Mining Ideological and Political Elements of Functions of Complex Variable and Integral Transform Based on HPM Model

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Abstract: Starting from the HPM model, this article explores the ideological and political elements of complex functions and integral transformations, cultivating students' motivation to learn mathematics, mathematical philosophy, and the qualities of adhering to truth and not fearing difficulties. The exploration of ideological and political elements enriches the theoretical basis of ideological and political education reform for this course and has guiding significance for teachers' teaching practice.

Keywords: HPM; Functions of Complex Variable and Integral Transform; Mathematical Moral Education; Curriculum Ideological and Political Education

1. Background of Ideological and Political Reform of Functions of Complex Variable and Integral Transform

1.1 Curriculum Ideological and Political Teaching Reform and Mathematics Subject Moral Education

Since the concept of "Curriculum Ideology" was proposed in 2016, its aim has been to cultivate talents with noble character and outstanding abilities. It aims to lead the higher education system towards a transformation to an educational model centered on "Curriculum Ideology." The core idea is not to add independent courses but to advocate for seamlessly integrating ideological and political education elements into the teaching content of various professional courses, achieving the dual goals of knowledge transmission and character cultivation, and effectively fulfilling the educational mission of "establishing virtue and cultivating people." For each course, teachers need to carefully consider how to cleverly integrate moral education content into classroom teaching, ensuring that it is naturally and smoothly displayed without disrupting the original course structure and teaching process.

In the field of mathematics education, the importance of moral education value has already received widespread attention before the concept of "Curriculum Ideology" was proposed. For students not majoring in mathematics, mathematics courses not only carry the explicit value of being tools and applications but also contain deeper philosophical thoughts and implicit moral education values. For example, Skovsmose's moral choices in the decision-making process of mathematical modeling is a clear example[1].

In view of this, Functions of Complex Variable and Integral Transform, as part of the mathematics curriculum system, should closely focus their moral education goals on cultivating students' critical thinking and rigorous mathematical confidence. The exploration of the implementation path of moral education in mathematics has been a concern and discussion in the academic community since the 19th century and has yielded fruitful results. Among them, the history of mathematics, as an effective teaching resource, has shown a positive role in promoting the achievement of moral education goals in mathematics course teaching, thus giving birth to a new field of mathematics education and history integration - HPM.

1.2 Characteristics of Functions of Complex Variable and Integral Transform

This course covers complex variable functions, integral theory, residue theorem, and integral transforms. Students will learn to deduce properties of complex functions, understand their interdisciplinary applications, and differentiate between complex and real analysis. They will also use mathematical software for operations on complex functions and

transforms. The course aims to develop skills in applying mathematics, identifying and analyzing complex engineering problems, establishing mathematical models, and using technology to study these problems. Complex analysis is essential in various fields, including fluid dynamics, electromagnetism, heat transfer, and control theory. Given the course's complexity, it is crucial to integrate ideological and political education effectively. A solid foundation in higher mathematics is essential for mastering this subject.

1.3 Ideological and Political Elements of Functions of Complex Variable and Integral Transform review

Proposed integrating ideological and political elements in engineering students' education to boost learning enthusiasm. Curriculum integration should occur in complex variable functions and integral transformations. Stories, history, and philosophy can present ideological elements. Assessment should reflect political goals. Shi combined mathematical knowledge to explore the ideological and political elements of this course[2]. Huang surveyed students on their perceptions of this integration. Results show high recognition and desire for more diverse elements and teacher-student interaction[3].

The implementation of ideological and political reforms in mathematics courses is widely acknowledged. Current research mainly focuses on the macro level, lacking detailed evaluation of how these reforms impact students' worldview, outlook on life, and values. To enhance the effectiveness of these reforms, it is crucial to integrate ideological and political elements into the curriculum. The history of mathematics and its philosophy offer a valuable approach for this integration. By studying these elements from a historical perspective, teachers can better understand and apply them, enriching the course content, enhancing teaching quality, and establishing a solid theoretical basis for the in-depth practice of ideological and political education in mathematics courses.

Using HPM model, this article explores strategies for ideological and political education in complex variable functions and integral transformations courses. It aims to provide a theoretical basis and practical guidance for the reform of college mathematics courses, promoting the implementation of "establishing virtue and cultivating people" in higher education.

2. The Connotation and Educational Value of HPM Model

The Congress on Mathematical Education focuses on the history of mathematics and its role in education. It aims to incorporate historical aspects into teaching at all levels, promote interdisciplinary collaboration, and use historical insights to foster mathematical development. Research areas include the use of historical materials in education, the impact of historical approaches on teaching practices, and the importance of mathematics history in cultural evolution. The Fourth International Congress on Mathematical Education saw HPM expand to include philosophical dimensions of mathematics. Freudenthal's concept of reconstructed history suggests that each student's learning process is a reflection of the historical development of the subject. Today, HPM is evolving to address how to integrate both the history and philosophy of mathematics into education.

