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Analysis and Improvement Paths of Curriculum Goal Achievement in Data Visualization based on the OBE Concept

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Abstract: OBE (Outcome-Based Education), as the core concept of talent training in emerging engineering disciplines, emphasizes student learning outcomes as the orientation and improves teaching quality through a continuous improvement mechanism. Data Visualization, a core compulsory course for the major of Data Science and Big Data Technology, integrates theoretical and practical aspects. Its teaching quality directly affects the cultivation of students' data analysis and visualization practical abilities. Taking the "Data Visualization" course as the research object, this paper constructs a curriculum goal achievement evaluation system based on the OBE concept, analyzes the current status and existing problems of curriculum goal achievement from three dimensions (quality, knowledge, and ability), and then proposes targeted improvement paths, providing a reference for the teaching reform of similar courses.

Keywords: OBE Concept, Data Visualization, Curriculum Goals, Achievement Analysis.

1. Introduction

In the era of big data, data visualization has become a key bridge connecting data and decision-making[1-2]. Its core value lies in transforming abstract data into intuitive and understandable graphical expressions, providing support for industrial applications and scientific research[3]. As the core carrier for cultivating talents in data processing and analysis, the major of Data Science and Big Data Technology places great importance on the "Data Visualization" course, whose teaching quality directly relates to the formation of students' professional core competencies. The OBE concept, centered on "student-oriented, outcome-driven, and continuous improvement", requires the entire teaching process to focus on preset learning outcomes, and continuously optimize teaching links through systematic evaluation and feedback mechanisms[4]. This is highly consistent with the training requirements of applied talents in emerging engineering disciplines.

As a compulsory course for the major of Data Science and Big Data Technology, "Data Visualization" has clearly defined three-dimensional curriculum goals (quality, knowledge, and ability) in its teaching syllabus[5-6], and established corresponding teaching and evaluation mechanisms. However, in practical teaching, issues such as whether the curriculum goal achievement meets expectations, what restrictive factors exist in teaching links, and how to continuously improve teaching quality based on the OBE concept remain to be further explored. Based on the course syllabus and the core requirements of the OBE concept, this paper systematically analyzes the current status of curriculum goal achievement, identifies key problems, and proposes scientifically feasible improvement paths, providing theoretical and practical support for curriculum teaching reform.

2. Analysis of the Current Status of Curriculum Goal Achievement in Data Visualization Based on the OBE Concept

2.1. Analysis of Curriculum Goals

The OBE educational concept originated in the United States in the 1980s. Its core logic is to clarify the knowledge, abilities, and qualities (learning outcomes) that students should possess after completing their studies, and then reverse-design curriculum content, teaching methods, and evaluation systems based on these outcomes. Through continuous achievement evaluation and feedback, a closed-loop improvement of teaching quality is realized. The OBE concept includes three core elements: first, focusing on student learning outcomes rather than teaching content; second, emphasizing the measurability and achievability of students' abilities by defining curriculum goals with clear action verbs; third, establishing a continuous improvement mechanism to dynamically optimize the teaching process based on evaluation results. Therefore, the overall curriculum goal adheres to the training requirements of applied talents in emerging engineering disciplines, integrates ideological and political elements into teaching, and cultivates students' core technologies and practical abilities in data visualization through modular and project-based teaching. The sub-goals are divided into quality goals, knowledge goals, and ability goals:

Quality goals: Cultivate students' value orientation of strengthening the country through science and technology, craftsmanship spirit, and social responsibility, and establish correct professional values and outlooks on life.

Knowledge goals: Master the basic principles, core concepts of data visualization, operational skills of common tools (Matplotlib, seaborn, pyecharts), and be familiar with visualization design principles and aesthetic elements.

Ability goals: Possess practical abilities in data preprocessing, visualization graph drawing, and interactive function implementation; be able to independently complete data visualization projects; and have cross-disciplinary communication and lifelong learning abilities.

In addition, the expression of curriculum goals adopts Bloom's action verbs (such as "master", "possess", "be able to") in the teaching design, ensuring the measurability and achievability of the goals, which is consistent with the clarity requirements of learning outcomes in the OBE concept.

