Augmented reality in high school education

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Abstract. *This paper describes different ways of how Augmented Reality can be used in secondary school education and what is needed for its use. What is Augmented Reality (AR) and benefits of AR are explained. Research of readiness of schools to use AR is done on example of one high school and results are presented and explained.*

Keywords. Augmented reality, virtual reality, education, conference paper, template

1 Introduction

High School education is considered to be the most important part of the education cycle, it defines us as adolescents and help us decide on our further education by helping each one of us discover his or hers talents and affiliations. Problem in education in general is that many fields of study do not have an interesting and up to date approach on the subject. Even though technology is giving us a potential for advancement of everyday curriculum, it is largely unused. This is so because teachers do not have time or appropriate skills to do that extra work in preparing for teaching.

Technology advances and via mainstream culture, often commercials, it comes to the children and it is now, for instance, a common thing for an adolescent to have a smartphone. Smartphones are usually being used for games, web surfing etc. but it is a potential that cannot be unused in education [1]

Children and adolescents can develop and learn better with the aid of technology and this is a niche on which some companies should focus. Of course, programmes and topics that these companies would provide must be approved and supervised by authorities (etc. Ministry of Education).

In this research focus is on high school education, although some aspects can be used in primary education as well, because the complexity of proposed models is greater than ones needed in primary education and because there is more individual and team work in gaining new knowledge by self-study (independent learning).

Foundation for successful implementation of augmented reality in high school education is owning of a smartphone. While augmented reality is a relatively new technology, it has already seen implementations in several serious fields of science, not just in fun and games everyday use. It allows us to display virtual environment side by side with real objects and to add more information in limited space. Augmented reality can place both static and dynamic images on location where pattern is recognized and by doing it; AR can enrich the presentation of subject material which is being studied. Our goal is to enrich the study books and educational material with models and 3D images of the chosen study book's topic.

2 State of the art

The technology itself is present and is an integral part of today's educational process [2]. Biology classes tend to use three-dimensional model to teach about human body [3], chemistry classes use models to teach about atoms and molecule structure, physics classes use more advanced technology like computers and computer modelling to show how laws of physic work [4].

"The first resource is a three-dimensional model of the adult brachial plexus: a network of nerves extending from the neck down to the shoulder, arm, hand, and fingers. This will be incorporated into existing didactic classroom teaching under the supervision of an anatomy teacher. The second resource is a piece of online courseware which will teach the embryological development of the brachial plexus. The delivery method will be the WebSET framework, a collaborative environment that allows a teacher to manipulate 3D models over the Web in real time whilst providing explanation and help to students. In this way the courseware can be used for

both self-directed study and 'virtual anatomy demonstrations' within an online peer group." [3]

History classes have maps, while geography adds the globe to enrich the class.

However, all these visual teaching tools are becoming more and more outdated. Multimedia content is being included as a valid teaching tool where students learn from audio and video materials. The World Wide Web is also being used [5] as a tool and a platform for distributing educational content.

Augmented reality (AR) is a system in which, usually, 3D virtual objects get integrated with the real world environment. AR is an advancement of Virtual Environment Systems (VES) in which the user interacts with synthetic environments, usually generated by computers. [6] The advancement is based on the fact that with AR systems user interacts with the real environments and additional informative content is being displayed on, usually mobile devices equipped with the appropriate software.

As described in the thesis "A Survey of Augmented Reality" [6], AR systems have three basic characteristics:

1. They combine real and virtual environments;
2. They are interactive in real time;
3. They are registered in 3D.

While AR can be used in health industry, manufacturing and repairing processes, annotation and visualization, robot path planning, entertainment or military (particularly in weapons navigation), AR can also be used in education. Augmented reality is being used in mathematical and geometry education [7] as well as in other educational fields [8], like engineering [9].

Since the latest smartphone models are equipped with GPS [10] and compass [11] modules, they have become the most useful interface between virtual and real environments. Creating an appropriate software, user can engage its smartphones camera to get real world environment on-screen, while GPS and compass will locate and orientate the device in that environment. Depending on the features of the software, users will be able to get information on objects around them.

Smartphones and technology in general is highly accessible in the high school education.
However, they are not being used enough:
"...access to equipment and software seldom led to widespread teacher and student use. Most teachers were occasional users or nonusers. When they used computers for classroom work, more often than not their use sustained rather than altered existing patterns of teaching practice." [12]

Combining augmented reality systems with the equipment which schools and even students personally already possess, high school education might get a new level of demonstrations in classes, while students might get more interested in classes due to progressive usage of technology [13].

