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The Effects of using Geogebra on 10th-11th grade students

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Abstract.

The article presents new trends in teaching methods through the Geogebra program, which can be especially important for the future development of e-learning for 10th-11th grade students. Also, the article gives an idea of the various methodological frameworks with several features, examples for teaching mathematics at the level of 10th-11th grade students on an interactive and creative path. This article discusses the conclusions of the didactic experiment, where it was found that GeoGebra was used in the teaching of algebra, geometry, graphing, 3D, and more! Especially integrals, polyhedrons, volume, and surface area of geometric shapes had a positive impact on understanding and knowledge of students. Also, a survey instrument was used to elicit students' perception on the use of GeoGebra. Analysis of the questionnaire responses indicated a positive overall perception of using GeoGebra in learning about circles.

Keywords: GeoGebra, teaching mathematics, the mathematics of 10th-11th grade students, creative environment, didactic experiment, circles, interactive teaching method.

Түйіндеме.

Бұл мақалада Geogebra бағдарламасы арқылы жаңа үрдістер мен оқыту технологиялары қарастырылған, бұл 10-11 сынып мектеп оқушыларына электронды білім беруді дамыту үшін аса маңызды. Бұдан басқа, бұл мақала интерактивтік және шығармашылық жолда, 10-11 сынып мектеп оқушыларының деңгейінде математиканы оқытуға арналған бірнеше ерекшеліктердің әдіснамалық негіздерінің таныстырылымы болып табылады. Сондай-ақ, осы мақалада дидактикалық эксперименттің қорытындылары талқыланып, Geogebra алгебра, геометрияны оқытуда, 3D және графика үйренуде қолданылғанын анықтадық. Әсіресе интеграл, көпжақтар, геометриялық фигуралар бетінің көлемі және ауданын табу оқушылардың түсінуі мен біліміне оң әсер етті. Сонымен қатар, студенттердің Геогебраны қолдануды қабылдауын анықтау үшін сауалнама құралы қолданылды. Сауалнамадағы жауаптарды талдау шеңберді зерттеу кезінде Геогебраны пайдаланудың жалпы оң қабылдауын көрсетті.

Түйінді сөздер: GeoGebra, математика оқыту, 10-11 сынып математикасы, шығармашылық орта, дидактикалық тәжірибе, шеңберлер, интерактивті оқыту әдістері

Аннотация.

В статье представлены новые тенденции в методах обучения через программу Geogebra, что может быть особенно важно для будущего развития электронного обучения для учеников 10-11 класса. Кроме того, статья даёт представление о различных методологических рамках имеющих несколько особенностей, примеры для преподавания математики на уровне учеников 10-11 класса на интерактивном и творческом пути. Кроме того, был использован инструмент опроса для выяснения восприятия студентами использования Геогебры. Анализ ответов на вопросник показал позитивное общее восприятие использования Геогебры при изучении окружностей.

В данной статье обсуждаются выводы дидактического эксперимента, где выяснилось, что GeoGebra использовалась в преподавании дифференциального исчисления, имела положительное влияние на понимание и знание студентов.

Ключевые слова: GeoGebra, преподавание математики, математика 10-11 классов, творческая среда, дидактический эксперимент, круги, интерактивные методы обучения.

Introduction

The introduction of interactive forms of learning is one of the main tasks of schools, at least 20% of classroom studies should be carried out with their application. To help in organizing Interactive forms of teaching algebra and geometry at schools can be provided by various mathematical packages and tools.

One of the tools is a free distributed interactive geometric system GeoGebra (GIS "GeoGebra"), which has a simple user interface and allows you to make geometric shapes, constructions, graphs on a computer so that when the original drawing objects retains its integrity. In nowadays the GeoGebra tool is being widely introduced into the educational process of both schools and universities [1].

The article presents how dynamic mathematical software GeoGebra is introduced. Some reference information about the software and its development is described. The most important characteristic of GeoGebra, which makes it distinct from dynamic geometry. The software and implementation user interface explained the principles of e-learning. GeoGebra can also be used to create training materials, a review of the necessary basic skills that are given in the training materials supported by the GeoGebra program.

