

Teaching 2D and 3D geometry with the aid of augmented reality technologies

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Abstract

The visualization of content in secondary educational institutions is one of the key factors in the excellent assimilation of educational material and its continued usage in the learning process. Visualizations require the academic subjects that are the most challenging to comprehend and, for the most part, lack widespread practical application at the beginning of the study, which are primarily mathematical items. To better visualize teaching geometry; this study examined mobile tools that can be utilized for this purpose. The method of teaching geometry in secondary school middle classes is the subject of the study. The use of augmented reality tools to teach geometry to children in grades 7-9 is the focus of the project. The analysis and justification of the selection of mobile augmented reality for the study of mathematics were research methodologies employed in the study. Geogebra, ArloonGeometry, and Geometry AR were two augmented reality technologies that were revealed via analyses. Teachers can use these tools to visualize lesson material and create challenging scenarios in order to help pupils learn geometry and succeed academically. Due to the utilization of augmented reality, the geometry lectures specifically provide the right setting for a fruitful emotional exchange between the student and the teacher. Additionally, it helped to lessen negative attitudes towards geometry lectures such as fear and anxiety. The emotional aspect of learning fosters interest in mathematics, realizes creative potential, and creates the circumstances for diverse approaches to solving geometric problems. It also encourages improved recollection of the instructional material.

Keywords: Geometry, Augmented Reality Tools, Arloon Geometry, Geogebra, Geometry – Augmented Reality.

Introduction

The younger generation must be able to quickly adapt to all situations, gain knowledge under all circumstances, and be able to put their newly acquired knowledge into practice due to the fast-changing information and communication technology and the present pace of life.

All of the Ministry of Education's most recent developments are focused on ensuring that graduates of educational institutions have a certain set of skills and the ability to independently pick up the knowledge they need to solve particular difficulties.

In order to remain competitive in the domestic and international labor markets, a graduate of a modern secondary or higher education institution must fulfill certain standards. They must gain knowledge and build a range of competencies during their education.

But the current status of secondary and higher education systems falls well short of state needs and demands for change.

Literature review

A review of scientific research has revealed that one method for improving the state of the educational system is the competent and methodical integration of mobile information and communication tools and technologies into the learning process as well as the alteration of the learning model, which entails the switch from conventional to novel forms and methods of instruction.

The innovations of traditional psychology and pedagogical research provide the foundation for the revolutionary force that is the informatization of education. The construction and successful integration of information and communication technologies in educational practice necessitates the establishment of special tasks.

The incorporation of mobile ICT into classroom instruction will lead to higher education standards. By giving them greater freedom and choice over the time and place of study, it also contributes to the improvement of educational chances for people with disabilities. Training materials are sent to their mobile devices according to their requirements. This meets the needs of lifelong learning and training while improving the learning process's adaptability.(Serhiy O. Semerikov,2019)

Scientists believe that integrating cutting-edge mobile technology like augmented reality into the educational system is one approach to increasing the quality of mathematics teaching, particularly in geometry.

It cites Construct 3D as a stunning example of the application of augmented reality in the study of geometry as a tool for creating three-dimensional geometric structures. Personal interactive panels and stereoscopic primary displays are used in this application. Multiple individuals can work together in the same area using Construct3D to create various geometric models that are similar to the actual world.(Dyulicheva, 2020)

Students have the chance to make connections between things in their environment and geometric shapes to ascertain their properties by using the AR Math application. This fosters the development of not only spatial thinking but also the capacity to make logical connections. Such education involves manipulating virtual items in augmented reality.

Machine learning algorithms, such as the k-mean algorithm for choosing clusters of objects based on colour or shape, are used in the implementation of AR Math projects. Real mathematics is studied more effectively because of the presence of a virtual assistant who involves pupils in an augmented reality setting by telling them "Stories" about fascinating historical figures and challenging problems.

The GeoGebra AR program is yet another intriguing tool that helps kids comprehend the world of geometry. According to the article's writers, this application will be helpful for future maths teachers as well as students who want to improve their spatial thinking. GeoGebra 3D Calculator with AR can be used systematically to help students improve their research abilities, increase their socialization opportunities through ICT learning, and guarantee the development of universal STEM competencies. It goes without saying that every STEM teacher's main objective should be to inspire and involve their pupils in research projects.

The purpose of this essay is to assess a few mobile ICTs that can be employed in the secondary education system to make studying mathematics easier.

Objectives of the study

To study the teaching of two-dimensional and three-dimensional geometry with the aid of augmented reality tools.

Knowledge of cloud computing applications and services in the fields of science and education

It is recommended that seventh-grade geometry students be introduced to the Spanish-language Arloon Geometry program (<http://www.arloon.com/>), since this will facilitate

their understanding of the geometry learning process. The creators advise using this program to familiarize yourself with geometric forms and bodies beginning at the age of ten (fig. 1).

Figure 1

The ArloonGeometry application window.



With the following basic prerequisites for your mobile device: iOS 8.0 or above, or Android 4.0.3 or higher, you may get this program from Google Play. This software is entirely independent, not connected to any textbooks, and is available for free, albeit it does have a nominal \$2.99 pricing.

