A Research on Computer Experimental Course Teaching Model Based on OBE Philosophy–Take Data Analysis and Visualization Course as an Example

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Abstract: The teaching of computer courses is an important way to cultivate students' computer skills and logical thinking capability. Taking the teaching of data analysis and visualization as an example, this study aims to explore how to improve the experimental teaching model of data analytics through the philosophy of OBE, the outcomes of the experiment and to improve students' learning effect. Through the study of teaching models, this paper establishes a BRS teaching model, including experiment purpose definition, task selection, and teacher role positioning. The results show that BRS model can stimulate students' interest in learning, improve their learning motivation, and develop students' logical thinking and practical ability.

1. Introduction

In the era of data economy, data analysis is a basic and important production skill. Data analysis can help people obtain valuable information, data visualization can help people better understand the results of data analysis, and provide a basis for human social and economic activities. The Data Analytics course teaches students the basic theories of data analytics and enables them to master the principles and knowledge of systematic data analytics. Through systematic case experiments, students are proficient in the basic operation process of data analysis and the operation skills of corresponding tools. Through the study and experiments of this course, students will initially have the ability to apply data analysis methods and data visualization techniques to solve disciplinary problems and work problems, and have the ability to analyse and display results.

Computer science courses focus on computer technology, covering knowledge of computer hardware, software, networks, and other aspects. These courses require students to have certain technical foundations and operational abilities, and students need to master the basic principles and operation skills of computers. Computer technology is developing rapidly, and new technologies and applications are constantly emerging. Therefore, computer science courses need to update textbooks and content in a timely manner to adapt to the development and application requirements of new technologies. Teachers need to continuously learn and update their knowledge to keep up with the industry. Students need to improve their innovation ability through project practice, teamwork, and other methods.[1]

The rapid development of computer technology has posed new challenges and opportunities in the field of education. The teaching of computer courses should not only cultivate students' computer operation skills, but also cultivate students' ability to think and innovate, so that they can adapt to the development needs of the information society. However, traditional teaching methods often focus too much on the inculcation of knowledge, and lack the cultivation of students' ability to think about problems logically and complete tasks innovatively.[2] How to teach students experimental knowledge and methods is a difficult problem, and there are often situations where teachers lead students to do experiments smoothly, seems no any problems, but students are helpless to operate by themselves in exams. Therefore, how to establish scientific and innovative teaching models to make the teaching of computer courses more effective and efficient has become an important issue in current educational

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research.

The experiments in the data analysis and visualization course involve sixteen experiments and three different application software tools, which is a relatively difficult task for students to master the theoretical knowledge of data analysis and the operation of the three software in one semester. It is difficult for students to master the knowledge structure and software operation skills by copying the experimental instructions that written in the textbook. How to improve the experimental teaching model to adapt to the current technological development and the quality and ability of talents needed by society is a topic that needs to be continuously discussed.

2. Methods

2.1 OBE philosophy

As an advanced educational concept, Outcome based education (OBE, also known as competency-based education, goal-oriented education or demand-oriented education) was proposed by William Spady in 1981 and has quickly gained people's attention and recognition, and has become the mainstream philosophy of national education reform such as United States, United Kingdom, and Canada. The United States Association for Accreditation of Engineering Education (A-BET) has fully embraced the OBE philosophy and integrated it throughout the accreditation standards for engineering education.[3] In June 2013, China was admitted as a signatory to the Washington Accord. It is of practical significance to use the concept of result-oriented education to guide the reform of engineering education.[4]

OBE refers to the goal of instructional design and instructional implementation as the learning outcomes that students achieve through the educational process. This model is examined in Spady's book Outcome-Based Education: Controversy and Answers. The book defines OBE as "the clear focus and organization of the education system around ensuring that students have experiences that will be substantially successful in their future lives." [5] The concept of OBE promotes the reform and reconstruction of the traditional education and teaching system, emphasizing the value orientation of outcome-based, the educational concept of student-centered, and the quality culture of continuous quality improvement. Realize the transformation from teaching-centered to learning-centered, and from knowledge system-centered to competence-acquiring.

2.2 BRS model

At present, the main problems in teaching are divided into two categories, one is what to teach, and the other is how to teach. The first type of problems mainly includes the knowledge content and the use of tools. The key is to build a structural model of knowledge content, as well as the structural model of software tools. The second type of problems are mainly composed of objective definition, task orientation, and role positioning.

Based on the OBE philosophy, this paper proposes an improved and innovative teaching model, the BRS model. The focus of this model is the following three points:

1) Definition of objective: How to Be instead of how to do;
2) Orientation of task: Result-orientation instead of process-orientation;
3) Positioning of teacher’s role: role as a Student instead of as a teacher.

The focus of the experiment is on the goal, not the process. It allows students to understand that the way to achieving goal is not unique, and it avoid students trapping into tools and processes. During the demonstration, teachers try to imitate the students' scenarios as much as possible, so that the students can pay attention to the teacher's logical thinking and trial and trial-and-error process in the process of solving problems.

2.2.1 Objective Definition

The goal of the experiment is fundamentally to improve logical thinking, to understand and accumulate knowledge, and to improve skills. The outcomes of this course are as follows:

1) Problem-solving logics: Socratic's heuristic questioning (from known to unknown);

2) Problem-solving methods: Trial-and-error method, Three-ask approach(Definition of the three-ask approach: Asking to books; Asking Internet; Asking classmates. The study of university courses needs to focus on cultivating students' ability to consult books and literature, the ability to use Internet information, and the ability to teamwork with people. This leads to one of the ways for college students to learn knowledge and solve problems, the three-ask approach).