2.2. Analysis of Curriculum Goal Achievement

2.2.1. Achievement of Quality Goals

The course takes the organic integration of ideological and political elements and teaching content as the core path. Through typical cases such as value mining of 315 Gala data, infiltration of the strategy of strengthening the country through science and technology, and discrimination of online data authenticity, it constructs a teaching scenario where value shaping and knowledge transmission are promoted synergistically, guiding students to establish correct professional values, social responsibility, and data ethics awareness. However, from the perspective of practical goal achievement, there are significant limitations in the current integration of ideological and political elements: first, the integration carriers are relatively simplistic, mainly relying on theoretical transmission methods such as classroom discussions and case introductions, lacking immersive and experiential ideological and political practice platforms (e.g., data visualization public welfare projects, industry ethics research). This leads some students to only have a conceptual understanding of quality goals, making it difficult to effectively transform theoretical cognition into behavioral consciousness; second, the evaluation mechanism lacks systematic design. Quality goals do not have independent quantitative assessment indicators, and are only indirectly inferred through students' viewpoints expressed in classroom discussions. The single evaluation dimension and strong subjectivity make it impossible to comprehensively and objectively measure students' actual achievement levels in terms of value orientation, craftsmanship spirit, and social responsibility, and it is difficult to form a closed-loop feedback for quality cultivation.

2.2.2. Achievement of Knowledge Goals

The achievement of knowledge goals relies on a three-dimensional teaching system of "classroom teaching-case analysis-exercise consolidation". The curriculum syllabus clearly defines the teaching hour allocation, core key and difficult points, and ability mapping relationships of each knowledge point, forming a relatively complete knowledge transmission framework. At the evaluation system level, a diversified evaluation combination of assignments (20%), quizzes (25%), and examinations (30%) is adopted, covering core knowledge modules such as basic principles of data visualization, core concepts, and tool operations, which can systematically assess students' abilities of memorization, understanding, and application of knowledge. However, in the actual teaching process, the achievement of knowledge goals still faces dual challenges: on the one hand, the curriculum knowledge system is characterized by "scattered theories and practical operations". Key and difficult contents such as refined adjustment of Matplotlib parameters and logical construction of pyecharts interactive graphs have high requirements for practical operation abilities. Due to weak theoretical foundations and insufficient practical training, some students have problems such as insecure knowledge mastery and inflexible application, leading to obvious individual differentiation in the achievement of knowledge goals; on the other hand, there is a lag in the connection between knowledge content and actual industrial needs. Some teaching cases fail to keep up with cutting-edge applications in the field of data visualization (e.g., artificial intelligence-assisted visualization, multi-modal data visualization), resulting in students' insufficient understanding of cutting-edge industrial knowledge and affecting the practical adaptability of knowledge goals.

2.2.3. Achievement of Ability Goals

The cultivation of ability goals takes project-driven teaching as the core carrier. Through practical projects such as new retail intelligent sales data visualization and radio and television big data visualization, combined with 8 class hours of in-class practice, a capacity-building chain of "theoretical learning-practical application-project implementation" is constructed. From the perspective of the evaluation mechanism, links such as classroom discussions (25%) and summative examinations (30%) partially cover ability goals, but there is an imbalance in the distribution of assessment weights: practical operations and project reports, as the core manifestations of ability achievement, have relatively insufficient assessment weights, making it difficult to comprehensively and accurately reflect students' actual abilities in terms of standardization of data preprocessing, logic of visualization scheme design, and control of project management processes; in practical teaching, some students show obvious ability shortcomings, specifically manifested in non-standard data cleaning and processing processes, low information transmission efficiency of visualization graphs, and weak logical structure and professional expression ability of project analysis reports, leading to the failure of ability goal achievement to meet expectations. In addition, core ability dimensions such as cross-disciplinary communication ability and lifelong learning ability lack targeted training modules and evaluation indicators, resulting in a one-sided achievement of ability goals, which is difficult to meet the requirements of emerging engineering talents for comprehensive abilities..

