the elementary school using lapbook.

As a result of work, aimed at visualizing the education material, a free mobile app LiCo.STEM was developed; it can be downloaded from the overall-available resource Google Play Market. Representation of the developed video materials on the mobile gadgets is conducted by "binding" them to individual images-"markers" for every laboratory experiment.

Applying such technologies gives an opportunity to establish educational activity, based on interference of adults with children, oriented on interests and abilities of each kid, development of curiosity, cognitive motivation and educational energy; development of imagination, creative initiative, including the speech, ability to chose the materials, types of work, participants of the common activity, promotion of conditions for parents participate in the common study activity.

Keywords: information and communication technologies, Augmented Reality technology, mobile education, 3D-visualisation, Vuforia, Unity 3D.

1 Introduction

1.1 The problem statement

Nowadays, the development of information and communicational technologies allows to modernize the education process in general schools, utilizing various trends of the contemporary education. New methods of teaching natural and mathematical sciences, as well as chemistry, have to deal with up-to-date demands for using informational technologies [4; 8; 9; 10; 11; 12]. Applying information and communicational technologies (ICT) within chemistry training allows to intensify the educational process, accelerate the knowledge and experience transfer, as well as upgrade the quality of study and education [4; 5]. Utilization of multimedia presentations, Internet-resources during the lessons gives teacher an opportunity to explain the theory understandable, increase the pupils' interest for study, keep their attention in a better way.

At the same time, natural sciences are mostly experimental ones. An effective pupils' knowledge perception in natural science, and later on in physics, chemistry, biology and astronomy depends not only on the way of presenting the theory, but also on accomplishment of the experimental part in practical works and laboratory experiments, which demands decent theoretical background both from the teacher and the pupils.

Besides, the nowadays condition of material support of the majority of schools demands an update and does not allow a proper performance of practical works and laboratory experiments by the pupils. Within the primary school another appearing problem is professional training of the primary school teacher, not enough to perform laboratory experiments in natural sciences (physics, chemistry, biology etc.). Because these subjects are not their specialization, performance of such an experimental part in class requires extra training.

1.2 The objective of the research

The objective of the research is creation of mobile app (supported by Android) for visualization of chemical structure of water and to display video-data of laboratory experiments that can be used by the teacher and pupils for an effective background for learning natural cycle subjects and performance of laboratory experiments in the elementary school using lapbook.

2 Discussion and results

In the modern era, there are a lot of views about the definition of mobile learning [6; 15; 16; 17; 18; 19; 21]. The European eLearning Guild defines it [22] as any activity, allowing people to be more productive in consumption, interference or creating information by compact digital gadgets, if they do these actions on a regular basis, has a reliable connection and the gadget can be stored in a pocket or a little bag. In this

case, using present day mobile gadgets (smartphones, tablets etc.), which are an inevitable attribute of a general school pupil, they can prepare him for performance of a practical work in chemistry, physics, biology, introduce the safety regulations and demonstrate the performance technique [7].

Visualization of the study process makes its perception and digestion easier. The demonstration material, chosen in the right way enables better understanding of different processes and phenomena, the structure of chemical compounds and mechanisms of their interference. Usual 2D images of the traditional handbooks and textbooks does not give the full image about the basic ideas of the natural disciplines: the spatial structure of molecules, physical processes, mechanisms of the courses of chemical reactions etc. In this way, for an effective study of natural sciences, at the present day, it is practical to use numerous demonstrations, which are impossible without utilization of applications-implementors of augmented reality.

Augmented reality (AR) gives the ability to visualize an object (atoms and molecules, their interference, circuits of the devices, technological processes, etc.) as much as possible, meaning to convert a 2D image to 3D, as well as "make it alive". AR allowing to visualize information, show 3D-models, the pupils can receive it ready to be precepted and they will not waste time and cognitive efforts on its interpretation.

Thomas P. Caudell and David W. Mizell [1], characterizing the augmented reality, emphasize the simplicity of representation of virtual objects, comparing with virtual reality.

