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Research on the Application of SPS Case Sandbox Teaching Method in Calculus Teaching

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Abstract: *Introduces the SPS case sandbox teaching method and the necessity of its application, and conducts case teaching practice, which effectively verifies that the SPS case sandbox teaching method can not only improve the effect of mathematics classroom teaching, but also greatly improve the analysis of problems and solutions for students the ability to question.*

Keywords: *Case Sandbox; Teaching Practice; Calculus Teaching*

1. Introduction

Time development requirement of university mathematics teaching must satisfy the conditions of new era of applied talents training, and the cultivation of applied talents pay attention to is the effective management of knowledge and application of the characteristics of calculus as an applied mathematics course, in the solution actual problem and course contests, the application of mathematical contest in modeling is essential. Facing the challenge of the whole Internet, we see and encounter pain points in the actual teaching of calculus. It is necessary for us to combine science and technology with teaching. At present, there are many reforms and innovations, such as: Turn for lessons, classroom, online, etc., these changes also make our teaching towards a new stage, but the lack of the concrete practice of the students, also is the disconnection between knowledge and social demand, therefore, on the basis of technology assisted teaching, we need a kind of new practical teaching mode -- SPS sandbox teaching cases, the it knowledge and practice innovation oriented, In order to train students' ability to solve practical problems, it lays a good foundation for discipline competition.

2. SPS Case Sandbox Teaching Method

SPS is a general term of Structured, Pragmatic and Situational. Case is the form, sandbox is the environment, and teaching is the goal, specifically, SPS case sandbox teaching will be teaching and concrete practice, experiment or social practical problems together, through solving practical problems to achieve the purpose of cultivating students' ability. Specific implementation steps:

(1) According to the characteristics, objectives and basic needs of specific chapters of calculus course, teachers will select appropriate practical cases, compile short case guides, decompose the core needs into specific key thinking points, and guide students to practice as the implementation link.

(2) Group the students into groups. Group members form associations with the background, current situation, core themes, key thinking points and relevant reference data of the case, face and solve practical problems, and make plans.

(3) The implementation and implementation of specific solutions, usually different student groups will have different results, which is the significance of teaching, ability training and innovative pre-research.

(4) Summarize the problems and shortcomings of each group in the whole case practice, and give specific guidance for these problems to help students grow.

3. Implementation of SPS Case Sandbox Teaching Method in Calculus Course

(1) Chapter selection

Excerpt from the fourth section of the fourth chapter of calculus textbook published by Renmin

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University of China -- extreme values of functions.

(2) Teaching design

① Status and role

This section is the continuation and deepening of function derivative and function monotonicity, which lays the foundation of knowledge and method for the maximum value of function in the next section, and serves as a link between the preceding and the following. This lesson will further explore the application of derivatives in the study of extreme values of functions, which are very important in this chapter and in mathematics as a whole.

② Learning situation analysis

There are two levels of differentiation in the basis of students, their thinking level is uneven, and their ability to understand and apply knowledge is slightly inadequate. In teaching, it is necessary to consider the learning feelings of students at different levels, divide students into groups, make more students participate in learning and stimulate their interest in learning through question guidance and inquiry teaching. Students have learned the method of using derivatives to study the monotonicity of functions. This class will further improve students' ability of using derivatives to study functions and realize the tool function of derivatives.

③Teaching difficult points

Teaching emphases: the concept and discriminant method of extreme value of function; The procedure for finding the extremum of a differentiable function.

Teaching difficulties: understand that stagnation point of derivative function is a necessary and insufficient condition for extreme point of function.

④ Teaching objectives

a)Knowledge objective: to understand the concept of extreme value of function and realize that extreme value is the local property of function; Master the general methods and steps of using derivatives to find extreme values of functions; Understand the conditions necessary for a function to attain an extreme value at a certain point.

b) Ability objective: Through students' active participation, cultivate students' learning ability of observation, analysis, exploration, and induction of mathematical concepts and rules; Deepen students' understanding of the part and the whole, and train students to solve problems by combining numbers and shapes.

c) Emotional goal: to cultivate students' spirit of in-depth and meticulous study of things; Experience the dialectical relationship between the part and the whole in mathematics.

