Жамият ва инновациялар –
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Visual approach to higher mathematics

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ARTICLE INFO

Article history:
Received January 2021
Received in revised form
30 January 2022
Accepted 20 February 2022
Available online
15 March 2022

Keywords:
higher mathematics,
visualization,
complex numbers,
interactive geometric
environment,
GeoGebra,
cognitive-visual approach,
computer programs.

ABSTRACT

The article discusses the possibilities of visualizing abstract mathematical concepts with the help of computer programs for educational purposes. The use of the interactive geometric environment GeoGebra in the study of certain topics of higher mathematics at the university contributes to the formation of visual representations of the studied mathematical objects.

DOI: https://doi.org/10.47689/2181-1415-vol3-iss2/S-pp211-216

Oliy matematikaga vizual yondashuv

Kalit so'zlar:
oliy matematika,
vizualizatsiya,
kompleks sonlar,
interaktiv geometrik muhit,
GeoGebra,
kognitiv-vizual yondashuv,
kompyuter dasturlari.

ANNOTATSIYA

Maqolada mavhum matematik tushunchalarni o'quv maqsadlarida kompyuter dasturlari yordamida vizualizatsiya qilish imkoniyatlari muhokama qilinadi. Universitetda oliy matematikaning ayrim mavzularini o'rganishda GeoGebra interaktiv geometrik muhitidan foydalanish o'rganilayotgan matematik obyektlarning vizual tasvirlarini shakllantirishga xizmat qiladi.

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Визуальный подход к высшей математике

Ключевые слова:
высшая математика, визуализация, комплексные числа, интерактивная геометрическая среда, GeoGebra, когнитивно-визуальный подход, компьютерные программы

АННОТАЦИЯ

В статье рассматриваются возможности визуализации абстрактных математических понятий с помощью компьютерных программ в образовательных целях. Использование интерактивной геометрической среды GeoGebra при изучении отдельных тем высшей математики в вузе способствует формированию наглядных представлений об изучаемых математических объектах.

The study of higher mathematics at a university for students of engineering specialties and areas of training is a rather complicated process. On the one hand, the difficulties of studying mathematics among first-year students are caused by their insufficient school mathematical preparation. On the other hand, the number of classroom hours allotted for the study of mathematical discipline at the university is decreasing every year. It should also be noted that the studied sections of higher mathematics are, as a rule, abstract in nature, which causes great difficulties with the perception of the material being studied by students.

Currently, there is an active development of information technology. They have found their application in almost all spheres of human life, including in the educational process of school and university.

In this regard, the requirements for graduates of engineering specialties and areas of training in the field of IT competence, as well as for knowledge in the field of higher mathematics, have increased. A modern graduate must have a wealth of mathematical knowledge that will allow him to create his own software tools, as well as apply software in the performance of engineering and technical developments.

The studied topics of higher mathematics cause certain difficulties in the perception and understanding of educational material among first-year students. On the one hand, the difficulties in studying higher mathematics are caused by the insufficient school mathematical preparation of applicants entering the university for engineering specialties and areas of study.

Studies show that the traditional approach to teaching mathematics at a university is based, first of all, on the possibilities of abstract-logical thinking of students. Which also does not contribute to the achievement of the proper level of knowledge of higher mathematics among future engineers.

The solution to these problems and the deep understanding and assimilation of mathematical knowledge can be the use of a cognitive-visual approach to teaching higher mathematics. The implementation of the approach to the theory and methodology of teaching certain sections of higher mathematics at the university is reflected in the works of V.A. Dalinger, A.I. Ryzhkova, N.V. Schukina and others.

In his publications, V.A. Dalinger talks about the need to build the process of teaching mathematics on the basis of a cognitive-visual (visual-cognitive) approach. He

notes that: “One of the central provisions of this approach is the wide and purposeful use of the cognitive function of visualization. The implementation of the cognitive-visual approach in the process of teaching students mathematics allows us to construct a visual learning environment - a set of learning conditions in which the emphasis is on using the reserves of visual thinking of students” [1. P. 297].