In nowadays the GeoGebra is one of the most innovative math software programs that can be downloaded freely from www.geogebra.org. It works on a wide range of operating system platforms that have and installed Java virtual machine. GeoGebra was created by Markus Hohenwarter in 2001/2002 as part of his master's thesis in mathematics education and computer science at the University of Salzburg in Austria. Since 2006 GeoGebra is supported to maintain the free availability of the software for mathematics education at schools and universities. GeoGebra offers geometry, algebra, and calculus in a fully connected, compact, and easy to use the software. In other words, this tool extends the concepts of dynamic geometry in the field of algebra and mathematical analysis [2].

GeoGebra, developed specifically for educational purposes and can help students study experimental, problem-oriented, and science-oriented sections of mathematics, both at University and home. Students can simultaneously use a computer algebra system and an interactive one a geometric system that you can use to increase your cognitive abilities.

Also, the program allows you to teach math in secondary school and college, because it combines the ease of use of software in the study of dynamic geometry with some features of a computer algebra system, which allows us to bridge the gap between mathematical disciplines geometry, algebra, and even calculus. GeoGebra can be used to visualize mathematical concepts and prepare training materials.

What is valuable is that in the study of dynamic geometry, the program able to support the design drawing from points, lines, and all conic sections. It provides typical functions for a computer algebraic system, such as searching for important points functions (roots, local extremes, and inflection points of functions), direct input of equations and coordinates, finding derivatives and integrals of the entered functions.

The main idea of GeoGebra

The main idea of GeoGebra is to provide two presentations, to each mathematical object in its algebra and graphic windows. If you change an object in one of these windows, his presentation in another will be updated immediately. Computer algebra systems and software for dynamic geometries are powerful technological tools for teaching mathematics.

Multiple results of the research show that these software tools can be used to encourage discovery, experimentation, and visualization in traditional mathematics teaching. However, for most teachers, the main problem is how to provide a universal system for successful integration knowledge.

Benefits of using GeoGebra:

- Compared to a graphing calculator, it is more convenient for the user, as it offers an easy-to-use interface, multilingual menus and commands;
- Program for encouraging student projects in math, multiple presentations, and teaching experimental and guided discoveries;
- Students can personalize their creative abilities using the adaptation interface (for example, change the font size, language, graphic quality, color, coordinates, line thickness, line style, and other functions);

GeoGebra was created to help students better understand mathematics. Here, students can easily manipulate variables by simply dragging "free" objects around the drawing plane. You can also generate changes using the technique of manipulating free objects and find out how they will be influence dependent objects on each other. In this case, there is an ability to solve problems by exploring mathematical relations of dynamicity [3].

The program is used in teaching differential calculus and has a positive impact on understanding and knowledge of students. This once again proves that it can be a powerful tool for visualizing and stimulating key concepts differential calculus (slope of the tangent line, a connection between the slope of the tangent line and the gradient graph of the function, continuity/discontinuity of function, the relationship between differentiability and continuity, etc.) a fact that helps students improve their knowledge.

Nowadays there are two types of educational software that include geometry and algebra, which are used for teaching mathematics. Dynamic geometry training software allows users to create and dynamically modify structures. Geometric properties and relationships between objects used in the construction, they are supported because manipulating the object also changes the dependent objects accordingly. Some dynamic geometry programs even emphasize the basic algebraic features, displaying equations of lines or conical sections, as well as other mathematical expressions that usually they can't be changed directly by the user.

GeoGebra combines two types of software, where geometry, algebra, and calculus are considered equal partners. The software offers two views for each object, a numeric algebraic component shows either coordinates, either explicit or implicit equations, or the equations are in parametric form, while the geometric component displays the corresponding set of solutions. In GeoGebra, both views can directly affect the user. On the one hand, a geometric representation can be changed by dragging it with the mouse, resulting in the algebraic representation changes dynamically. On the other hand, however, the algebraic representation can be changed using the keyboard, which causes GeoGebra to automatically configure corresponding geometric representation.

Teaching experience shows that most teachers who are using GeoGebra tend to use it as a representation and visualization tool. They usually prepare training materials at home, so there is no need to manage the software in front of the students. The competence of the presentation in the audience requires a higher level of confidence and usually develops after some practice with using the software.

