

A Case Study of Student-Centered Teaching of Matlab to Find Extreme Values

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Abstract: In the realm of student-centered teaching, utilizing the concept for multivariate function extreme value problems in advanced mathematics is valuable. By incorporating Matlab software, which includes visualization capabilities, students can engage in operations and analyses that aid in understanding complex problems. This approach fosters the development of students' fundamental skills, encourages systematic and rigorous thinking in tackling real-world problems, and increases student involvement during the learning process. Many college teachers tend to solely emphasize the use of formulas when teaching the course, overlooking the development of students' data processing and analytical skills. This leads to students struggling to grasp the knowledge effectively and encountering difficulties in understanding the subject matter.

1. Introduction

In the 1950s and 1960s, the American humanistic psychologist Carl Rogers put forward the teaching concept of "student-centeredness", pointing out that students should be allowed to think and explore knowledge independently, stimulate their learning enthusiasm, become the main body of classroom learning, develop the habit of independent learning, and cultivate the ability of independent innovation. Higher mathematics, as an important part of the public courses in colleges and universities, is the first professional foundation course after students step into the university, and its purpose is to cultivate applied talents with logical thinking ability and professional ability, which provides a strong support for the subsequent professional field of study and research. In higher mathematics, specific methods and operational steps are outlined in textbooks for handling extreme values. By utilizing Matlab's robust plotting functions, data can be visually represented to transform abstract problems into intuitive graphics. This approach enhances students' understanding, fosters observational skills, promotes practical applications, and encourages a spirit of exploration.

Matlab software launched by Mathworks has powerful numerical calculation and graphic visualization functions, and is a professional information technology software, which can enrich the theoretical level of mathematics courses, provide convenience for the development of theoretical courses, and to a certain extent can also enhance the hands-on operation and innovation ability of students, which is an important means to improve the quality of higher mathematics courses. The extreme value of multivariate function is an important concept in higher mathematics, which has

important theoretical and methodological support for the study and application of subsequent courses. However, in teaching practice, due to the strong comprehensiveness of this method, the teaching effect of the course is often unsatisfactory, and students are not able to effectively master the basic method after learning, not to mention the application of the method to solve practical problems in the future.

In recent years, Matlab software is widely used in universities and research units, because of its programming language is simple and easy to learn, there is a great auxiliary role in the teaching of higher mathematics classes. For some complex problems, students can conduct experiments and simulations through Matlab, program writing, increase the rendering effect, the theoretical knowledge into a tool for solving practical problems through, is that students can intuitively and comprehensively understand, establish a thinking model, and effectively solve the mathematical problems of the high degree of abstraction and complexity, so as to improve the teaching effect.

In this paper, regarding the status quo and insufficiency of the teaching content of higher mathematics on the polar value problem of multivariate functions, we propose to carry out the teaching and practice of the polar value of multivariate functions based on Matlab software, to concretize and visualize the knowledge of the polar value problem, and to carry out the "conceptual enhancement - hands-on practice" teaching case design, which is based on the teaching model, teaching design and teaching practice of the students' focus, to carry out the "conceptual enhancement - hands-on practice" teaching case design. "The teaching case design is based on student-centered teaching mode, teaching design and teaching practice, which helps students better understand and master the basic knowledge and methods of extreme value, enhances their self-confidence in learning, meets the needs and development requirements of students, and facilitates the implementation of the student-centered teaching concept into the teaching process.

2. Research background

The teaching concept of "student-centered" is conducive to stimulating the innovative spirit of students and cultivating their core qualities and key abilities [1]. It can be seen that the "student-centered" teaching model pays more attention to letting students become the main body of thinking and learning, stimulating students' enthusiasm and inner drive and potential, so that students can reap high-quality learning results[2]. As the number of university enrollment continues to increase, teaching methods, student differences and many other factors will affect the teaching effect. This paper takes the course of the institution as an example, mainly from the content of the extreme value, teaching methods and student differences in three aspects of the current situation and shortcomings of this content.

From the viewpoint of the teaching content of the extreme value of multivariate functions, the syllabus will be designed for the content of two lessons, including concepts, judgment conditions, applications and the most value, the actual lesson time and the content of the required learning fashion gap. In teaching, it is crucial to keep up with the lessons to ensure they are not too challenging. While this may help cover the curriculum, it might not solidify students' understanding for future courses and practical use, leading to a sense of confusion among students during real-world applications.