Currently, there are a large number of different educational computer programs that contribute to the creation of the necessary visualization of abstract mathematical concepts. Computer programs, as a rule, allow you to perform all possible algebraic calculations, geometric constructions of various mathematical objects, and have animation capabilities. Among the programs for educational purposes, the following are especially widely used: GeoGebra, “Live Geometry”, GONExT, Cabri Geometry and others.

The interactive geometric environment GeoGebra, in addition to performing various algebraic calculations, allows you to perform geometric drawings of mathematical objects and, by changing the required parameter, modify the finished drawing.

Using the capabilities of the GeoGebra interactive geometric environment in the educational process allows students to demonstrate a mathematical object, depending on the chosen learning approach. So, for example, considering the concept of "ellipse" most often use its classical definition. Using the GeoGebra program, you can draw a curve drawing based on its definition.

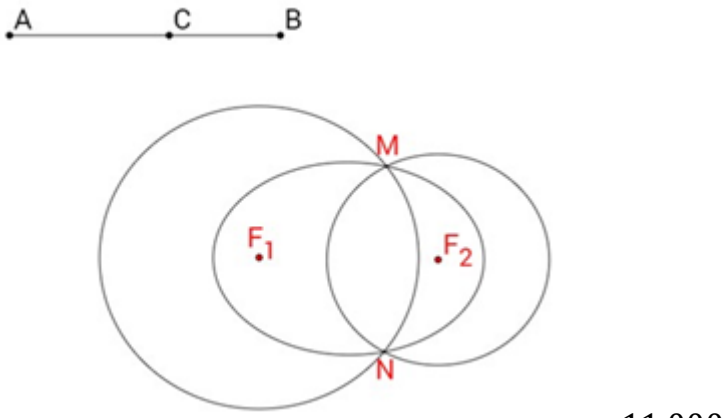

Fig. 1. The classical definition of an ellipse

As you know, the largest amount of information that a person receives in his life is visual in nature. It is worth noting that “the advantage of a visual image in comparison with motor or auditory ones is that it allows you to simultaneously highlight many aspects in the model-image, instantly penetrate the essence of the problem in all its complexity. In a visual image, it is possible to fix various theoretical connections and dependencies (spatial, structural, functional, temporal)” [1. P. 63].

The visual, representation of abstract concepts of the university course of mathematics can be facilitated by various computer programs for educational purposes. Among them, we should highlight: GeoGebra, C.a.R., Cabri Geometry, GEONExT, “Live Geometry” and others. The listed interactive geometric environments allow you to

perform algebraic calculations, geometric drawings of mathematical objects, manipulate the finished drawing by changing parameter values, have animation capabilities, etc.

The concept, of an ellipse can also be introduced through the use of a conical surface. Let the plane intersect the conical surface. If the cutting plane is not parallel to any of the generators of the conical surface and does not pass through the top of the cone, then the line of intersection is called an ellipse (Fig. 2).