3 Augmented reality in high school education

Augmented reality should be used is today's classrooms in order to replace and modernize existing maps, 3D models and visual representations of elements, places, events etc. Schools are often too slow in upgrading their equipment to keep up with current subject matter, so upgrading their software (and releasing it to the students) would make the change faster.

Books with patterns that display, for example, an atomic structure of a molecule, can make it easier for students to grasp the idea of how the atoms are connected. Also, 3D model of human body (for biology class) can be made more fun and with a click of a button students can change the display from human organs to human skeleton all that overlaid over the real body of a classmate. In some maps, small 3D animations of perhaps history battle tactics can be made. As we can see, the options are virtually limitless.
Making this software available to students, the cost and need for many physical models and maps is reduced. The funding intended for it can be diverted in other areas of education.

Ecological impact of augmented reality is in saving the resources and, since this is only software that is upgradeable, reducing the waste usually produced by throwing out large number of learning material and pedagogical tools for use in frontal teaching and teamwork in classroom.

Suggested procedure for implementation of augmented reality in high school education begins with a start of new school year. Student would be informed how and where to download need software and how to register for its use. With the AR software they will be able to scan and see the 3D models in places designed for it (books, posters, pins, etc.). Upgrades would be periodically released. Feedback by the students at the end of the semester and at the end of the year will give us needed information of the results and guidelines for future improvements.

4 Research

Following section shows goals and results of a small research on how ready are today schools for implementing AR as their teaching tool. Research was

done in Gymnasium Bjelovar, Croatia on a group of 100 students in April, 2012.

4.1 Research goals

In our research we have tried to gather information about students in secondary school, education tools and technology. Questions that we have asked in our poll were focused on:

- how many students have and use smartphones.
- have they ever earlier encountered Augmented Reality software.
- are 3D models used in teaching in their school.
- do the students wish that there was more technology involved in learning/teaching process.
- would the students pay more attention if there was AR models in classes.
- can 3D models improve their learning and remembering abilities.

With these answers we wanted to see if implementation is possible and if there was desire to use it. Our initial expectations were that ⅔ of students have smartphones and that less than 10% of them will know what AR is. For use of models, our predictions were that all classes that have need of them will use it (i.e. model of human body in biology, models of atoms and molecules in chemistry, geometry in mathematics etc.). We predicted that the benefits of modern technology in learning will be obvious for the majority of students.

4.2 Research results

The results were as following:

- 52% of the students own a smartphone - this is a smaller number than we expected and would make implementation of AR in classrooms difficult because the students lack basic tool (smartphone).
- 23% of the students have said that they were familiar with AR, this is a good thing. it shows that a part of the students that have a smartphone also know how to use AR and they would be able to teach others in using AR software in learning new materials.
- Barely 3% of the students said the 3D models are used in their school which is a very low percentage and teachers should strive to increase number of models. Possible lack of funds (because some models are very expensive) can be a justified reason for this low use of models as teaching tool.
- 88% of the students wish that there was more technology involved in learning/teaching process as we have expected.
- 86% said they would pay more attention in class if there was AR involved.
- 87% answered that such models would improve their learning and remembering abilities.

While the students express a large desire to implement more technology in secondary school education, and there is a realistic need for models, since only a half of the students have smartphones it would be problem to give all the students same benefits of AR.

We propose a group approach to implementing AR in high school, i.e. that students observe 3D models during Computer Science periods or on school smartphones that will be used specially for that purpose during group work assignments.

5 Business model

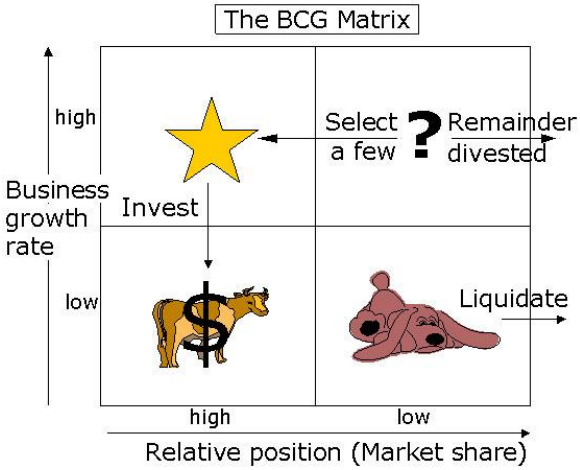

Figure 1. The BCG matrix places products into four different groups [14]

Every product should be positioned in a BCG matrix to understand its purpose in the overall system. BCG matrix (Growth-Share matrix, Boston Matrix, Boston Consulting Group analysis, Portfolio diagram) is a chart which helps corporations in product line analysis.