3. Improvement Measures for Curriculum Goal Achievement based on the OBE Concept

To address the current status and restrictive factors of curriculum goal achievement in Data Visualization, and in line with the core requirements of the OBE concept, this section proposes improvement paths from four dimensions: optimizing teaching content, innovating teaching methods, improving the evaluation system, and strengthening practical teaching.

3.1. Optimize Teaching Content and Strengthen Outcome-Oriented Content Reconstruction

Centered on the OBE outcome-oriented principle, the teaching content system is optimized from three dimensions: case update, module integration, and knowledge expansion. Firstly, based on the cutting-edge developments and industrial application needs in the field of data visualization, the teaching case library is dynamically updated by adding cases in emerging areas such as artificial intelligence data visualization, government affairs big data visualization, and medical data visualization. Actual enterprise projects are transformed into teaching materials to strengthen the connection between knowledge goals and industrial demands. Meanwhile, ideologically and politically relevant cases with contemporary characteristics-such as "the application of data visualization in the construction of a Digital China" and "social responsibility in epidemic prevention and control data visualization"-are deeply explored to enhance the pertinence of quality goal cultivation. Secondly, the teaching content is reconstructed following the logic of "basic module-core module-comprehensive module": the basic module focuses on foundational knowledge such as data visualization concepts and the installation of Anaconda and Jupyter Notebook; the core module centers on the core functions of three key tools (Matplotlib, seaborn, pyecharts) to strengthen data processing and graph drawing skills; the comprehensive module integrates knowledge from multiple modules around project-based practice, promoting precise alignment between teaching content and ability goals to achieve the organic unity of knowledge and ability. Finally, based on the interdisciplinary nature of data visualization, interdisciplinary knowledge such as design aesthetics and user experience is supplemented to guide students in designing visualization works that are both aesthetically pleasing and effective. Simultaneously, relevant knowledge is pre-infiltrated in accordance with the requirements of subsequent courses (e.g., data mining, data analysis and computing) to lay a solid foundation for students' professional competence advancement.

3.2. Innovate Teaching Methods and Improve the Effectiveness of the Teaching Process

In the teaching process, project-driven teaching featuring "real projects + group collaboration" is deepened: curriculum practice projects are closely integrated with actual enterprise needs, guiding students to complete the entire process from demand analysis, data processing, and visualization design to project report writing in groups. Teachers only assume the role of guides and instructors, providing students with sufficient space for independent inquiry and innovation, and focusing on cultivating their project management and problem-solving abilities. For example, in the radio and television big data visualization project, students are encouraged to independently design schemes and explore diverse visualization tools and methods to effectively achieve ability goals. For theoretically intensive content such as data visualization principles and design principles, the flipped classroom model is promoted: students independently study basic knowledge through online resources (e.g., teaching videos, electronic textbooks, case analyses) before class, and deepen their understanding through interactive activities such as group discussions, case reviews, and Q&A sessions during class. This model not only fully mobilizes students' learning initiative and improves classroom teaching efficiency but also cultivates their independent learning abilities. Additionally, modern information technologies such as virtual simulation technology and online teaching platforms are actively integrated to enrich teaching methods: virtual simulation platforms are used to simulate the real working environment of data visualization projects, allowing students to conduct practical operations in immersive scenarios; online teaching platforms facilitate real-time interaction and feedback through homework assignment, quiz organization, and topic discussions; meanwhile, abstract concepts (e.g., data visualization mapping principles) are intuitively presented in the form of animations and videos using multimedia technology, effectively reducing students' comprehension difficulty and enhancing the intuitiveness and interactivity of teaching.