This program's features include the ability for students to study geometry in both space and on a plane. Volumetric forms have a planar sweep, and students can convert flat shape combinations they've made themselves into space; Utilizing the program will enable students to locate and identify polyhedrons and other geometric bodies in their surroundings; independently complete the tasks in the "guess," "right / wrong," and "calculation" sections and assess how much material they have learned. When working with spatial bodies, one can learn how to calculate the volume or area of the side surface of the body. Additionally, the program can

choose the "perform exercises" mode and study formulas or calculations that apply to one or more of a spatial polyhedron's side faces.

One of the program's shortcomings is that it costs money and is only supported in Spanish and English at the moment.

Students that are exposed to this program in geometry lessons will be able to distinguish between 2D and 3D geometry in addition to developing their spatial vision skills. But first, understand the geometry task's foundations to determine geometry's applied orientation. There are programs for chemistry, biology, arithmetic, anatomy, and astronomy in addition to augmented reality geometry software. (Modlo et al, 2019)

It is advised to use a mobile augmented reality tool such as Geometry—Augmented Reality when studying geometric forms. (figure 2).

Figure 2

A R Window of Geometry



You may get this software for free from Google Play if your Android version is 4.0 or higher. Since its first release in 2017, this app has not gained significant traction. You also need

to download and print the labeled letters for this program in order to work with geometric forms. In order to create polygons, the four letters A, B, C, and D can be repeated.

With the use of this program and a mobile device, students can build segments and calculate their length using standard units, build triangles and calculate their perimeter and surface, and build quadrangles and calculate their perimeter and surface.

Figure 3

Triangle construction

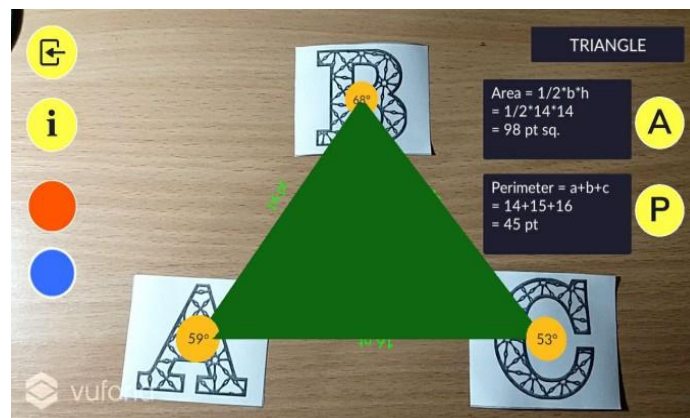
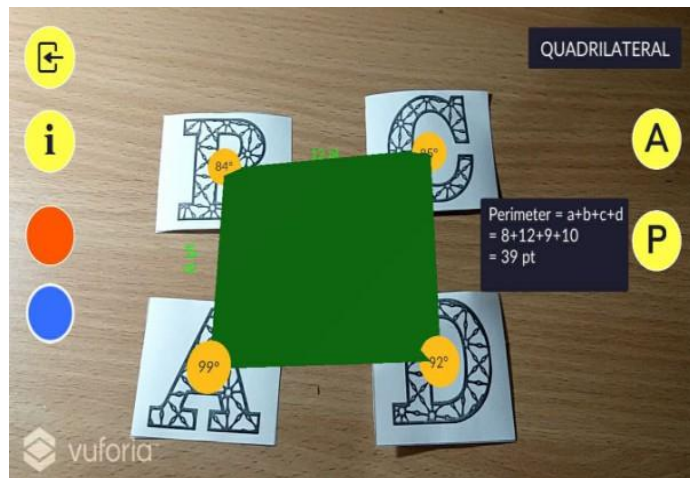


Figure 4

Quadrilateral construction



The ability to self-visualize quadrilaterals and to separate their characteristics becomes increasingly more crucial when the educational system shifts to a blended learning approach. As a result, augmented reality tools have become essential in this kind of educational system.

After looking into a number of augmented reality tools and technologies, it was discovered that school curricula, particularly for geometry classes, are not well-established or customized. On the other hand, a variety of platforms have been created to let teachers create their own augmented reality programs or to offer students this option.

Figure 5
Geogebra logo



An open-source dynamic mathematics program called GeoGebra may be used to learn mathematics in elementary school, secondary school, and even higher education. (Akkaya et al, 2011)

The development of spatial imagination, practical knowledge, and logical reasoning are the three basic aims of teaching geometry, and these may be accomplished by teachers using

GeoGebra to build interactive materials. GeoGebra may be accessed over mobile Internet in both standalone and online modes.

The different features offered by Geogebra software indicate that it might be an excellent tool for rapidly, precisely, and effectively visualizing abstract geometric objects for its users.

