

Enhancing elementary student learning in natural sciences through mobile augmented reality technology

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The main aim of the presented paper is to describe the implementation of Mobile Augmented Reality (MAR) applications in teaching practice as an innovative way to transfer knowledge in education. It has been envisioned to revolutionize the way in which information is accessed and presented to students and thus enhance their perceptions. Although MAR technology is not new, its potential in education is relatively unexplored. This was the reason the “Research&Development” Division of Plovdiv University to start a research project dealing with the usage of augmented reality technology with mobile devices in the learning process. The aim is to design, develop, implement and evaluate innovative mobile services using augmented reality technology in the natural science education in elementary school. The project started in 2013 and its duration is 2 years.

The hypothesis of the study is that mobile augmented reality technology can be successfully applied in Bulgarian elementary schools and has didactical value. In order to confirm or reject this hypothesis, a pedagogical study was conducted by developing a system of mobile augmented reality applications and usage of adequate diagnostic tools. The system of MAR applications developed within the project includes the following components:

- A mobile application in which multimedia models of objects from the “Man and Nature” textbook are visualized by using augmented reality technology. They can be seen on the screen of a smartphone or tablet.
- An adapted mobile application with augmented reality in astronomy for the needs of students in Bulgarian primary school.

The implementation of these MAR applications in teaching practice is organized as a pilot experiment. Teachers and 4th grade students from several elementary schools has participated in the experiment. The data obtained from the study is evaluated using Microsoft Excel. The results clearly demonstrate the potential benefits of using MAR in the learning process.

Key words: augmented reality, mobile learning, educational technology

INTRODUCTION

Augmented Reality (AR) is considered to be one of the most promising technologies likely to impact the way we teach and learn [1]. The potential power of AR as a learning tool is its ability “to enable students to see the world around them in new ways and engage with realistic issues in a context with which the students are already connected” [2].

In this paper we describe our experience in applying this technology to enhance elementary student learning in natural sciences. The pilot study is within a research project entitled “Usage of Augmented Reality Technology with Mobile Devices in the Learning Process”, within the research project competition of the “Research & Development” Division of Plovdiv University “Paisii Hilendarski”. The project started in 2013 and its duration is two years.

THE MAR PACKAGE

The project aim is to design, develop, implement and evaluate innovative mobile services using aug-

mented reality technology in the natural science education in primary school [3].

The achievement of this aim involves completing of the following tasks:

1. Developing didactic models of using “augmented reality” technology and mobile technologies in the context of natural science education in elementary school.
2. Designing and developing a SYSTEM with mobile “augmented reality” applications for natural science education in elementary school.
3. Preparing audio visual and multimedia learning resources for mobile devices in accordance with the characteristics of natural science education in primary school.
4. Integrating the learning resources in the developed System of mobile applications and their implementation in education - MAR package (Mobile Augmented Reality).
5. Conducting an experimental study of the pedagogical efficiency of the use of “augmented reality” technology through the use of mobile devices in natural sciences teaching at primary schools.
6. Analyzing the results.

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The development of didactic models using “augmented reality” technology and mobile technologies in the context of natural science education in elementary school is done according to the following pre-defined conditions:

- consistency with the requirements of the state educational curriculum documents and teaching textbooks available;
- consistency with the requirements of the target group of users - students and teachers in primary education;
- specific features of mobile platforms;
- characteristics of the digital objects presentation and accessing them by mobile devices in all popular formats: text, images, video, audio;
- possibilities of “augmented reality” technology.

Based on the didactic model a SYSTEM with mobile “augmented reality” applications for natural science education in elementary school is developed in the following variants:

- visualization of multimedia object models from the “Man and Nature” textbook which can be seen on the screen of a smartphone or tablet (Fig. 1);
- adapted mobile application with augmented reality in astronomy for the needs of students in Bulgarian primary school (Fig. 2).

Audio visual and multimedia learning resources for mobile devices are created in accordance with the characteristics of natural science education in primary school.

The final result of the integration of teaching materials in the developed system with mobile applications and their implementation in education on the basis of the established teaching model we called “The MAR package”.

IMPLEMENTATION OF THE MAR PACKAGE IN TEACHING PRACTICE

Methodology of the study

The organization of the pilot study aims confirmation of the project hypothesis, which is: mobile augmented reality technology can be successfully applied in Bulgarian elementary schools and has a didactical value.