Fauvel identified 15 reasons for integrating the history of mathematics into teaching, which are diverse and sometimes overlapping. Scholars have since refined these reasons, categorizing them into instrumentalist and objectivist perspectives. This novel classification lacks clarity in practical teaching. By the late 20th century, the teaching goal framework allowed for a direct correlation between mathematical history and three teaching objectives, emphasizing its value in fostering students' emotions, attitudes, and values. This includes sparking interest, offering psychological comfort, motivating learning, connecting disciplines, demonstrating mathematics' societal role, and cultivating qualities like truthfulness, innovation, and resilience.[3].

3. Ideological and Political Elements of Functions of Complex Variable and Integral Transform from the perspective of HPM

The teaching objectives of emotional attitudes and values are consistent with the connotations of the goals of moral education in mathematics and ideological and political education in the curriculum. Therefore, in line with the educational value of literacy goals as proposed by HPM, the exploration of ideological and

political elements in this course includes the motivation for learning mathematics, the philosophy of Functions of Complex Variable and Integral Transform, and the quality of perseverance in the face of difficulties.

3.1 Learning Dynamics for Functions of Complex Variable and Integral Transform

Complex variable functions and integral transforms, as an applied mathematics course, are closely related to other disciplines. Teaching designs that are disconnected from practical applications can lead to students becoming bored with the course and developing a fear of mathematics [4]. Taking the teaching design of Fourier transforms as an example, introducing knowledge with practical applications of Fourier transforms as an entry point can encourage students to start from real-life scenarios around them and gradually understand complex mathematical models. This approach can make students aware of the applicability of mathematics, thereby igniting their enthusiasm for learning mathematics. At the same time, it also fosters interdisciplinary knowledge connections, cultivating a global perspective in students.

Fourier transforms decompose sound frequencies in physics. They analyze sounds we hear daily, from multiple sources, into mixed sound waves.By transforming sound into a waveform, Fourier transforms can solve the problem of how to decompose a mixed waveform into individual frequency sounds. It can decompose sound into the sum of trigonometric functions in both the time domain and frequency domain, which can serve as a motivation for students to learn Fourier transforms $\int_{-\infty}^{+\infty} f(t)e^{-iwt}dt$ .Mathematical philosophy of complex functions and integral transformations.

3.2 Mathematical Philosophy of Functions of Complex Variable and Integral Transform

The subject of study for complex function theory is functions on the complex number field. The first part of this course is dedicated to introducing complex numbers and their related operations. When designing the curriculum for this content, teachers often introduce new concepts by solving the quadratic equation $x^2+1=0$. However, the emergence of complex numbers is a significant event in the history of mathematics. The birth of complex numbers came from a problem that arose within mathematics itself, a field born out of internal motivations. The unit of complex numbers:*i*, originated from an absurd question. In 1845, the mathematician Cardan proposed if there existed two numbers whose sum was 10 and whose product was 40. The solution to this problem involved the form -15, which led to the introduction of imaginary numbers and thus the birth of complex numbers.

Innovation is an important task in mathematics education[5].Teaching the concept of complex numbers by following their historical development can cultivate students' ability to think about problems from multiple perspectives. Traditionally, the mathematics that students learn has been generated due to practical application needs, driven by factors external to the field of mathematics. In contrast, complex numbers originated from an internal mathematical problem, created to pursue the completeness of the powers and roots of real numbers. By learning about the emergence of complex numbers, students can also be guided to focus on their own long-term development, realizing that not all motivations come from external needs, and to consider the internal driving forces behind their own development, encouraging them to think about problems from various angles.

3.3 The Quality of Upholding the Truth and Being Fearless of Difficulties

The theory of complex functions has seen a rapid development from its inception to its widespread application, during which many outstanding mathematicians emerged. Facing complex and difficult problems, they did not give up but continuously engaged in discussions and exchanges, ultimately achieving gratifying results. For instance, when designing teaching for the Cauchy integral theorem, one could introduce the stories of mathematicians Cauchy and Goursat, guiding students to learn their persistence in pursuing truth and their spirit of diligent research.

The Cauchy integral theorem, as a fundamental theorem in complex integration, reveals the necessary and sufficient conditions for the independence of complex integration from the path, demonstrating the importance of analytic functions in complex analysis. The sequence of

teaching this content starts with discussing the independence of complex integration of analytic functions on simply connected domains, leading to the Cauchy-Goursat theorem. Then, the conditions of the domain are gradually relaxed, leading from the simple to the complex, to obtain the deformation of closed paths theorem and the homotopic closed path theorem. This exploratory process is one of gradually generalizing simple problems to complex ones, which can cultivate students' courage to face difficulties. It teaches them to start with the simplest problems and gradually challenge more difficult ones, persisting in their quest for truth.

4. Conclusion

Based on the analysis of the progress of HPM and the characteristics of the course on complex variable functions and integral transforms, it is clear that HPM is a effective model to more effectively promote the reform of ideological and political education in the curriculum. Although the development history of complex variable functions is relatively short, there are still many elements that can be integrated into ideological and political education that can be explored. During the teaching process of complex variable functions, the ideological and political elements can be explored from three directions: the historical development behind the content of each part, the motivation of mathematical learning, mathematical philosophical thoughts, and the quality of perseverance in the face of difficulties. HPM not only provides teachers with strong support for ideological and political teaching but also provides a theoretical basis for the practice of mathematical moral education for students.

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