3.3. Improve the Evaluation System and Construct a Diversified Achievement Evaluation Mechanism

With "measurability, feedback, and improvement" under the OBE concept as the core, a diversified evaluation mechanism covering the three-dimensional goals of quality, knowledge, and ability is constructed. Corresponding evaluation paths are designed for each dimension: quality goals adopt a combination of "process evaluation + outcome evaluation," comprehensively assessed through process indicators such as classroom discussion participation and project collaboration attitude, as well as outcome carriers including ideological and political case analysis reports and career planning reports; knowledge goals rely on a combined model of "assignments + quizzes + examinations" to focus on testing students' mastery of core concepts and tool operations; ability goals are evaluated through a three-dimensional approach of "practical operations + project reports + oral defense" to comprehensively measure practical application, project management, and communication skills. Meanwhile, the core role of process evaluation is strengthened by appropriately increasing its weight, incorporating indicators such as classroom participation, group collaboration performance, and practical operation processes into the evaluation scope. During project-driven teaching, phased reviews are conducted on students' demand analysis reports, data processing processes, and visualization design drafts, with timely targeted feedback and improvement suggestions provided. A student self-evaluation and peer evaluation mechanism is also established to foster students' self-reflection and evaluation abilities. Furthermore, refined quantitative standards are formulated for each evaluation indicator: for example, the "project report" under ability goals includes scoring criteria based on dimensions such as the completeness of demand analysis, standardization of data processing, rationality of visualization design, and scientificity of analysis conclusions; the "ideological and political case analysis report" under quality goals defines evaluation bases around the correctness of values, depth of analysis, and accuracy of language expression. These quantitative standards avoid subjectivity in evaluation, ensure the objectivity and credibility of evaluation results, and provide precise data support for the analysis of curriculum goal achievement and teaching improvement.

3.4. Strengthen Practical Teaching and Improve Students' Application Abilities

Guided by consolidating practical foundations, aligning with industrial needs, and stimulating innovative potential, practical teaching links are strengthened from multiple dimensions. Firstly, the in-class practical hours are appropriately increased from the original 8 to 12-16 hours to ensure sufficient time for students' practical operations. Meanwhile, the scope of practical content is expanded by adding comprehensive and design-oriented projects such as "custom-themed data visualization system design" and "multi-source data fusion visualization analysis," focusing on cultivating students' innovative and comprehensive application abilities. Secondly, university-enterprise collaborative education is deepened: stable cooperative relationships are established with Internet enterprises and big data companies to jointly build practical teaching bases; enterprise technical experts are invited to participate in curriculum teaching to provide cutting-edge industrial knowledge and practical guidance; students are organized to conduct internships and training in enterprises, deeply participating in the development and implementation of actual enterprise projects to immerse themselves in real work environments and address practical problems and challenges. Simultaneously, real data sets and tool platforms provided by enterprises are utilized to enrich practical teaching resources and enhance the authenticity and pertinence of practical teaching. Finally, scientific research resources are actively integrated to promote the integration of scientific research and teaching: teachers' scientific research projects are transformed into practical teaching tasks, encouraging students to participate in research work such as data visualization algorithm optimization and visualization system development. Through scientific research practice, students' scientific research capabilities and innovative thinking are honed, and their mastery of cutting-edge technologies is improved. Additionally, students are organized to participate in data visualization-related skill competitions and innovation and entrepreneurship competitions, promoting learning and practice through competitions to comprehensively enhance their practical application abilities and market competitiveness.

4. Summary

The research on the analysis and improvement paths of curriculum goal achievement in "Data Visualization" based on the OBE concept is an important exploration of curriculum teaching reform under the background of emerging engineering disciplines. Taking the "Data Visualization" course as the research object, this paper systematically analyzes the current status of curriculum goal achievement and proposes a four-dimensional improvement path of "optimizing teaching content, innovating teaching methods, improving evaluation systems, and strengthening practical teaching". By reconstructing outcome-oriented teaching content, innovating diversified teaching methods, constructing scientific evaluation systems, and strengthening practical teaching links, the achievement of curriculum goals can be effectively improved, and students' core data visualization abilities and professional qualities can be cultivated.

In the future, it is necessary to continuously track the achievement of curriculum goals in teaching practice, continuously optimize improvement paths by collecting information such as students' learning outcome data, teachers' teaching feedback, and changes in industrial needs, forming a closed-loop teaching system of "goal setting-teaching implementation-achievement evaluation-continuous improvement". At the same time, strengthen exchanges and cooperation with similar universities, share teaching reform experience, and promote the overall improvement of teaching quality in data visualization courses, providing strong support for the training of applied talents in emerging engineering disciplines.

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