Construction of a Procedural Evaluation Framework for Functions of Complex Variable and Integral Transform under the OBE Concept

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Abstract: This article analyzes the content characteristics and teaching objectives of complex functions under the OBE education concept, and combines interview data from experts and teachers to construct a programmatic evaluation framework for complex functions and integral transformations. The framework includes three dimensions: homework, chapter tests, and classroom questioning. At the same time, in accordance with the principle of outcome-based education, three levels of assessment are delineated for each of these dimensions. This framework provides an assessment tool for the teaching of complex functions, and has practical value in promoting high-quality development in higher education.

Keywords: Functions of Complex Variable and Integral Transform; OBE; Procedural Evaluation

1.Introduction

In recent years, there has been a shift in the concept of evaluating educational outcomes, moving from assessing learning results to evaluating the entire learning process, with the deeper impact being that evaluation is conducted for the sake of learning. The form of evaluation has shifted from a single summative assessment to a mix of various assessment methods, allowing for a comprehensive evaluation of the student's learning process. In traditional higher education, summative assessments often occupy a very high proportion, even using summative assessment exclusively as the method for evaluating student learning. This evaluation model has shown drawbacks in the public courses of higher education[1]. Therefore, to promote high-quality development in higher education, the evaluation model should incorporate a student-centered approach, focusing on the evaluation of the course learning process.

The content of evaluations corresponds to the training objectives in the talent cultivation plan. In the current era, the formulation of training objectives for engineering courses is based on outcome-based education (OBE), focusing on the outcomes that students can produce through learning. All forms of assessment should be directed towards the student performance outcomes that the course objectives are concerned with.Functions of Complex Variable, as a required course for engineering majors, studies functions on the complex number field, including key content such as Cauchy integrals and Fourier transforms, which have extensive application value in physics and mechanics, among other subjects [2].For a long time, this course has been one of the compulsory public courses for engineering students in various higher education institutions. Research on its course objectives and summative assessment is mature, but there is a lack of discussion on formative assessment.

Based on the needs of the reform of the course evaluation for Functions of Complex Variable, in conjunction with the requirements of teaching practice，discuss the establishment of a structured and procedural evaluation framework, specifically tailored for intricate functionalities and integral transforms, is undertaken within the ambit of the Outcome-Based Education (OBE) philosophy. This framework aims to provide a systematic and rigorous approach to assessing the performance and efficacy of these complex operations, ensuring alignment with the desired learning outcomes and educational objectives.

2. Course Objectives for Functions of Complex Variable and Integral

Transformunder OBE Educational Philosophy

2.1 Overview of OBE Educational Philosophy

The OBE educational philosophy, proposed in 1981 as an outcome-based educational goal concept, has recently gained attention and recognition from researchers at various educational levels. It is centered on the student, focusing on the outcomes students should produce, the value of these outcomes to society, how to design instruction to help students achieve these outcomes, and how to assess students' learning progress [3]. The OBE concept has been applied to university mathematics courses with some mature discussions. Research on talent output and training objectives has reached a consensus and has achieved some results in the form of course objectives and teaching strategies [4]. Some studies suggest that to implement the OBE characteristics of complex variable function courses, application examples should be included alongside the transmission of knowledge points [5].Therefore, always centering on the student and focusing on the various outcomes displayed during the learning process is the core idea of the Outcome-Based Education (OBE) philosophy, and it has practical value for teachers to diagnose teaching effectiveness and improve the quality of instruction.

2.2 Objectives of the course on Functions of Complex Variable and Integral Transform

Complex function theory and integral transforms are important compulsory courses for science and engineering majors. Through the study of this course, students are expected to understand the concepts of analytic functions, Cauchy's theorem, Cauchy's integral formula, series theory, residue theorem, integral transforms, and other core contents in complex function theory, master the basic theories and computational methods of complex functions, and be able to apply these theories to solve related practical problems [6]. Under the OBE concept, the core learning outcomes of this course include enabling students to learn the basic theories of complex functions and the mathematical methods commonly used in mathematical physics and engineering technology, while also consolidating and reviewing the basic knowledge of higher mathematics, improving mathematical literacy, and laying the necessary mathematical foundation for learning related follow-up courses and further expanding mathematical knowledge. It plays a particularly important role in cultivating students' abstract thinking ability, logical reasoning ability, spatial imagination ability, and scientific computing ability.This course primarily employs classroom lectures and multimedia-assisted teaching methods to impart knowledge of complex analysis to students; in addition to classroom lectures on complex analysis, it also places particular emphasis on reviewing higher mathematics knowledge points through comparison and analogy, identifying similarities and differences of related knowledge points on the complex plane, and enabling students to understand the unique charm of complex variable function knowledge and the powerful applications of integral transformations.