Objects of our study are:

- The quality of the developed digital learning resources
- Students’ and teachers’ attitude toward the MAR package

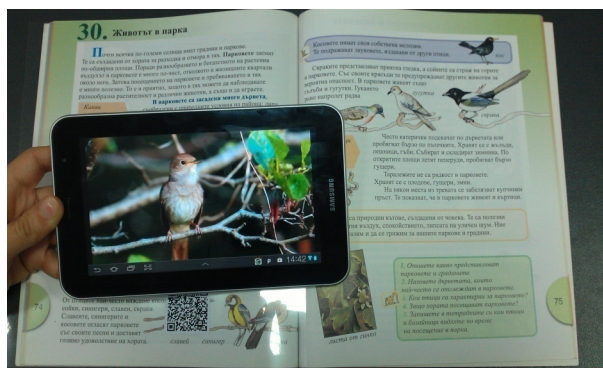


Fig. 1. Multimedia educational material started after scanning the relevant QR code.

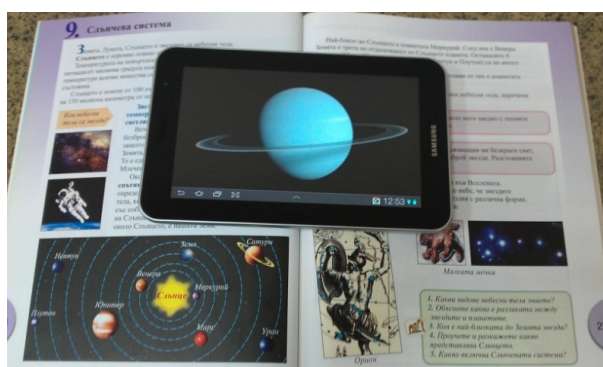


Fig. 2. Developed application for viewing sky objects by using Google SkyMap.

The following diagnostic methods are used:

- Expert assessment- for analyzing the quality of the developed digital learning resources for mobile devices
- Classroom observation
- Interview Face-to-face interviews with students in order to understand their perception of using the mobile “augmented reality” technology in education
- Completion of a questionnaire by the students participating in the study
- Video Analysis- analyzing videos captured during classes, in order to obtain more reliable information.

The implementation of the MAR package in the teaching practice is organized as a pilot experiment with the 4th grade students from two Plovdiv schools (Fig. 3, Fig. 4). The total number of participating students is 92 (52% of them are girls and 48% are boys).

The experiment involves an use of the mobile “augmented reality” technology in the “Solar system”, “Life in the Park”, “Life in the marshes” lessons from the “Man and Nature” textbook for 4th grade.



Fig. 3. Pilot experiment.



Fig. 4. Pilot experiment.

For this purpose, we selected three video clips presenting in an attractive way: the Sun and the planets of the Solar system, a singing nightingale (Life in the park) and a great diving beetle (Life in the marshes). Each of the videos supplements and expands the learning content in the textbook.

Teachers, involved in the experiment, were pre-trained how to work with the MAR package. These teachers together with team members prepared plan scenarios of lessons in which “augmented reality” technology and mobile technology are embodied by using the MAR package. The location of each generated QR code on the transparencies was also pre-set.

Members of the team project attended the lessons in order to observe the learning process. All lessons

were recorded by video camera which allowed us to conduct a subsequent analysis.

Before the beginning of each lesson, students and teachers were handed tablets and transparencies with the corresponding QR code. All tablets were purchased with project funds. The teacher instructed students how to work with tablets right before the first scanning of a QR code.

After each lesson a face-to-face interview with two randomly selected children from a class (a girl and a boy) was conducted. All questions in the interview are open-ended.

At the end of the experiment, students were asked to complete a questionnaire with 7 questions. All questions are closed-ended.

