The Application of Geogebra in Higher Mathematics Teaching

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Abstract. This paper mainly discusses the application of dynamic mathematics software Geogebra in higher mathematics teaching. By analyzing its advantages in function image drawing, limit and continuity, derivative and differential, integral and spatial analytical geometry, this paper expounds how to use Geogebra to improve students' interest in learning, enhance intuitive understanding and cultivate mathematical thinking ability, which provides new ideas and methods for the reform of higher mathematics teaching.

Keywords: Geogebra, higher mathematics teaching, mathematical software, ability of thinking

1 Introduction

As an important basic course of science and engineering major, advanced mathematics is highly abstracted and logical. Traditional teaching methods often rely on blackboard writing and static graphics, so it is difficult for students to deeply understand the complex mathematical concepts and processes. With the development of information technology, dynamic mathematics software such as Geogebra has brought new opportunities for higher mathematics teaching. Geogebra with powerful graphic drawing, dynamic demonstration and interactive functions, it can present abstract mathematical knowledge to students in an intuitive and vivid form, and improve the teaching effect.

2 The Characteristics and Advantages of Geogebra

2.1 It has Powerful Functions

Geogebra can draw various function images, space curves and surfaces for numerical calculation, dynamic demonstration, etc. It supports the creation and operation of a variety of mathematical objects, such as points, lines, faces, functions, etc., to meet the various needs of higher mathematics teaching[1][2].

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2.2 It has a Strong Intuition

Through the dynamic demonstration of mathematical processes, such as the changes of functions, the approach of limits, and the tangent lines of curves, students can intuitively see the actual performance of mathematical concepts and deepen their understanding of abstract knowledge.

2.3 It has a Very Good Interaction in Nature

Students can interact with mathematical objects through dragging, clicking and other operations, independently explore mathematical rules, and improve their initiative and enthusiasm in learning.

2.4 Easy to Operate

Many graphics drawing only need to input the corresponding command, very suitable for classroom teaching and students learn to use.

3 The Specific Application of Geogebra in Higher Mathematics Teaching

3.1 Function Image Drawing

Geogebra can clearly shows the properties of functions such as monotonicity, parity, periodicity, etc. For instance, y=sin$x$ and y=cos$x$ can dynamically demonstrate their periodicity and symmetry through Geogebra, so that students can intuitively feel the characteristics of the function[3][4].As shown in Fig.1.

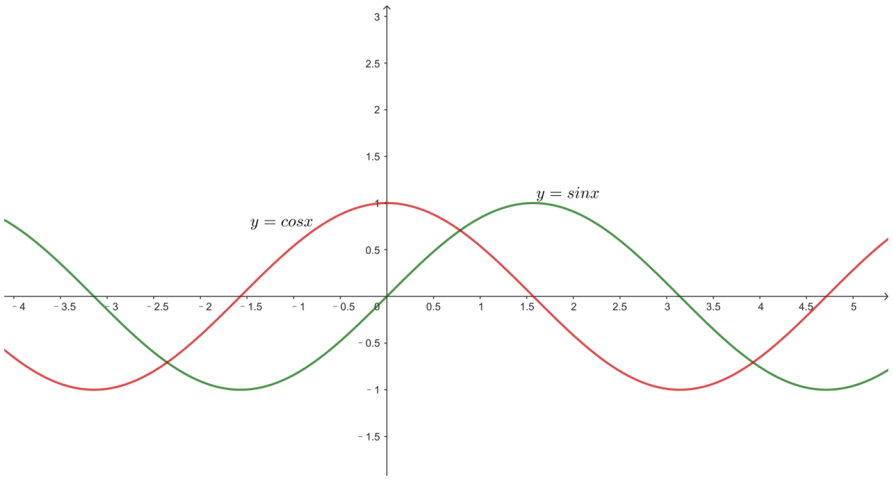

Fig. 1. images for y = sin$x$ and y = cos$x$

3.2 Limit and Continuity

Geogebra can dynamically demonstrate the limit process[5], so that students can intuitively see the change trend of the function when the variable tends to a certain value. For example, show the process $a_n = 1+(-1)^n/n$ in which the value of the series approaches to 1 when n tends to infinity. As shown in Fig.2.

