**Journal of Education and Educational Research**
ISSN: 2957-9465 | Vol. 11, No. 2, 2024

# Course Construction of Cloud Computing based on Outcome Based Education

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**Abstract:** With the rapid development and application of cloud computing technology, cloud computing has become an important component of contemporary information technology. The demand for cloud computing talents in society is also increasingly urgent. However, the current cultivation of cloud computing talents in universities is still insufficient to meet this demand. In response to these issues, the concept of Outcome-Based Education (OBE) is proposed to reform the course construction of the "Cloud Computing Technology" course. This paper systematically introduces the content arrangement of the theoretical part, the construction ideas and methods of the experimental sessions, and the course evaluation system in the "Cloud Computing Technology" course, and summarizes the teaching results.

**Keywords:** Cloud Computing; Outcome-Based Education; Course Construction.

## 1. Introduction

In the contemporary era of rapid information technology development, cloud computing has emerged as a crucial driver for the digital economy and informatization construction, playing a significant role in advancing technological progress. In recent years, domestic and international enterprises and research institutions have continuously achieved fruitful results in cloud computing technologies and products. According to the research report "China Cloud Computing Industry Market Comprehensive Research and Development Prospect Forecast Report, 2024-2029" by China Industry Research and Development Institute [3], cloud computing, as a new type of digital infrastructure, has become the core engine of the new generation of information technology. With the acceleration of digital and intelligent innovation in government and enterprises, the market demand for cloud computing that can provide powerful and secure "computing power" is increasing daily. [1] [2]

With the rapid development of cloud computing technology, the demand for professionals in related fields is also becoming increasingly urgent, and the demand for talent in cloud computing-related positions continues to grow. As the cradle of talent cultivation, universities shoulder the responsibility of cultivating professionals for the country. However, the current cultivation of cloud computing talents in universities is still relatively lagging and insufficient to meet the demand:

1. The content of cloud computing courses needs to be optimized: Cloud computing courses cover a wide range of technical areas, including virtualization, containerization, distributed storage, network management, automated operation and maintenance, big data processing, etc. To ensure a complete knowledge system and deep understanding by students within a limited number of class hours, it is necessary to purposefully and specifically optimize and adjust the content.

2. The experimental design of cloud computing courses is complex: The theory of cloud computing technology is complex and abstract. To enable students to deepen their understanding of the theory through practice, practical sessions are essential. However, cloud computing experiments usually require the establishment of a simulated cloud computing environment, which includes installing and configuring various cloud computing software and services, such as building distributed systems, virtualization software, container management platforms, etc. This requires a significant amount of computing and storage resources, resulting in high costs.

3. Teaching methods and philosophies need to be updated promptly: Cloud computing is a rapidly evolving new generation of technology, and existing teaching methods and philosophies should also keep pace with the times.

## 2. Outcome-Based Education Based on the OBE Concept

OBE (Outcome-Based Education) is also known as outcome-oriented education. It was first proposed by American scholar Spady William G. in 1982 and has been widely recognized by scholars since its introduction. It is also the core concept of engineering education certification in China [1], emphasizing a student-centered approach and maximizing student ability output as the orientation, with a focus on developing students' higher-order cognitive abilities [4].

Outcome-oriented education emphasizes three key aspects: design, implementation, and evaluation. The design phase focuses on reverse design, starting with needs, determining cultivation goals based on needs, determining graduation requirements based on cultivation goals, and determining the curriculum system based on graduation requirements. The implementation phase emphasizes a student-centered approach, shifting from a "teaching-centered" to a "learning-centered" approach. The evaluation phase emphasizes continuous improvement methods and effects, with cultivation goals, graduation requirements, and teaching activities closely linked for continuous improvement [5, 6].

# 3. Course Objectives

In accordance with the Outcome-Based Education (OBE) philosophy, which emphasizes a student-centered and output-oriented approach, we first need to reversely design the curriculum system to ensure that students meet graduation requirements and possess the abilities to adapt to societal needs after graduation. Based on this, we have clearly defined the objectives that students should achieve after completing the "Cloud Computing Technology" course.

Through multifaceted analysis of societal, industry, and student needs, we have formulated the following course objectives:

1. Understand the basic principles and concepts of cloud computing, comprehend the differences and advantages between cloud computing and traditional computing architectures (such as on-demand allocation, load balancing, dynamic scaling, etc.), and be aware of the history and current status of cloud computing development.

2. Comprehend cloud computing technology architectures, core cloud computing technologies, the three basic service models (IaaS/PaaS/SaaS), and virtualization technologies (storage resource virtualization, computing resource virtualization, network resource virtualization).

3. Possess self-learning abilities, understand solutions provided by typical domestic and international cloud computing vendors, and keep track of hot topics and frontier development trends.

4. Possess certain practical skills, such as the ability to deploy cloud computing platforms and utilize them for application development, while cultivating innovative thinking and teamwork abilities.

# 4. Reversely Designing the Course

Based on the course objectives, we reversely design the teaching content, teaching strategies, and evaluation system of the course.

1. Designing Teaching Content Oriented Towards Course Objectives

To ensure that students can achieve the course objectives through learning, the teaching content is divided into two parts: theoretical learning and practical operation.