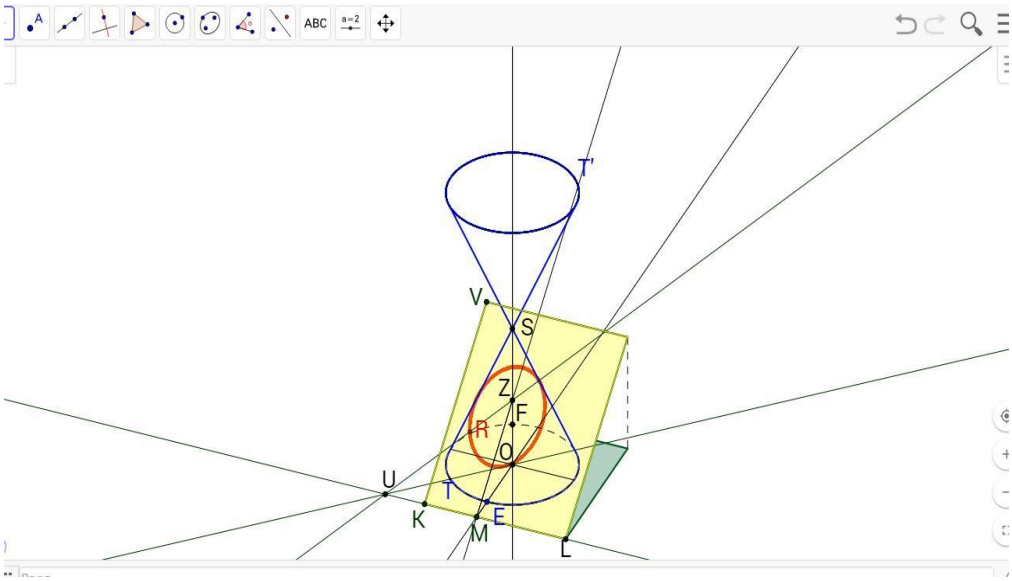

Fig. 2. Definition of an ellipse through a conical surface

An ellipse can also be represented as a line of a plane. Let's add on the finished drawing (Fig. 2) the image of two spheres inscribed in a conical surface that touch the cutting plane: the upper one at the point F1, and the lower one at the point F2 (Fig. 3).

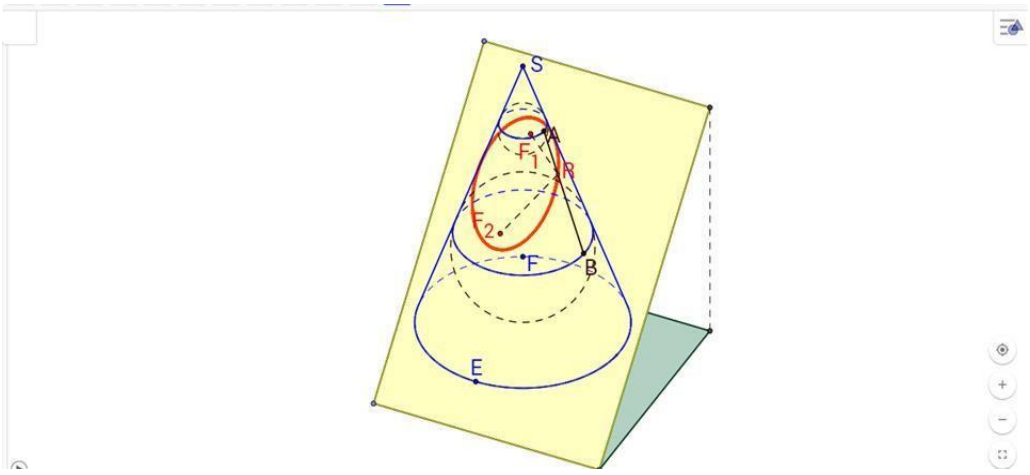

Fig. 3. Definition of an ellipse as a line of a plane

Of the above computer programs, GeoGebra occupies a special place. The peculiarity of this geometric environment lies in the interactive combination of geometric, algebraic and numerical representation. GeoGebra has the ability to create

structures with points, vectors, lines, conic sections, mathematical functions, and also allows you to dynamically change them.

In the process of studying the topic “Complex Numbers” there are a number of abstract concepts related to the performance of actions: multiplication and division of complex numbers, raising to a power and extracting a root from a complex number. All of the above actions, as a rule, are communicated to students in the form of appropriate formulas. Therefore, performing actions with complex numbers for students of engineering specialties and areas of training is very abstract. Using the interactive geometric environment GeoGebra, you can clearly demonstrate to students’ what kind of object is obtained as a result of the multiplication of complex numbers.