⑤ Teaching process

a) Create situations and introduce new lessons;

b) Put forward the problem, observe the introduction, get the definition of the extreme value of the function;

c) Organize students to explore independently and summarize the steps of finding the extreme value of the function;

d) Deepen and improve the understanding of the concept and method of function extremum through examples and exercises.

⑥ Teaching effect

In the teaching process, we pay attention to students' learning situation, organize classroom teaching reasonably, students actively participate in, master effective learning methods, and achieve the teaching objectives in knowledge, ability and emotion.

⑦ Integration of ideology and politics into the course

Guide students to correctly look at the ups and downs of life, learn to use the viewpoint of movement to look at the problem, beyond a narrow range to look at the truth and the whole picture of things, encourage students to pay hard, hard work.

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(3) To review

①Using derivatives to judge the monotonicity of functions?

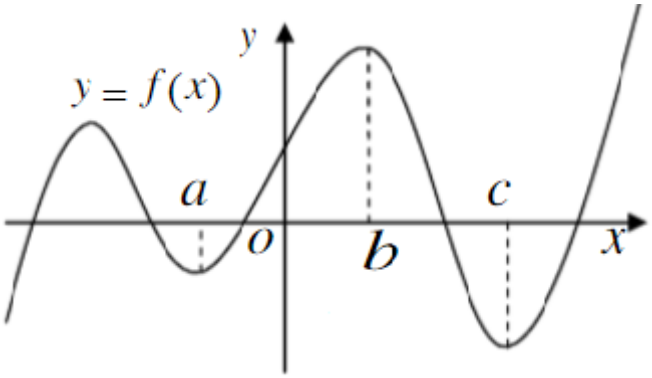
② Find the monotone interval of the function?

(4) Introduction of new lessons

Cite: a workshop on the wall to build a rectangular cabin, the existing brick is only enough to build 20m long walls, ask should surround what kind of rectangular to make the largest area of this cabin? (The only extreme point in a real problem is the maximum point.)

(5) The new lesson

Question one: What is the relationship between the value of the function $f(x)$ at the point a(point b) and the value of the function on either side of it in the figure below?



The group discussion concluded that:

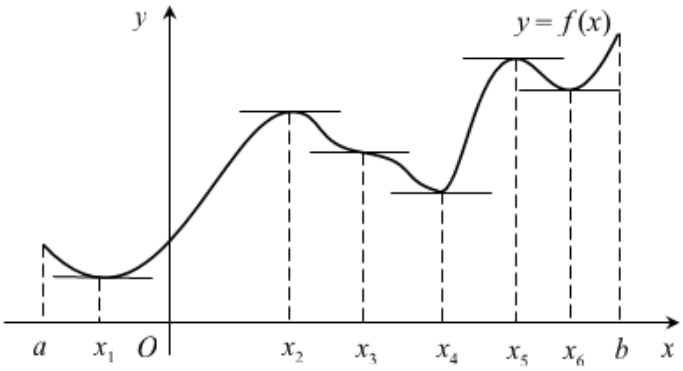
The value of the function at that point is smaller than the value of the function at any other point near that point. Similarly, the value of the function at a point is greater than that at any other point near the point.

① Definition of extreme value: Suppose that the function $f(x)$ is defined in a neighborhood of a point x_0, if for any point x $(x \neq x_0)$ in the neighborhood, constant

$$f(x) < f(x_0) \text{ Or } f(x) > f(x_0)$$

It is called the maximum value (or minimum value) obtained at the point x_0, and x_0 is the maximum value point (or minimum point) of the function $f(x)$. Maxima and minima are called the extremum of the function, and maxima and minima are called the extremum of the function.

Note: Extreme value is a local concept of a function.



In the figure above,, x_0, x_4, x_6 are minimum points; x_2, x_5 Is the maximum point; x_3 is not an extreme point.

Question two: Which of the following statements is true ( )?