From the perspective of teaching methods, the main alternative to PowerPoint teaching, still lack of intuitive analysis and practical operation, teacher-student interaction and student participation is low, students can not hand can be feedback and application, encountered in the perspective of the actual problem is at a loss. The training goal of engineering students is to emphasize application, and there is a certain gap between this approach and the actual goal.

From the students' side, with the massification and popularization of higher education, the

students who enter our school generally do not have solid knowledge. Influenced by high school learning, they focus on deduction, for the theory put into practice is relatively weak, do not know how to use after learning, and even some students can not distinguish between the extreme value and the most value, and slowly lose interest in learning, so that the classroom participation is low, which is easy to cause the thought of desertion, playing with cell phones. Therefore, the concept of "student-centered" is essential to improve students' independent learning ability and enhance their learning initiative and enthusiasm in teaching.

Based on the above analysis, Matlab is introduced into the teaching and practice of multivariate function polar value in higher mathematics as an example, so as to increase students' participation in the classroom, improve classroom efficiency, enhance students' motivation for learning, and demonstrate the "student-centered" teaching of higher mathematics through the teaching process of dynamization and visualization.

3. Matlab practice in teaching extreme values

The traditional teaching of multivariate function polar value is usually lectured by teachers and practiced by students, the task is relatively simple and the content is independent, which is not conducive to students' mastery and understanding, not to mention the application of the Matlab notable function is to display the results of the calculations in graphs, so that the students can have an intuitive feeling of the conclusions, and thus find out the intrinsic connection and the law of the complex problem. The theoretical knowledge of the polar value of multivariate functions can be learned through classroom lectures, extracurricular reading, etc., while the practical skills need to be mastered through actual programming operations[3]. Different from the traditional teaching mode, Matlab-based multivariate extreme value is a computer-assisted teaching mode combined with the traditional teaching mode, which draws on both traditional teaching and computer-assisted teaching to inspire students and explore their creativity, and guide students to actively think about the source, scope and expansion of mathematical problems[4]. When students are learning new knowledge, analyzing examples through their own thinking may be more conducive to their learning and mastery of mathematics. Programming experiments on examples will enable students to know the ins and outs of each knowledge point and its specific application, which is conducive to students' understanding and helps to cultivate their observation ability, application awareness and spirit of exploration[5].

Case Study: Find the extreme values of a function.

In higher mathematics, specific methods and operational steps are outlined in textbooks for handling extreme values. By utilizing Matlab's robust plotting functions, data can be visually represented to transform abstract problems into intuitive graphics. This approach enhances students' understanding, fosters observational skills, promotes practical applications, and encourages a spirit of exploration.

3.1. Use the command of "ezmesh" to depict the graph of $z=f(x,y)$

In order to illustrate how extreme values indicate the localization of a function, you can plot the graph of $z = f(x,y)$ and ask the students to identify the extreme points on the graph.

```
syms x y
z=x^3-y^3+3*x^2+3*y^2-9*x;
ezmesh(z)
```

3.2. Use the command of “diff” to find the partial derivative of the function f(x,y)

```
zx=diff(z,x);  
zy=diff(z,y);  
The results are as follows  
zx=3*x^2+6*x-9  
zy=-3*y^2+6*y
```

3.3. Use the command of “solve” to find the stationing point of f(x,y)

```
[xi,yi]=solve(zx==0,zy==0)
```

Here you can use the formatted output to show students that the function has several residences, namely (1,0),(-3,0),(1,2),(-3,2).

3.4. Find the second order derivative of the function f(x,y)

```
zxx=diff(z,x,2);  
zxy=diff(zx,y);  
zyy=diff(z,y,2);
```

3.5. Check if the stationary point satisfies the sufficient condition for extreme values.

To calculate the values of A,B, and C at each stationary point,use the "subs" command. Next, determine whether the stationary point is an extreme point by evaluating the expression $AC-B^2$ and the value of A.