Results analysis

Our observations during lessons show that:

1. Students did not encounter any difficulties in working with tablets. The teacher gave instructions to students only one time, just before the very first scanning of a QR code and then the children worked entirely alone. This shows that mobile devices are a suitable tool for education, because there is no need of preliminary training of students in using them.
2. All our fears that mobile devices can be distracting to students proved completely unfounded. Children worked with tablets only when teachers allowed this. We noticed only one child who was playing with the tablet during the lesson.
3. There was some slowdown in the learning process during the lesson “Solar system”. The slow Internet connection and the relatively large file size of the video clip (about 18MB) delayed the opening of the video, which is a potential risk for the discipline in the classroom. The other two videos were small in size and opened almost immediately. This indicates that digital resources should be with a file size less than 10 MB.
4. The students easily answered most of the questions concerning the observed digital resources. Even in the lesson “Solar System”, it was observed that many children used in their answers words and phrases from the video. This is certain evidence that the technology “augmented reality” stimulates their cognitive activity.
5. Students were very excited to work with tablets but this doesn't hinder the lesson. On the con-

trary, we can say that mobile devices stimulate their interest and they actively participated in all class games and tasks. After lessons many children asked us such questions like: “When will we use tablets again?”; “Where can we download these clips from?”. This clearly and doubtlessly proves their interest.

At the end of the experiment, students completed a questionnaire. The purpose of the survey was to examine their attitude towards the use of mobile “augmented reality” technology in the learning process.

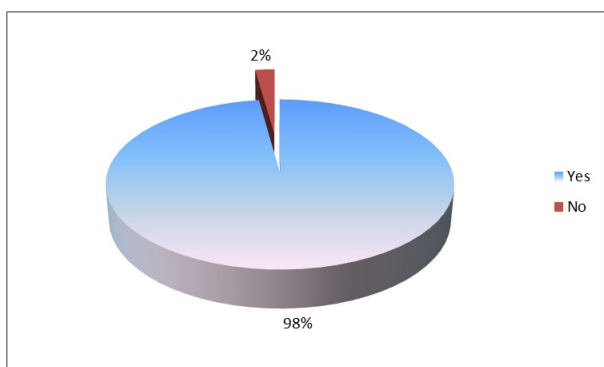


Fig. 5. Did you receive enough information from the videos about the Solar system / A singing nightingale / The great diving beetle?.

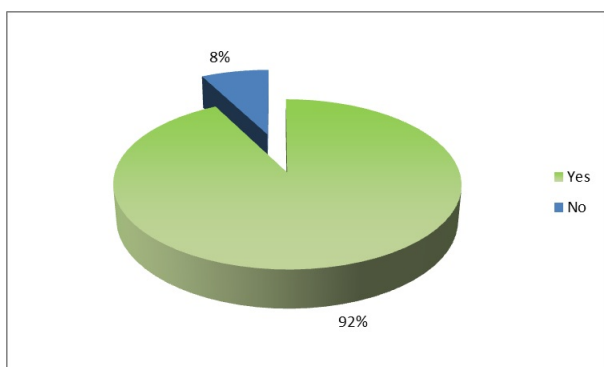


Fig. 6. Would you like to watch these videos at home?

All students answered “Yes” to the question “Was it interesting to use tablets during the lesson?”. 98% of children give a positive response to the second question, “Did you receive enough information from the videos about the Solar system / A singing nightingale / The great diving beetle?” (Fig. 5). 92% of students would like to watch these videos at home (Fig. 6). Furthermore, 99% believe that this technology has helped them to learn more easily (Fig. 7), and all would like this technology to be used in other

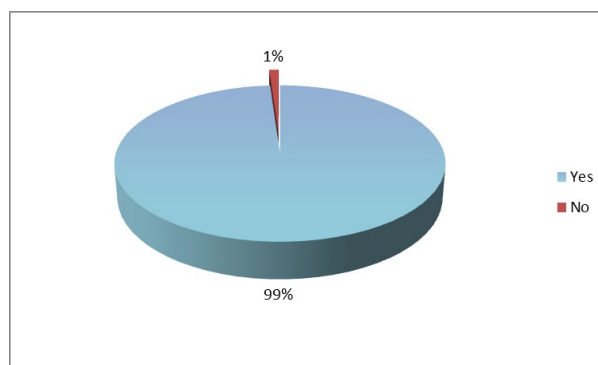


Fig. 7. Do you think that this technology has helped you to learn more easily the lesson?