Figure 6
Plotting lines in Geogebra

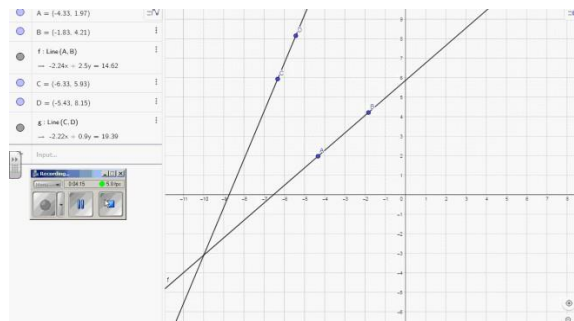


Figure 7
Creating polygons

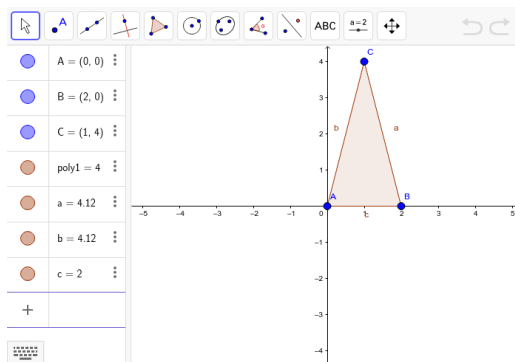
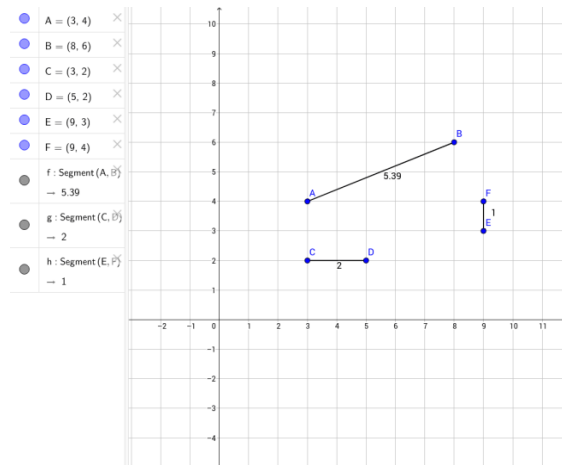


Figure 8

Finding length of line segments



Look at some of the platforms that make it possible to create applications in an AR format, which are freely available or subject to specific licensing requirements :(Stolyarova & Shulzhenko, 2019)

- **HP Reveal**, which was Aurasma until 2018 and is available for download from Google Play, is a platform for building augmented reality applications. The process of creating instructional resources on this platform is highly engaging and allows users to showcase their creative talents to both teachers and pupils.
- **AR Toolkit** is a collection of resources for developing AR apps and design solutions. For developers, this platform is the most widely used. (<http://artoolkit.hitl.washington.edu/>)
- **Metaverse** is a platform that lets you make engaging educational exercises without requiring a lot of programming knowledge (<https://studio.gometa.io/landing>).
- For all programmers, **EVToolbox** (<https://nitforyou.com/ev-toolbox/>) is an easy-to-use constructor. Augmented reality can be made independently by the instructor or student.

EV Toolbox Designer allows users to personalize the visualization of mathematical abstractions and textbook content. It also displays produced objects, such as three-dimensional geometric surfaces and forms, on a smartphone screen. The drawings made by the kids on the aircraft are simultaneously turned into interactive three-dimensional objects.

- The platform **Vuforia** (<https://developer.vuforia.com/>) lets you build augmented reality (AR) apps for iOS and Android smartphones. With the use of virtual controllers, the user may rotate and zoom the item in addition to creating and analyzing flat pictures, rudimentary three-dimensional objects, and geometric forms.

Virtual Object Interaction visualizes an action that would almost certainly not be capable of being carried out on paper. It can therefore be concluded that a teacher in his field must not only use the created enhanced reality, but also create educational products which will enable him to develop his creative potential.

These are regarded as effective teaching and learning resources because they:

- improve the way mathematics is taught;
- support conceptual growth;
- improve geometric visualization;
- provide the groundwork for analysis and deductive reasoning;
- Foster creative thinking.

Conclusion

An investigation of a few augmented reality technologies that might be used to teach geometry in classrooms leads to the following conclusions:

- 1) A teacher's main responsibility is to set up the educational process so that pupils may realize who they are and develop their creativity in an engaging way;
- 2) The instructor in the learning process serves as the inspiration for creating a personalized learning route. He exhibits his capacity to use an array of information and communication technologies and tools for personal growth and advancement;
- 3) A teacher's personal impact on a student's emotional state is also significant. The truth is that a student's disposition towards a teacher is an indicator of how they feel about the subject. When a student's emotional connection with the instructor plays a significant role in providing motivation, learning outcomes improve, students' cognitive abilities grow, creativity is recognized more fully, and so on;
- 4) The way that geometry is studied has a significant impact on students' emotional needs. It is advised that every geometry class begin with a teaching approach that empowers students to learn and relate what they have learned to their everyday lives on an emotional level;
- 5) The application of augmented reality in geometry instruction creates just the right kind of atmosphere for positive interactions between students and instructors. Students first learn that there are particular ways in which they may utilize their mobile device to structure, extend, and enhance their educational experience.

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