Any augmented reality tool can be an educational object [20], if it is controlled and supports interference of the user with real objects for the purpose of learning their characteristics during experimental research.

Applying augmented reality tools [14; 20]:

- gives ability to increase the realism of the research;
- provides the emotional and cognitive experience which enables engagement of students into systematic study;
- gives correct data about settings within the experimental process;
- creates new methods of presentation of real object within the education process.

Educational AR-technologies modify visual and contextual education, boosting the meaningfulness of the information as much, as up to 80% remains in short-term memory comparing with 25% while aural perception (traditional lectures) or reading text [5].

Nowadays, the system of primary education is being fundamentally changed [13]. An important aspect of education is the development of a pupil's skill "to learn by themselves". A contemporary child does not need to know as much, as think consistently and argumentative, demonstrate mind activity [13]. The context and methods of education in the primary school are aimed at the development of concentration, memory, creative thinking, for training the ability to compare, emphasize special characteristics of objects, classify them for a certain feature, get satisfaction from a solution found. When a kid interferes with object personally, it discovers the world around it in a better way, that is why, working with children, the

priority must be given to practical methods of education [13]. Especially effective are these methods while learning the integrated course “I discover the world”.

Due to this the pedagogues have a task to find new unusual forms of interference with our pupils. Traditional education is being changed by productive one, which is aimed at the development of creative abilities, growth of pupils’ interest for creative activity. One of the promising methods, supporting the solution of this problem, is a lapbook [13].

Combined with augmented reality, lapbook gives opportunity to improve understanding of the theory, specify and illustrate it, which promotes increasing of perceptional activity and development of creative thinking. The goal of using such technologies is establishment of learning activity based on interference of adults with kids, oriented at interests and abilities of every child, development of curiosity, perceptional motivation and educational activity, development of imagination, creative initiative, including the speech, the possibility of selecting the materials, types of work, participants of the common activity, arranging conditions for participation of parents in the common education activity.

Advantages of lapbook applying [13]:

1. Helps organizing the information, received from the subject learned, voluntarily.
2. Promotes better understanding and remembering the data.
3. A convenient method of repeating and generalizing the learned.
4. The pupil learns to analyze and make conclusions by himself.
5. Lapbook can be created on any topic.
6. Creation of a lapbook is one of the types of common activities of adults and kids. It can also be a form of representing some project conclusions or a topic-based week.
7. The child learns to chose and sort the information, added to the lapbook.
8. The child is more interested in learning, when it is “alive”, and can be touched.
9. A lapbook can be created individually or within a group, depending on the reasonable goals for any child.
10. Lapbook can be a meaningful element of the depending environment of a group.

The only “minus”: to create a lapbook they need time, imagination, efforts and absence of laziness.

This research is dedicated to learning of the subject “Water” in the first form (week 12) on “I discover the world” lessons. According to the requirements, learning this subject includes the next questions and tasks:

Research / problematic questions

Where does the water “live”? How does it travel?

Why do we need to drink water? Why is needed for human and nature?

What can water be?

What happens, if water disappears?

How to safe water?

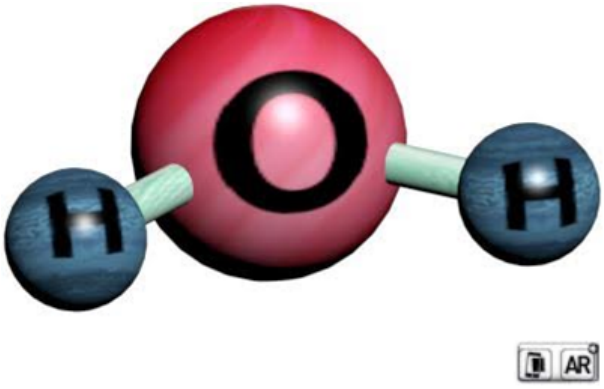
In the developed lapbook the objects, represented by the AR technology, have the relevant mark 

; there is a mark about this on the back side of the lapbook.