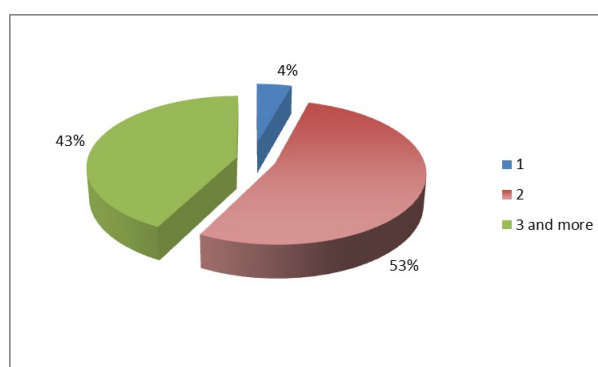


Fig. 8. How many times have you observed the videos?

lessons from “Man and Nature”. To the question “How many times have you observed the videos?” 4.3% answered 1 time, 53.3% – 2 times and 42.4 percent – three times or more (Fig. 8). Variation in responses to this question is due to the fact that on each tablet video files have been downloaded with different speed and that automatically affects the number of observations. 95% give a positive response to the question “Would you like to show these videos to someone else?”.

CONCLUSIONS

Results from the pilot study doubtlessly reveal that the mobile “augmented reality” technology is positively accepted by all students. We observe that the usage of tablets in the classroom does not distract students. Moreover, we can conclude that mobile devices are a suitable tool for education, because there is no need of preliminary training of children how to use them. The collected data show that mobile “augmented reality” technology stimulates students’ interest in learning content and encourage their cognitive activity. It makes learning more attractive and fun,

which is essential for achieving educational effectiveness.

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ПОДОБРЯВАНЕ НА РЕЗУЛТАТИТЕ ОТ ОБУЧЕНИЕТО ПО ПРИРОДНИ НАУКИ В НАЧАЛНОТО УЧИЛИЩЕ ЧРЕЗ ИЗПОЛЗВАНЕ НА ТЕХНОЛОГИЯТА “ДОБАВЕНА РЕАЛНОСТ” С МОБИЛНИ УСТРОЙСТВА

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(Резюме)

Основната цел на статията е да се опише използването на технологията “добавена реалност” с мобилни устройства и съответните приложения в преподавателската практика като иновативен начин за предаване на знания в областта на образованието. Посредством тази иновативна технология съществено може да се промени начина, по който информацията е достъпна и се представя на учениците, което ще подобри техните възприятия. Въпреки че, технологията “добавена реалност” не е нова, нейният потенциал в областта на образованието е сравнително неизследван. Това е причината, поради която поделение “Научна и приложна дейност” на Пловдивския университет финансира проект, който изследва използването на технологията “добавена реалност” с мобилни устройства в процеса на обучение. Целта е да се проектират, разработят, внедрят и оценят иновативни мобилни услуги чрез използване на технологията “добавена реалност” (augmented reality) в обучението по природни науки в началното училище. Проектът стартира през 2013 г. и е с продължителност две години.

Изследването е подчинено на хипотезата, че използваната иновативна технология “добавена реалност” с използване на мобилни устройства е успешно приложима в началното образование в българското училище и има дидактическа стойност. За потвърждаване или отхвърляне на тази хипотеза, е проведено педагогическо изследване, като са разработени подходящи мобилни приложения с добавена реалност и е използван адекватен диагностичен инструментариум.

Системата от приложения MAR, разработена в рамките на проекта включва:

- Мобилно приложение за визуализиране на мултимедийни модели на обекти от съответния използван учебник по “Човекът и природата”, които могат да бъдат визуализирани на дисплей на смартфон или таблет;
- Адаптирано мобилно приложение с добавена реалност по астрономия за нуждите на учениците в българското начално училище.

Внедряването на тези мобилни приложения в преподавателска практика бе организирано като пилотен експеримент. В експеримента участваха четвъртокласници от две пловдивски училища. Резултатите от пилотния експеримент несъмнено показват, че технология “добавена реалност” с мобилни устройства се възприема положително от всички ученици. Използването на таблети в класната стая не отлича вниманието на учениците. Освен това, можем да заключим, че мобилните устройства са подходящ инструмент за обучение, тъй като не изисква от децата предварителна подготовка за работа с тях. Анализът на получените резултати показва, че технологията “добавена реалност” с мобилни устройства стимулира интереса на учениците към учебното съдържание и насърчават тяхната познавателно дейност. Това прави ученето по-привлекателно и забавно, което е от съществено значение за постигането на образователна ефективност.