A. The maximum of A function is the maximum;

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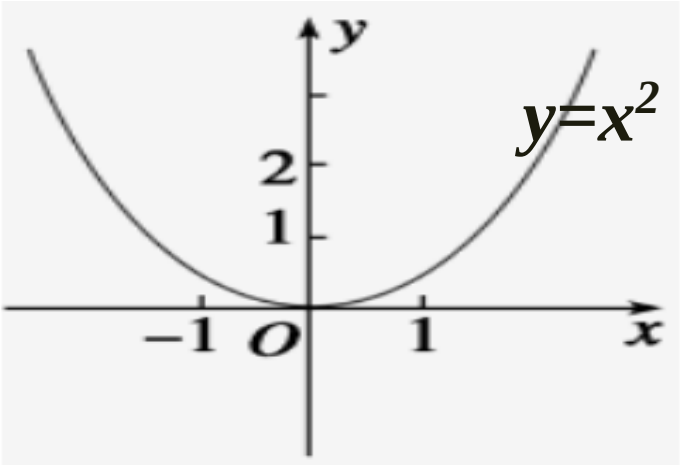
B. The maximum and minimum of a function are uniquely determined;

C. The maximum of a function must be greater than its minimum;

D. The extremum of a function must not be an endpoint of an interval.

②Conditions for the existence of extreme values

What is the extreme point of the function $y=x^2$? What's the derivative of $y=x^2$ at $x=0$? What is the characteristic of the tangent line of $y=x^2$ at $x=0$?

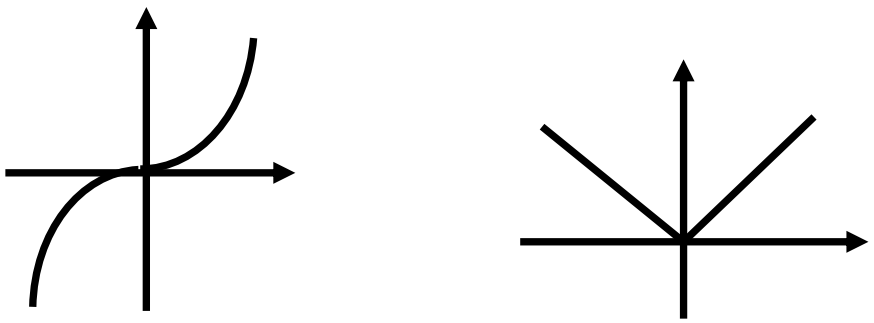


Group discussion conclusion: $x=0$ is the minimum point of the function $y=x^2$, and the tangent of $f'(x)=0$, $y=x^2$ at $x=0$ is the x axis.

Theorem one (necessary condition for the existence of extremum) let the function $f(x)$ be differentiable at x_0, and obtain extremum at x_0, then $f'(x_0)=0$.

Ex.:

$y=x^3$ $\qquad$ $y=|x|$



Note: For common functions, extreme values may have stagnation points or points where derivatives do not exist.

Question three: How does the derivative of $y=\sin x$ change near the $x=-\frac{\pi}{2}, x=\frac{\pi}{2}$ sides? Is $x=-\frac{\pi}{2}, x=\frac{\pi}{2}$ the extreme point of function $y=\sin x$?

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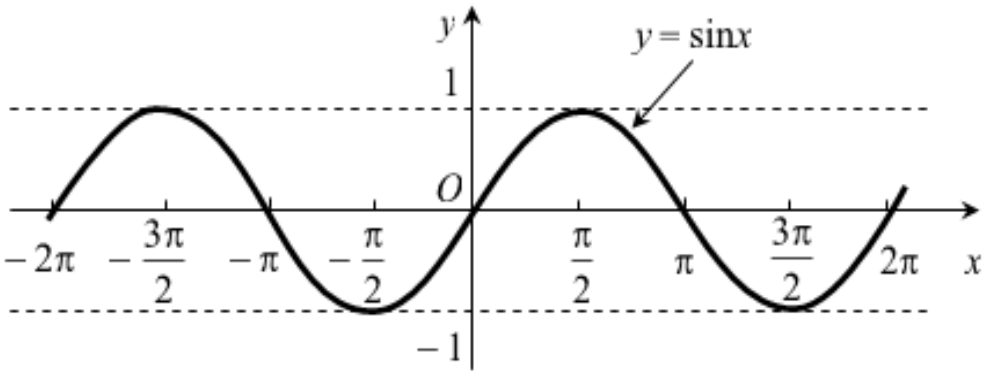

The results are as follows: $x=-\frac{\pi}{2}$ changed from negative to positive, $x=\frac{\pi}{2}$ changed from positive to negative. $x=-\frac{\pi}{2}$ is the minimum of $y=\sin x$, $x=\frac{\pi}{2}$ is the maximum of $y=\sin x$.