As a result of work, aimed at visualizing the education material, a free mobile app LiCo.STEM was developed; it can be downloaded from the overall-available resource Google Play Market.

On the first stage, 3D-images of water molecules and ice structure (crystal grating), water and water vapor.

Augmented reality gives an opportunity to visualize the water molecule maximally, meaning convert 2D image into 3D, as well as make it "alive" [4]. Applying such a tool of ICT while learning new material allows to develop and boost spatial imagination of pupils, "to see" the invisible (molecule, crystal grating) and to understand the heard material deeper, which promotes its better understanding and development of certain practical skills [4]. This method has its advantages over applying computer programs, because it gives the opportunity to visualize the lapbook images with a phone or tablet no matter where the pupil is located (in class, on a walking-tour, home, etc.) and does not require being in front of a computer or laptop.



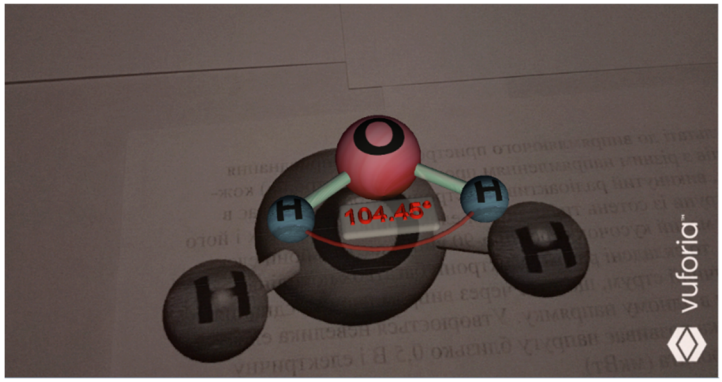


Fig. 1. 2D-image ofwater molecule, located on the lapbook, which can be represented with AR-technology in LiCo.STEM mobile app.

For applying AR-technology, augmented reality markers were developed [1] on the Vuforia platform; 3-D objects (water molecule and ice, water, vapor structures) were modeled [4] in 3ds Max program, augmented reality objects were realized using multiplatform instrument for development of two- and three-dimensional mobile apps Unity 3D [2; 3].

If they point a mobile phone or tablet at a marker (Fig. 1), the image "becomes alive", its 3D model appears on the screen and it can be manipulated in some way (inversion, expansion, view from different angles) for a better understanding of its structure, operating principle etc.

On the second stage, video-data of laboratory experiments, researching surface tension, capillary effect and water filtration methods.

For development of practical skills while studying this subject the next experiments can be performed:

1. **Surface tension:** Surface tension research; Damage of the surface tension.
2. **Capillary effect:** Capillary effect analysis; Plant nutrition.
3. **Methods of filtration:** Selecting the appropriate filter; Water filtration with a table napkin.

Fig. 2. Marker for representing laboratory experiments, researching capillary effect, located on the lapbook (displayed by AR-technology on the LiCo.STEM application).

Fig. 3. Marker for representing laboratory experiments, researching surface tension, located on the lapbook (displayed by AR-technology on the LiCo.STEM application).

The video materials developed demonstrate the laboratory experiments, performed by an experienced lab scientist keeping up all the safety regulations. The experiment performance is subtitled with text explanation. Applying the developed video information gives pupil an opportunity (guided by the teacher or parents), to repeat such

experiments in class or home, makes the perception of this material easier and demonstrates sometimes hard understandable experimental part in a perceptible form.