The four groups of products in a BCG matrix are:

- Cash Cows.
- Dogs.
- Problem Child / Question Mark.
- Stars.

"Cash Cows are units with a high market share with a minimal growth or in a slow-growing industry, the base for company's cash-flow. Dogs are units with a low market share and low profit income (slow-growing industry), usually a sign that these products need to be discontinued. Problem Child / Question Mark represent new products, fresh units which grow fast and consume large amounts of capital, but due to low market share, they don't generate much income. Analysts should be careful in deciding which products to keep and make them "BCG-stars" and which products should be discontinued, while Stars are units with high market share and high profit income; stars have a fast grow rate but they generate a high income as well. Companies hope to get units from being a star to become a Cash Cow were input capital is much lower than for the stars." [15]

Augmented reality software should be developed for specific classes and specific topics. If a school would develop its own application or AR teaching platform, it could benefit from it in a way that application would become a Star in BCG matrix at the beginning of a school year. Licensing the application would secure its "cash cow" position in BCG matrix, bringing steady, additional income for the school which developed the system.

If a school can't afford to develop the application nor the content for augmented reality education systems, it might contribute with creating new curriculums for augmented reality education. Creating new curriculums or adaptation of current curriculums for AR-helped models in education could also be useful. Technical schools could develop the framework for creating AR content and in that way helping other schools and teachers to easily create AR models, elements and content.

If needed, collaboration would be possible in two different models:

- Other schools could develop additions to the original application covering some other topics which weren't covered in the original edition.
- The school could create a deal with publishers to distribute the application via the Internet, where publishers would publish a link to the application inside the book, in textual or QR code form.

6 ARML

Augmented Reality Modelling Language (ARML) was proposed by Mobilizy in January 2010. [16]. The first edition of ARML was based heavily on KML (Keyhole Markup Language) with two main differences [16]:

- KML is a very rich standard. Most of the tags provided are not (yet) necessary for AR applications. ARML reduces the KML standard to the bare minimum;
- ARML adds some additional features to the KML standard.

While ARML 1.0 was consisted of two parts; the Content Provider section and the POI Section (Point of interest) [16]. While the Content Provider section holds all information like name, description, image etc., POIs need to be linked to only one content provider. Basically, ARML document in similar to popular XML documents due to its relation to KML.

7 System Architecture

In order to work properly, the hardware for using AR systems should be equipped with a GPS module, a compass and a video camera [17].
The software itself should be composed of three parts; the controller, video tracking module and the renderer. Data collection from the compass, GPS module and the video camera is being done in the controller part of the software in order to position and orientate the user in its environment.

"The purpose of the video tracking component is to integrate the augmentations seamlessly into the video image." [17]

"Rendering component is responsible for the presentation of all information to the user." [17] This component will render the augmentations into the video camera stream and display it to the user, as well as change the image whenever new data is available, e.g. when a user turns 90° to the left or to the right.

While there may be some issues with technology in education from a pedagogical point of view, it's clear that the sooner the schools adapt and embrace the modern-day technology, the better [18]. Augmented reality systems represent a step forward in that context.

8 Future Work

Making the education process more interesting to pupils and application of modern everyday technologies (AR) in that process is the goal of our future work. Making several 3D models and tools for use in the classroom and seeing how students react to using it will give us feedback on how to further adjust AR to needs of both students and lectures. Content distribution system and appropriate revenue share for contributor yet needs to be designed.

9 Conclusion

Modern technology in education must be used because of the benefits it gives to the education process. Student can learn more and are more entertained when something that they consider interesting is part of the learning process. Augmented Reality can be used as a learning tool to replace regular 3D models in classrooms and by doing so reducing the costs of models for certain topics while increasing the accessibility of those models to larger number of students.

Economic profit is measurable and with right planning it can make both sides gain from the exchange. Although not a business subject, students are expected to have the most indirect gain.

AR is one of many technological advances that are not used enough in education and it should me made part of it, along with other modern day technologies.

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