

Ideological and Political Elements in Complex Functions -- Taking Cauchy-Riemann Equation Teaching Design as an Example

Jiyang Yang¹, Guocui Yang¹, Yuanxian Hui^{2*}

1.Department of Date Science, Baoshan University, Baoshan 678000,

2.Department of Mathematics and Statistics, Huanghuai University,Zhumadian,463000

Abstract: Ideological and political education has formed a consensus in higher education as an educational concept, all courses in universities shoulder the responsibility of value guidance. Complex Functions is an extension of the knowledge system of Mathematical Analysis in the complex field, with both similarities and differences. We have deeper comprehensive and systematic understanding of the essence of theorem definitions only if by utilizing analogies and reverse mathematical thinking. The paper takes the Cauchy-Riemann equation in the analytical function as an example, fully exploring the ideological and political elements, carefully designing the teaching process, and integrating ideological and political education into the teaching knowledge. It enables students to fully understand the theory and thinking methods behind the problem and knowledge in the process of solving problems, stimulate their ideological collision and emotional experience, and achieve value guidance for students.

Keywords: Ideological and political education; Complex functions; Cauchy-Riemann equation; Teaching design

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1. Introduction

Complex functions are the core course of mathematics majors and the foundation course of engineering majors, widely used in the fields of natural science and engineering technology. Due to the higher theory abstractness, the content is mainly applied to fluid mechanics, thermodynamics, aerodynamics, and other aspects of physics, there are many difficulties in the learning. In order to improve the teaching effectiveness of the complex function course, colleagues on the teaching front line have actively explored and practiced teaching reform based on the actual situation of their respective schools. Currently, the leading research focuses are the analogy of the main content between Complex function with Mathematical analysis and the teaching methods of the complex function course [1]-[6], there is rare research about the ideological and political education of the course. The main research object of the theory is analytical functions, which are a class of specially differentiable functions. The Cauchy-Riemann equation (abbreviated as C.-R.) is the main condition of judging the differentiability and analyticity of complex functions. During the learning process, students are able to use the equation to judge the differentiability, but it's unclear how the equation originated? Why is more stringent to judge the differentiability of complex functions than real valued function of two variables? In the environment of ideological and political education leading, we adopt the teaching method of problem-oriented and use analogical induction to guide students to procure conjecture, stimulate students' learning enthusiasm and interest, during the process of verifying the correctness of conjecture, we will get the C.-R. equation, further guide students to use reverse thinking to fully derive the necessary and sufficient conditions for differentiability, in order to cultivate

students' innovative consciousness and establish a rational view of the world with dialectical and comprehensive perspectives.

2. Teaching design of C- R. equation

The teaching objective of the lesson is master the necessary and sufficient conditions for judging differentiability and analyticity of complex functions. In the process of mastering knowledge, learn the mathematical methods of analogy and conjecture, understand relevant mathematical history, improve mathematical literacy, stimulate learning interest and motivation. The focus of teaching is the differentiability conditions. The derivation process of the C.-R. equation is a teaching difficulty. Students has just learned the definition and properties of differentiability and analyticity of complex functions. based on the learning content and the student's reality, the main teaching method is elicitation guidance. The textbook used is Theory of Complex Functions (Fifth Edition) compiled by Zhong Yuquan.

2.1 Analogy induction, get conjecture

It's known that there is one-to-one correspondence between complex number and its real and imaginary part. The existence of limits for complex functions is equivalent to the existence of limits for its real and imaginary parts. Complex functions are continuous in a point if and only if their real and imaginary parts are continuous. By analogy, we can conclude that the necessary and sufficient conditions for a complex function to be differentiable is that both the real and imaginary parts are differentiable?

Design intention, Mathematical conjecture is a powerful driving force for the development of mathematical theory. It's also the most creative part of human rationality. the types, characteristics, proposed methods of mathematical conjectures have special value for the research of general scientific methods, especially for the cultivation of students' innovative. Students can naturally make guesses by analogy. It has stimulated students' enthusiasm for learning, captured their attention, mobilized their emotions, and played a decisive role in achieving the teaching objectives and breaking through teaching difficulties.