It is further concluded that the extreme point is the boundary point of increase and decrease, and the boundary point of derivative sign change.

Theorem 2 (first sufficient condition) let function $f(x)$ be continuous and differentiable (derivative may not exist) in some neighborhood of point x_0, and differentiable in its discentered neighborhood.

1>If in the left neighborhood of point x_0 $f'(x_0)>0$; In the right neighborhood of point x_0, $f'(x_0)<0$, the maximum value is obtained at point x_0.

2> If in the left neighborhood of point x_0, $f'(x_0)<0$; In the right neighborhood of point x_0, $f'(x_0)>0$, the maximum value is obtained at point x_0.

3> If in the centripetal neighborhood of point x_0, the sign does not change, then there is no extremum at point x_0.

③ Solving the extreme value of the function

a) Find the sum of the domain of the function $f(x)$ and $f'(x)$;

b) Find the stagnation point and non-differentiable point of the function $f(x)$;

c)Arrange the above stationary points and non-differentiable points from small to large, divide the domain into several sub-intervals, discuss the sign of $f'(x)$ on each sub-interval, and determine whether extreme values (positive left and negative right, maximum value; Negative left and positive right, minimum);

d) Find the extreme value.

④Examples explain

Find the extremum of function $y=(x-4)\sqrt[3]{(x+1)^2}$.

⑤Classroom practice

Find the extremum of function $f(x)=x^2-2\ln x$.

(Reinforce the concept)

What is the characteristic of the derivative of the function at the extremum?

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What is the relationship between the sign of the derivative of a function near the extremum?

Is the point where the derivative is 0 necessarily the extreme point of the function?

⑥ Instruct students to solve citation (the only extreme point in practical problems is the maximum point)

Some workshop relies on wall to want to build a rectangular cabin, existing put brick enough build by laying bricks or bricks only 20m long wall, ask should surround what kind of rectangular ability makes the area of this cabin largest?

⑦Summary

The concept of extreme value of function;

Solving the extreme value of the function;

The stagnation point of the derivative function is a necessary and insufficient condition for the extreme point of the function.

⑧ Homework

4-4:14 problem sets

4. Conclusion

Sandbox SPS case teaching method in combination with the actual situation of colleges and universities, starting from the practical level of calculus course, let the student to use knowledge to solve practical problems, to bridge the gap between and among universities, students and society, the education effectively "teacher center, book center, classroom centre" into "student center, experience, activity center" 4. It has the following promotion values :(1) it can promote the change of teachers' roles and make teachers carry out "ability positioning, curriculum design and teaching implementation" for students in a targeted and personalized way; (2) Stimulate students' enthusiasm and creativity, solve specific cases through practical exercises, so that they can "look up to the sky" and be more "down-to-earth"; (3) Lay the foundation for discipline competition, and provide continuous intellectual support and talent reserve for modern enterprises and society; (4) To promote the transformation of teaching mode and promote the theoretical innovation and practical reform at the micro level of higher education.

References

[1] Pan Shanlin, Ying Wenchi. SPS Case Sandbox Teaching Methods-Design, Implementation and Examples [M]. Beijing: Peking University Press, 2018:1-10.
[2] Li Bo, JIANG Yan. Application of Case Teaching method in college Mathematics teaching [J]. Higher Education, 2017 (10):166-167.
[3] xu liang. Case teaching of higher vocational mathematics course based on social life [J]. Journal of jiangsu vocational and technical college of engineering, 2016, 16(4):12.
[4] Bai Cuixia, Yang Yunfan, Chen Jing. Journal of hubei open vocational college, 2019, 32(12): 145-146.
[5] Zhao X F, Mei-Qin L I. A Research into Application of Case Teaching Method in Mathematics Teaching of Engineering Specialities [J]. Journal of Educational Science of Hunan Normal University, 2006.