The possibilities of Geogebra.

As a first approach, many teachers start using GeoGebra to create thumbnails and designs for presentations, handouts, notes, or quizzes. Instead of using the software in class, they can spend this time on creating the materials they need at home. This phase of indirect integrating GeoGebra in training allows you to practice using the software while learning its universal features. This approach of integrating the educational process software with "traditional" training requires minimal technical equipment in the classroom and therefore can be used by almost every teacher who wants to improve the daily teaching of mathematics [4].

The program has a rich ability to work with functions such as building curves defined parametrically, calculation of roots, extremes, integrals, expansion of a function in a series, etc. Except for creating constructions, the program allows users to perform computational actions, for example, on matrices, work with complex numbers, perform statistical calculations, etc. The GeoGebra tool also helps directly entering equations, inequalities, systems, and aggregates, manipulate coordinates. Using interactive geometric software in the course of solving problems, as well as in the study of lecture material allows you to perform a visual image of all the studied mathematical objects, which contributes to a better understanding of the new material, speeds up the process of solving problems, simplifies calculations, etc. The program is also used to demonstrate theorems. It is easy to view the tasks solved using it first in the mode presentations. You can export the created file as an interactive drawing to a web page format. In addition to the features, this program includes creating various types of geometric shapes interpretations that allow us to use functional-graphic, geometric methods and the method of the geometric location of points in the process of solving algebraic problems.

When building graphs you need to manually select functions so that the overall view of their graphs and they were well-known. Using GeoGebra helps to avoid wasting time on selecting functions and researching their properties since to plot a function, you just need to enter the formula that defines it in the input line [5].

Results of research questions

Students' perception on GeoGebra in the learning of circles

Table 1. Student perceptions on use of GeoGebra in the learning of circles

№	Questions	Yes		No	
1	I was excited about using the GeoGebra software	81%	25	19%	6
2	I learnt a lot using the GeoGebra	89%	27	10%	4
3	I felt confident using the the GeoGebra software during the activities	52%	16	48%	15
4	I was very engaged in the learning process	80%	24	20%	7
5	I benefited a lot through the teacher-students interaction	89%	27	11%	4
6	I was able to visualize and answer the questions after each activity	80%	24	22%	7

7	I was able to think creatively and critically in the discussions and during the question and answer session	70%	21	30%	10
8	I was able to make logical assumptions when attempting to hypothesize	76%	23	24%	8
9	I enjoyed learning mathematics much more using the GeoGebra	71%	22	27%	9
10	I was able to form better connections between previous learning and new learning	71%	22	29%	9

Results from Table 1 show that students generally gave positive feedback toward the GeoGebra software. The majority of students, about 89% of them said that they learnt a lot using the GeoGebra and benefited a lot through the teacher-students interactions when using the GeoGebra, while 81% of the students said that they were excited about using the GeoGebra software, participated in the educational process, and were able to visualize concepts related to circles and answer the questions after each activity. About 70% of students said that they were able to think creatively and critically in the discussions and during the question and answer session, were able to make logical assumptions when attempting to hypothesize. They also enjoyed learning mathematics much more when using the GeoGebra and were able to form better connections between previous learning and new learning. However, some students reported they were not so sure when using the GeoGebra software.

Discussion

The GeoGebra software can be used as an enabler in the teaching and learning of Mathematics, and more specifically of circles, as there was a significant increase in experimental students' conceptual understanding of circles as compared to the control group.

The findings also suggest that technology is a great motivational tool as students' confidence enhanced when the GeoGebra was used to increase the students' learning process. This was especially beneficial for the lower ability students.

When students were asked how the software affected them, they had many positive things to say, such as: it made them more participated in the educational process and enabled them to think at higher levels.

Conclusion.

In the article were explanations about some features and have been given some examples of how the GeoGebra program can be used in schools for the study of some basic concepts in linear algebra and geometry. GeoGebra has been shown to give many opportunities for students to form an intuitive sense and visualize adequate mathematical processes. Using the tools of this software allows students to learn a wider range of function types and provide the possibility of connections between symbolic and visual views.

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