To this end, two complex numbers should be given

$a=r\cdot(\cos\alpha+i\sin\alpha)$ and

$z=m\ (\cos\beta+i\ \sin\beta)$, complete the necessary constructions and inform students that point K is the result of multiplying complex numbers a and z (Fig. 4)

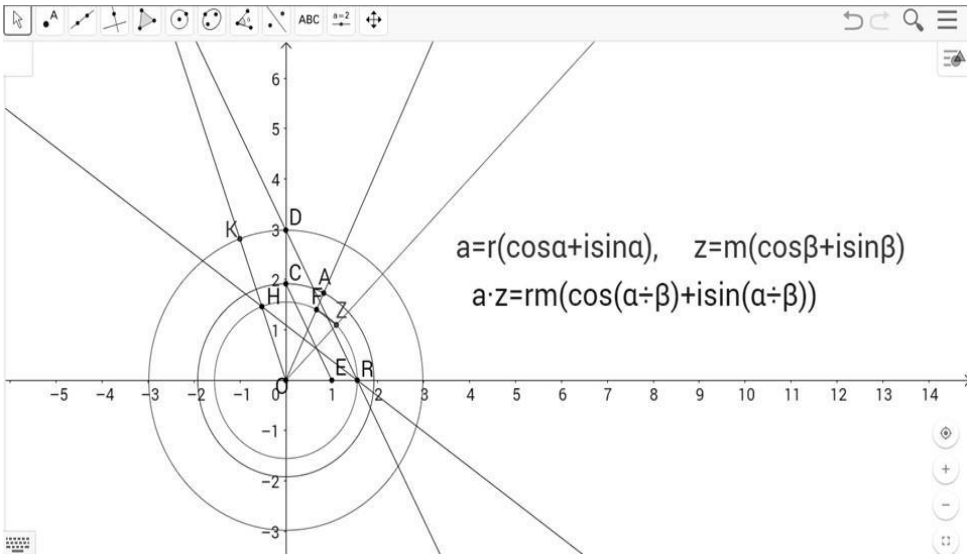

Fig.4. Product of complex numbers

Similarly, using the GeoGebra interactive geometric environment, you can visualize the process of dividing complex numbers:$a=r\cdot(\cos\alpha+i\sin\alpha)$ and

$z=m\cdot(\cos\beta+i\sin\beta)$.

Having completed all the necessary constructions in the computer program, we get that the point M is the result of dividing the complex number a by z (Fig. 5).

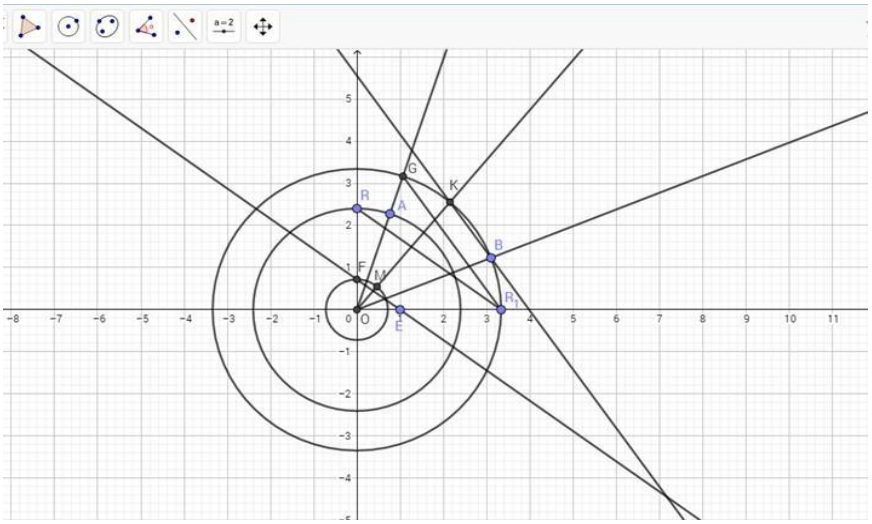

Fig.5. Division of complex numbers

The use of the interactive geometric environment GeoGebra and other computer programs for educational purposes allows the visualization of abstract mathematical concepts, which contributes to the speedy perception of the material being studied, its deeper understanding and increases interest in the discipline being studied.

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