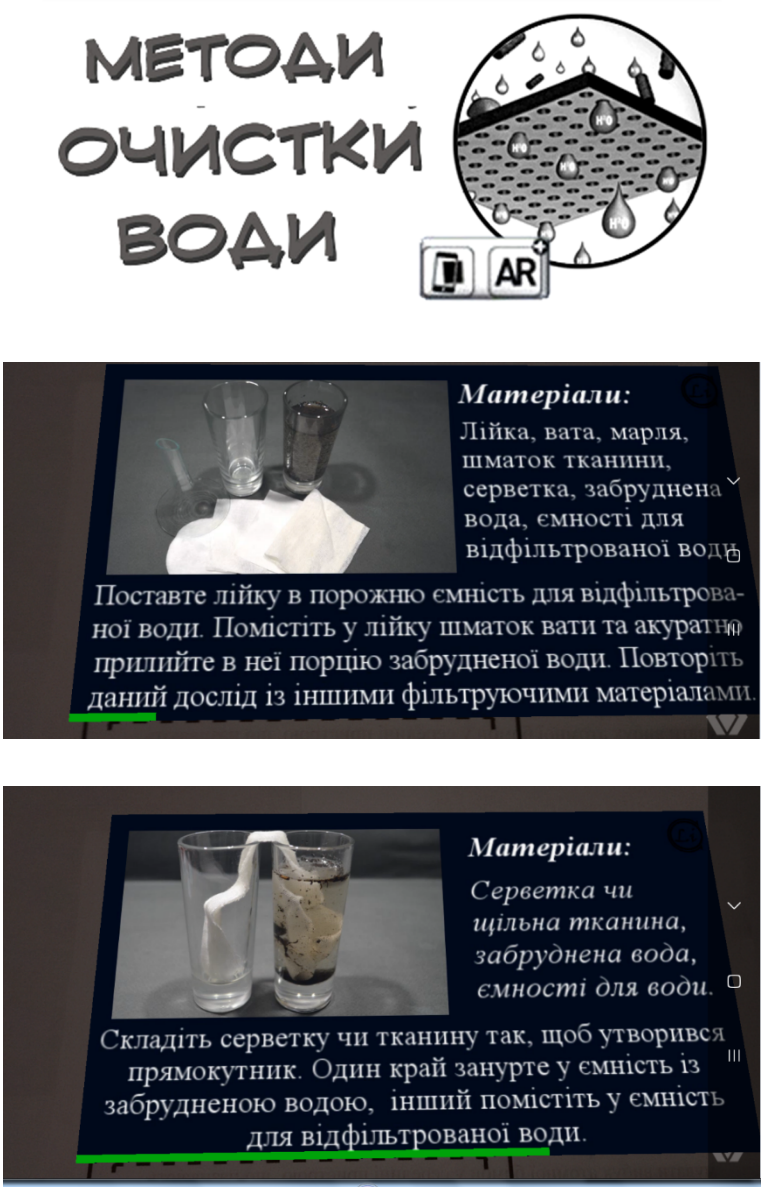


Fig. 4. Marker for representinglaboratory experiments, researchingwater filtration methods, located on the lapbook (displayed byAR-technologyon theLiCo.STEM application).

Representation of the developed video materials on the mobile gadgets is conducted by "binding" them to individual images-"markers" for every laboratory experiment (see Fig. 2-4).

Vector images were selected for markers"; they can show the context of the experiment, are established as objects of augmented reality by multiplatform instrument for two- and three-dimensional applications Unity 3D.

Fig. 2-4 show examples of the developed markers for recommended laboratory experiments on the subject "Water", located on the lapbook for teachers and primary school pupils.

3 Conclusions

A mobile application (supported by Android) was developed for visualization of chemical structure of water and representation of video materials of laboratory experiments, which can be used by the teacher and the pupils for an effective preparing to learn natural cycle subjects of the integrated course "I discover the world" and performance of laboratory experiments in the primary school using the lapbook.

In a combination with augmented reality technology, lapbook gives an opportunity to improve understanding of the theory, specify and illustrate it, which boosts perceptional activity and development of creative thinking.

Applying such technologies gives an opportunity to establish educational activity, based on interference of adults with children, oriented on interests and abilities of each kid, development of curiosity, cognitive motivation and educational energy; development of imagination, creative initiative, including the speech, ability to chose the materials, types of work, participants of the common activity, promotion of conditions for parents participate in the common study activity.

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