2.2 Prove conjecture ,deduce conclusions

After getting conjecture, the core questions need answer, is the conjecture right? what is the relationship between differentiability of complex functions and differentiability of real and imaginary parts? A series of questions have stimulated students' interest in learning and thirst for knowledge. As well known, analogy is a subjective and insufficient form of plausible reasoning. To confirm the correctness of conjectures, strict logical reasoning or a counterexample need to be used. Mention conjecture, the Goldbach Conjecture is not unfamiliar to everyone, "Any integer greater than 5 can be written as the sum of three prime numbers". The issue seem to simple, but its connotation is extremely profound. It has been unresolved for over 200 years and has influenced generations of mathematicians. Chinese mathematicians Chen Jingrun, Wang Yuan and others have made arduous journeys in the field with astonishing perseverance, gradually advancing the proof of the conjecture. Chen's theorem is the currently recognized best achievement, which was achieved by Chinese mathematician Chen Jingrun in 1966.

Under the guidance of the teacher, students will verify the correctness of the conjecture. By using the definitions of differentiability of complex functions and differentiability of binary real valued functions, students can easily conclude that if complex functions are differentiable, its' real and imaginary parts are also differentiable, and satisfy the C.-R. equation.

The system of equations first appeared in D'Alembert's work, and Euler linked it to analytical functions. In the late 18th century, complex numbers were still widely suspected. although complex functions were sometimes necessary to solve real problems, mathematicians during the period did not naturally use complex functions. Their work had an essential limitation, they separated the real and imaginary parts of complex functions for analysis and discussion. By the early 19th century, complex number had not yet been widely accepted. Until 1831 Gauss's work gradually eliminated worry about using the complex number. Cauchy used the equation to construct his function theory, Riemann developed the theory of single complex function based on this fundamental principle. Therefore, the equation was named by two founders Cauchy and Riemann. So, our conjecture is incomplete. From the above discussion, we can conclude the differentiable necessary conditions.

By the definition of differentiability, we can verify the conjecture is not all-sided. Students experience the joy of success and stimulate learning motivation. By introducing the historical background of the equation allows students to deeply understand the development path of new theories is difficult. Mathematicians are the true warriors who walk on the thorny road, they move forward bravely. Their tremendous efforts have composed magnificent and inspiring poems in the process of human civilization, and have also propelled the continuous and rapid development of the entire human civilization.

Design intention, by briefly introducing the Goldbach conjecture, students can understand that Chinese mathematicians have done a lot of pioneering work in number theory, complex functions and other branches, greatly promoting the development of related theories. Their work has also become a classic result in the field of related mathematics, playing an important role for half a century, Stim-

ulate students' sense of national pride and patriotism. It enables students to understand that mathematical conjecture is a powerful driving force for the development of mathematical theory. Although mathematical conjecture may not always be correct, it is a creative thinking activity and an important method of scientific discovery, playing an irreplaceable role in cultivating students' innovative awareness. But in the usual process of learning, the focus of students' learning often lies in the proof of concepts and properties, while neglecting conjectures and ways to cultivate innovative thinking by discovering problems, boldly guessing, verifying conjectures. So in the teaching process, teachers should consciously guide and inspire students to discover and solve problems through observation, analogy induction and summarization, master this mathematical methods of discovering commonalities from uniqueness to generality, and deeply experience the application of dialectics in mathematics.

2.3 Reverse thinking, get new condition

Guide students to further consider whether the inverse proposition of the above proposition holds true? By definitions, sufficient and necessary conditions for determining the differentiability can be obtained.

Design intention, set questions to inspire students to consider whether the inverse proposition holds, and guide students to derive sufficient conditions for differentiability of functions through the proof process of differentiable necessary conditions. The derivation process only requires students to master the relevant definitions. From a different perspective, reverse thinking is an essential thinking quality for creative talents and also a good thought quality in our learning and life. In daily teaching, attention should be paid to the cultivation of students' reverse thinking ability, and changing their thinking direction, improving their innovation ability and awareness, and viewing problems more deeply and comprehensively, forming a systematic and dialectical cognitive and worldview.

3. Conclusion

In the context of ideological and political education in the course, taking the knowledge of C- R. equation as an example, the teaching process is carefully designed to guide students to get conjectures by analogy. It enables students to fully understand the powerful role of conjectures in scientific development and the contributions made by the older generation of mathematicians in related fields during the process of verifying conjectures, deeply appreciate the role of analogy and reverse thought in the study of Complex function, stimulate students' enthusiasm and initiative, and cultivate their ability to use dialectics View the world from a rational perspective.

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About the author:

Jiyang Yang (1986-), female, Jiachuan, Yunnan Province, Master's degree, lecturer, majoring in nonlinear functional analysis and university mathematics teaching research

*Corresponding author:

Yuanxian Hui (1983-), male, Nanyang, Henan Province, associate professor, PhD, mainly engaged in the research of differential equations and dynamic systems, and biomathematic