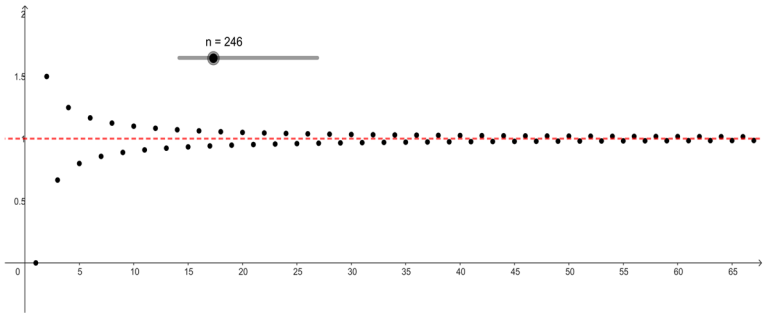

Fig. 2. Geometrical significance of the sequence limits
Note: Control the value of n through the sliding bar to observe the limit change process.

3.3 Derivatives and Differentials

Geogebra can visualize the geometric meaning of the derivative, namely, the tangent slope of the function at a certain point. Using Geogebra, we can draw function images and tangent lines at specific points, allowing students to intuitively see the relationship between derivative and tangent slope.

Geogebra can demonstrate the change rate of the function, by dynamically changing the value of the independent variable, observing the change of the value of the function and the corresponding derivative change, to help students understand the speed of the derivative reflecting the change of the function. As shown in Fig.3.

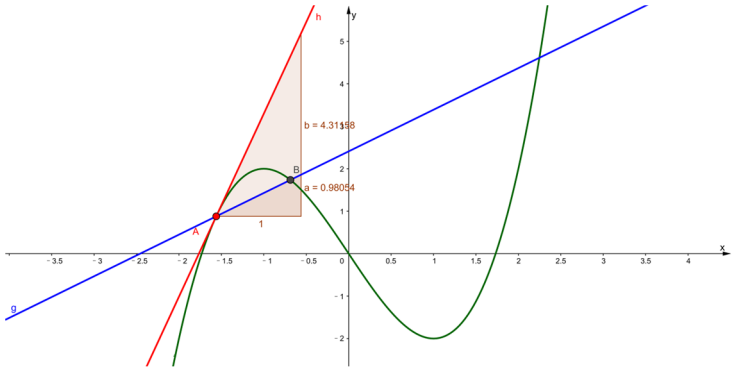

Fig. 3. Definition and geometric meaning of the derivatives
Note: Change the position of the increment and the point to demonstrate the change of the function value and the corresponding derivative change.

3.4 Integration

Geogebra can show the geometric meaning of the fixed integral[6], that is, the area of the area surrounded by the function curve, coordinate axis and interval boundary. With Geogebra, we can intuitively see the calculation process and results of the integration. As shown in Fig.4.

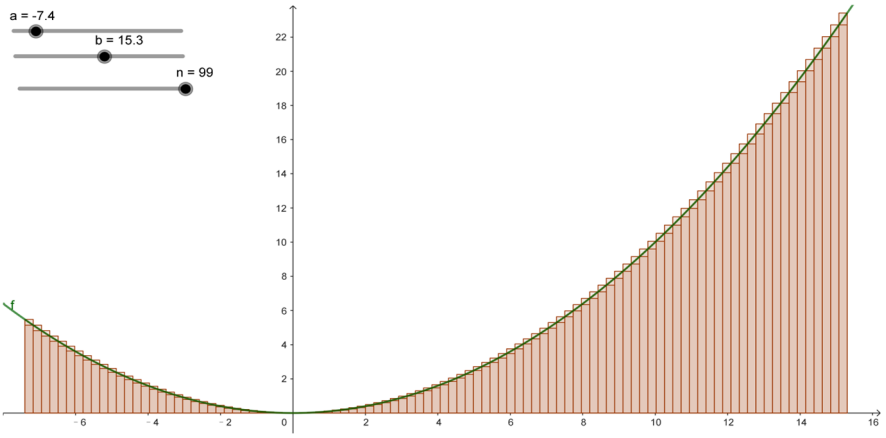

Fig. 4. Fixed integral segmentation process
Note: change the length of the interval and the degree of segmentation through the sliding bar, dynamically demonstrate the idea of "segmentation, approximation, sum and limit"

The integral can be calculated through the CAS function, such as the fixed integral $\int_{-3}^{3} x^2 dx$, and the integral instruction can be input into the product function and the integral interval to directly get the results, and the integral area graph can be displayed. As shown in Fig.5.