3.6. Static visualization

The extreme points and extreme values are labeled in the graph window, and the command window shows whether the stationary point is an extreme point or not. Specifically as shown in Figure 1, the complete program is shown in Appendix.

$$z=x^3-y^3+3x^2+3y^2-9x$$

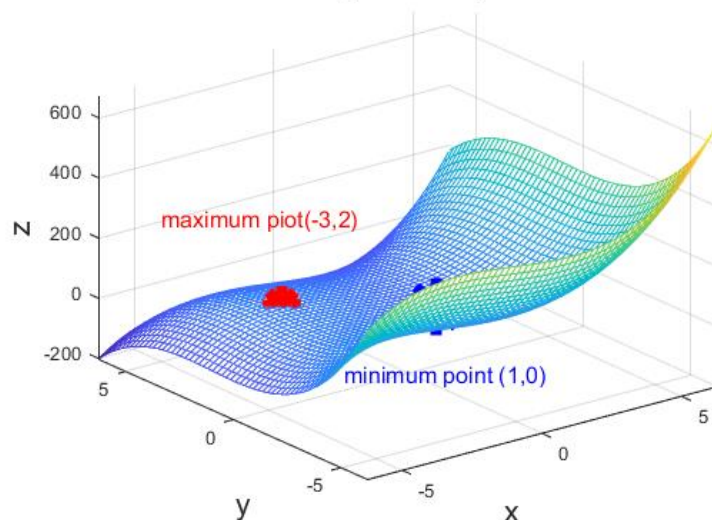


Figure 1: The graphic of visualization

From Figure 1, it can be visualized that the function has a great value of 31 at the point (-3,2) and a minimal value of -5 at the point (1,0). On the other hand, in the command window, the function is shown to have four stationary points, two of which are not extreme value points. Based on Matlab presenting the comparison between the extreme value and the minimal value, it deepens students' understanding that the extreme value is a local property of the function, which not only indirectly enhances students' classroom participation, but also lays the foundation for subsequent engagement in scientific research.

4. Conclusions

Matlab is a scientific computing language with powerful computing, analyzing and graphic processing functions. In the course of teaching higher mathematics, the introduction of Matlab software provides an efficient means and great convenience for multimedia-assisted course teaching. This paper describes in detail the application of Matlab software in the teaching of higher mathematics courses in the teaching of multivariate function extreme value, and gives the detailed operation process of the software in the depiction of function graphs, numerical calculations and visualization of specific cases. The integration of MATLAB software and multimedia teaching courseware enhances the experimental teaching of university mathematics. This approach enables students to achieve a deeper understanding and better mastery of complex topics in university mathematics. It also sparks students' enthusiasm for learning, expands their horizons, and improves the overall quality of teaching. By meeting the requirements of cultivating high-quality professionals in the new century and addressing challenges in comprehending and applying higher mathematics concepts effectively, this method proves to be valuable in enhancing the educational experience. The higher mathematical knowledge which is difficult to understand and calculate. Further with the help of Matlab graphic visualization can also mobilize students' enthusiasm, make students more interested in higher mathematics courses, easier to understand the content of the study, and at the same time allow them to further consolidate the knowledge they have learned. It plays an important role in the development of students' awareness of the combination of mathematics and shape as well as the image of the mind, which can effectively assist the students in the analysis of practical problems, so as to make their interest in higher mathematics courses significantly increased, and their awareness of mathematical applications significantly increased. It can effectively assist students in analyzing practical problems, so that their interest in higher mathematics courses will be significantly increased and their sense of mathematical application will be strengthened.

The introduction of Matlab in teaching is beneficial, but attention must be paid to certain issues. Firstly, it is important to introduce the basics and operations of Matlab at the beginning of the course. Secondly, an effective teaching design should be implemented throughout the course, and after each class, it is essential to record and reflect on the use of Matlab to continually enhance its effectiveness in teaching. While Matlab offers computational advantages, higher mathematics should still rely on textbooks as Matlab serves as a supplementary tool to aid students in comprehending abstract concepts. Exploring the integration of Matlab software into the curriculum warrants further investigation. Only in this way can we continuously improve the use of software-assisted teaching. Again, although Matlab has a lot of advantages in computation, but higher mathematics should be based on the textbook, Matlab is only a kind of auxiliary tool introduced to help students understand abstract knowledge. The details of Matlab software into the course teaching is worth our further exploration.

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