From the above analysis, it can be concluded that the outcomes of students from learning the course on Functions of Complex Variable and Integral Transform should first include the knowledge contained within the course, which serves as the foundation for solving subsequent problems. Then comes the ability to solve related problems based on the mastery of that knowledge.Based on the content characteristics and teaching methods of the course on complex function theory and Integral Transformations, the teaching objectives of this course under the OBE concept are summarized as follows:(1) Students are able to state the basic properties, analyticity criteria, series representation, integral theory, residue theorem, and integral transformations of complex functions(T1).(2) Students are able to deduce the properties of the discipline of complex functions, understand its applications in other disciplines, and distinguish the connections and differences between complex analysis and real analysis(T2).(3) Students are able to use mathematical software to perform basic operations of Functions of Complex Variable and Integral Transform(T3).

3. The Connotation and Development of Procedural Evaluation

Formative assessment is viewed in two ways: longitudinal and horizontal. The longitudinal

approach assesses students' learning stages over time, while the horizontal approach evaluates across multiple dimensions. Formative assessment covers learning methods, knowledge outcomes, and non-intellectual factors like attitudes. It involves teacher evaluation, peer review, and self-assessment. Challenges in China's university formative assessment include students' low engagement, limited content, single assessment subject, formalistic methods, delayed feedback, and fragmented knowledge.At present, formative assessment is widely implemented in educational institutions both domestically and internationally, but its effectiveness still needs to be further enhanced.

4. Framework for procedural evaluation of Functions of Complex Variable and Integral Transform

Through the analysis of the course objectives of Functions of Complex Variable and Integral Transform in the context of OBE, and the theoretical elaboration of procedural evaluation, principles for constructing a procedural evaluation framework for complex functions and integral transforms can be obtained. Firstly,analysis of expert interviews shows procedural evaluation constitutes 40% of the total assessment. Secondly, in accordance with the teaching model of the course, the content of procedural evaluation encompasses the links and stages of the learning process, including three dimensions: classroom Q&A, homework after class, and chapter tests. Finally, each dimension is quantitatively divided into three levels, with quantitative standards including frequency and scores, and specific values are set based on the course hours and content scope. Based on the above principles, the procedural evaluation framework and hierarchical division for complex variable functions and integral transformations are shown in Table 1 and Table 2.

Table 1. Dimension and proportion of procedural evaluation for Functions of Complex Variable and Integral Transform

Course Objectives	Evaluation Dimensions and Proportions (%)			Percentage (%)
	Homework	Chapter Test	Classroom Q&A	
T1	8	6	6	20
T2	8	3	3	14
T3	0	3	3	6
Percentage (%)	16	12	12	40

Table 2. Hierarchical Division of Dimensionality in the Procedural Evaluation of Functions of Complex Variable and Integral Transform

Evaluation Dimensions	Level 1 (80-100scores)	Level 2 (60-79scores)	Level 3 (0-59scores)
Homework	Submit homework after class on time; provide correct answers, with clear and well-organized writing.	Submit homework after class on time; answers have a few non-principled errors, but are well-organized.	Failing to submit homework after class on time; significant fundamental errors in the problem-solving process.
Chapter Test	Complete the chapter test on time, correctly, clearly, and organized.	Complete the basic knowledge test promptly, with minimal errors, and in an organized fashion.	Failed to complete the test on course knowledge promptly, with numerous basic errors in problem-solving.
Classroom Q&A	Students actively participate in classroom discussions and apply what they've learned, accurately answering questions and raising issues.	Students actively engage in class discussions and applications of course material, such as answering questions and raising doubts, but accuracy needs enhancement.	Students neither participate in discussing course applications nor interact in class.

This procedural evaluation framework takes the course objectives under the OBE concept as its core, with all evaluation content being assigned as tasks in the form of student outcomes. The dimensions of evaluation are highly operable, allowing for widespread application across similar courses at different educational institutions. With the design of this framework, data collection is convenient, which is conducive to improving the efficiency of

teacher instructional evaluation, and does not impose additional academic anxiety on students.

Table 2 provides the hierarchical criteria for each dimension, with specific assessment frequencies set according to the number of class hours and teaching content of the course at different schools, as well as the needs of the teachers.

5. Conclusions and Prospects

Following the reform path of educational goals, teaching models, and teaching strategies under the OBE concept, a process evaluation framework for complex variable functions and integral transformations guided by OBE teaching goals is proposed. The framework includes three dimensions: homework, chapter tests, and classroom questions, and each dimension is divided into three levels. This process evaluation framework has good universality and operability, for teachers to refer to during the teaching process. It also provides a tool to improve the teaching quality of this course and offers a case for the process evaluation of other courses in higher education. On this basis, the evaluation framework can be applied to empirical research in the future to further explore the practical strategies of the framework.

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