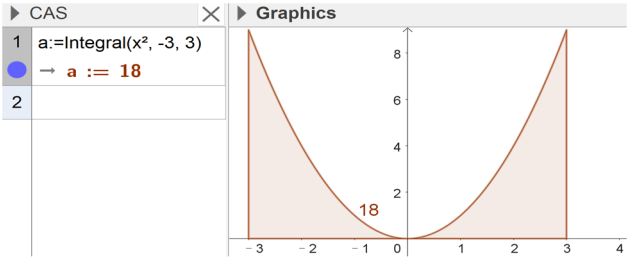

Fig. 5. Fixed integral calculation

3.5 Space Analytic Geometry

Geogebra can draw spatial curves and surfaces, help students to intuitively understand the shape and nature of spatial graphics, let students observe and analyze from different angles. As shown in Fig.6 and Fig.7.

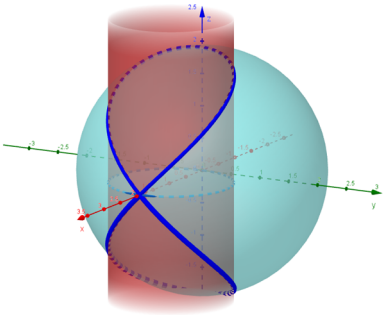

Fig. 6. Vivianne curve

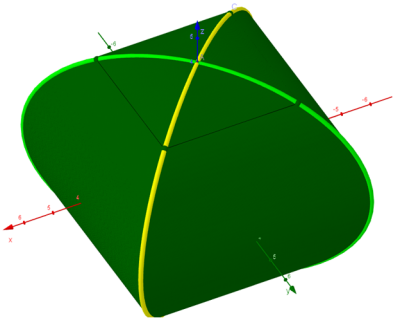

Fig. 7. Steinmetz solid

3.6 Draw Special Curves

Geogebra can be used to draw the special curve formation process, such as the heart line, the cycloid, etc., to help students intuitively understand the curve formation process, and better cultivate students' mathematical thinking ability. As shown in Fig.8 and Fig.9.

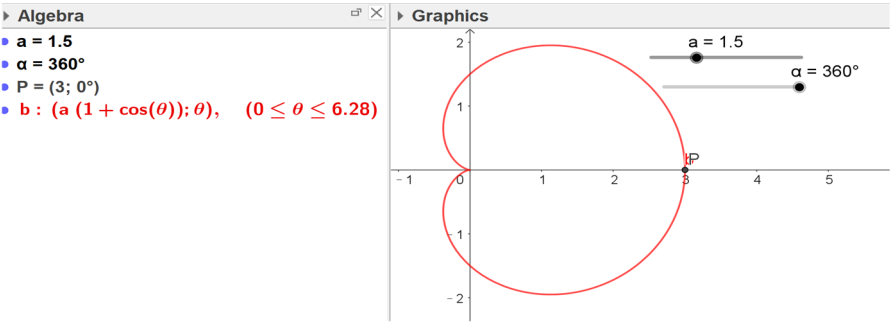

Fig. 8. Heart line formation process

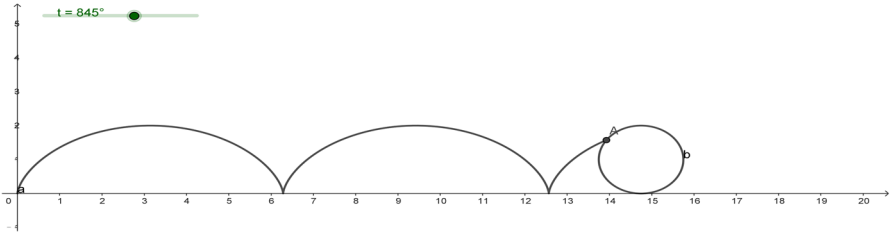

Fig. 9. cycloid curve

Note: Control the Angle through the sliding bar to display the dynamic cycloid generation process.

4 Conclusions

Geogebra as a powerful dynamic mathematics software, it has a wide application prospect in higher mathematics teaching. It can improve students' interest in learning, enhance intuitive understanding, cultivate mathematical thinking ability, and provide strong support for the reform of higher mathematics teaching. In the practical teaching, teachers should give full play to the advantages of Geogebra, combine the traditional teaching methods, innovate the teaching mode, and improve the teaching quality. At the same time, students should also actively use Geogebra for independent study and exploration, to improve their mathematical literacy and comprehensive ability.

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