The theoretical learning content includes:

(1) Overview:
- The important position and significance of cloud computing development
- The relationship between artificial intelligence, big data, and cloud computing
- The basic principles and concepts of cloud computing
- Cloud computing architecture and its differences and advantages compared to traditional computing architectures
- The history and current status of cloud computing development

(2) Cloud Computing Technology
- Cloud computing technology architecture
- Core cloud computing technologies: cloud storage, cloud data processing, cloud databases (cloud data management)
- The three basic service models of cloud computing (IaaS/PaaS/SaaS)
- Virtualization technologies: storage resource virtualization, computing resource virtualization, network resource virtualization

(3) Cloud Computing Product Cases
- Cases not only help students intuitively understand the concepts, principles, and applications of cloud computing but also stimulate their interest in learning, broaden their horizons, and enhance their practical and innovative abilities.
- Enhancing the Integration of Theory and Practice
- Broadening Students' Horizons
- Enhancing Practical and Innovative Abilities
- Stimulating Interest and Career Planning

In the course, solutions from typical domestic and international cloud computing vendors such as Huawei, Alibaba Cloud, Google, Amazon, and Microsoft are introduced. At the same time, frontier cloud computing research progress is studied through domestic and international journals and conference literature.

Finally, the architecture and basic technologies of cloud data centers, the concept of cloud data centers, energy-saving technologies for cloud data centers, energy efficiency ratios, construction plans and management mechanisms for typical cloud data centers (including Google's Belgium data center, Facebook data centers, etc.), and comparisons between cloud data centers and traditional data centers are introduced.

2. Teaching Strategies

"Student-centered," combining application cases to explain theoretical knowledge, and strengthening the design of practical sessions to deepen understanding of theories and concepts. Transform students from passive learners into actual designers and users. Through questioning, inspiring, and group discussions, practical abilities, innovative thinking, and teamwork abilities are enhanced.

Teaching methods should be flexible and diverse, focusing on cultivating students' practical abilities and innovative spirit. Methods such as case analysis, project-driven learning, and experimental practice can be used to allow students to learn and master knowledge through practice.

At the same time, to ensure the achievement of different course objectives, different teaching strategies need to be comprehensively utilized. For course objectives 1 and 2, classroom lectures, literature reading, and after-school assignments are mainly used; for course objective 3, classroom lectures, literature reading, and in-class group discussions are adopted; for course objective 4, practical methods are employed.

3. Practical Session Settings

To efficiently conduct teaching and deepen students' understanding of theoretical knowledge, practical teaching construction is indispensable: theoretical guidance informs practice, and practice deepens the understanding of theory. The design philosophy for practical sessions includes:

(1) Combining advanced teaching concepts and resources from both domestic and international sources to design comprehensive and practical teaching content.

(2) Establishing one's own cloud service platform.

(3) Utilizing experiments or practical projects to attract students' interest and deepen their understanding.

(4) Providing students with more practical opportunities and platforms through school-enterprise cooperation, industry-academia integration, and other means.

Currently, the practical session content is set as follows:

(1) Adopting school-enterprise cooperation to construct the experimental environment.
(2) Deploying virtual machines and building a virtual machine cluster for cloud computing experiments.
(3) Completing comprehensive experimental tasks based on Hadoop.

# 5. Ensuring the Evaluation System for Course Objectives

The evaluation system should comprehensively, objectively, and fairly reflect students' learning outcomes.

Firstly, clear evaluation standards are formulated: Specific evaluation standards and indicators are developed for each course objective to accurately assess students' learning outcomes.

Secondly, diversified methods can be used to evaluate learning outcomes, such as assignment evaluation, classroom performance (group discussion) evaluation, and practical project evaluation, to ensure the accuracy and effectiveness of the evaluation:

(1) Assignment evaluation: Assesses knowledge point mastery, literature review skills, and summary writing abilities.
(2) Classroom performance (group discussion) evaluation: Evaluates the rationality of topic selection, the design and production abilities of presentation materials, on-site expression and question-answering abilities, and the ability to summarize and understand professional knowledge.
(3) Practical project evaluation: Assesses the rationality of experimental schemes and the completion of experiments.

Finally, an effective student feedback mechanism is established to timely obtain students' feedback on course objectives, allowing for adjustments and optimizations to be made to the course objectives.

# 6. Continuous Improvement

The above measures have achieved certain results in the implementation process and have been recognized by students. The course group teachers have also improved their level of combining theory with practice in the process of exploring practice, forming teaching results and laying a good foundation for the rolling construction of the course. However, at the same time, due to the short course duration and diverse content, many exploratory works are still being carried out, and the curriculum team will continue to improve in the next step.

1. Regularly Assessing Course Objectives:

The achievement of course objectives is regularly assessed to understand students' learning effectiveness and the validity of the course objectives.

2. Making Improvements Based on Assessment Results:

Necessary adjustments and optimizations are made to the course objectives based on assessment results to adapt to changes in industry demands, student development, and societal needs.

3. Strengthening Teacher Training:

Teachers are provided with enhanced training and support to improve their teaching abilities and understanding of the OBE philosophy, ensuring the successful achievement of course objectives.

# 7. Conclusion

In the process of curriculum development for "Cloud Computing Technology" based on OBE, the entire teaching process, including teaching content design, teaching strategy implementation, and teaching effect evaluation, is centered around students and focused on enabling them to effectively achieve learning objectives. This has effectively enhanced students' learning initiative and creativity. Based on current teaching results, the curriculum development has achieved significant outcomes. However, continuous improvement and advancement of the next round of teaching work are still necessary.

# Acknowledgments

This work was supported in part by an Undergraduate Education Teaching Reform and Research Project of China University of Mining and Technology (Beijing) in 2022 (Project Number: J220412).

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