3) Knowledge of data analysis: Structural model of knowledges;

4) Operation of software tools: Trials by logical thinking, Reproducing by instruction;

2.2.2 Task Orientation

The task of the experiment is the result, not the process. In the process of demonstrating the experiment, the teacher needs to make it clear to the students that the task of the experiment is not to memorize the experimental process, but to achieve the required results by their proactive thinking and doing.

2.2.3 Role Positioning

The role of the teacher is "omniscient" in the traditional teaching model, imparting what the teacher already knows. This sense of role does not fit into the modern information age that tells the rapid development. Internet technology and artificial intelligence technology provide many fast and convenient channels for obtaining knowledge. Even in the courses taught by teachers, there is a lot of relevant knowledge that teachers cannot fully understand and grasp in depth. If the role of the teacher is only to transmit knowledge, there is no doubt that the current booming AI technology will do a better job than any existing teacher.

Obviously, the role of the modern teacher cannot be positioned as "omniscient", so it must be "non-omniscient". In the computer experiment course, the role of the teacher is defined as "the student who knows something, and doesn’t something", comprehending the experimental objectives, defining the experimental tasks, and operating the tools from the perspective of the students. This requires the teacher's ability to empathize, and more importantly, the teacher's knowledge scope of the course and the operation methods of experimental tools need to have a deeper and broader understanding and mastery.

3. BRS Model Application

The following is one of the examples of the BRS model being applied to the teaching of data analysis and visualization course. This case is a data analysis and visualization of the air quality index and major pollutant data of a city in a year. The following instance is a task that generates a view in the case.

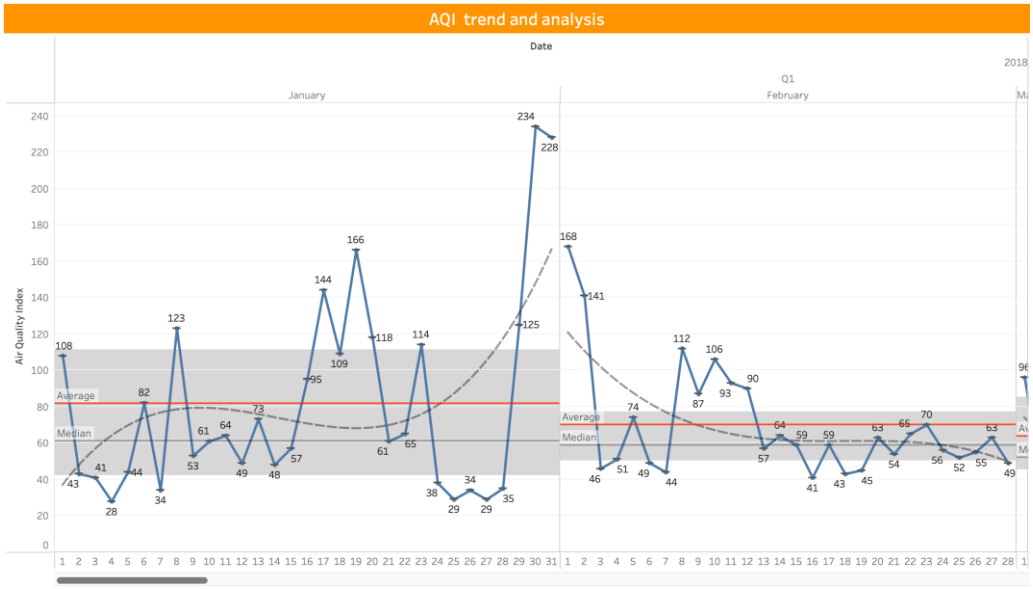

Figure 1 AQI data trend view

This instance is about Shanghai city air quality data analysis for year 2018, asking students to generate several views that visualize Shanghai city AQI trends, one sample was shown as following Figure 1.

Using the BRS model, the above experimental tasks are analyzed, and the specific contents are as following Table 1.

Table 1 Resolution of BRS model application

BRS model	Category	Description
Goal Definition: to Be	View type	Lines; mark type;
	View content	X axis – Date; Y axis - AQI data; data aggregation type;
	View format	Title format; Background, Font;
	Data analytics	Average line; Reference Line; Trend Line;
Task Orientation: Result	Result vs Process	Result orientation, not for specific process or methods;
	Same vs Similar	Similar result, not for exactly same as samples;
	Content & Format	Content need to be almost same, with similar format;
	System & Version	Various OS; Applications; Versions;
Role Positioning: as Student	Interface operation	Pivot Interface of EXCEL; similarity;
	Fields manipulation	Logical guess; Tool features (drag and drop);
	View generation	Mouse double-clicking; Drag and drop; Default effect;
	Problem solution	Three-ask approach; Trial-and-error method;

4. Results

4.1 Questionnaire design

The content of the questionnaire is designed around three categories: knowledge, tools, and methods of the data analytics course, with questions 1, 2, 3, and 4 being the knowledge part of the course, questions 5, 6, and 7 being the tools, and questions 8, 9, and 10 being the methods. Through these three types of questions, the practical effect of the BRS teaching model is investigated. The specific description of questionnaire was shown following table of Table 2.

Table 2 Questionnaire Content

Question	This course has made me very rewarding in the following areas:
1	I have learned about the definition and basic processes of data analytics. (Data analytics is the process of examining, cleaning, transforming, and modeling data with the goal of discovering useful information, drawing conclusions, and supporting decision-making. The basic process of data analysis includes identifying problems, collecting data, processing data, analyzing data, visualizing data, and presenting solutions.)
2	I have learned the definition, classification, and methods of data analysis. (Data analysis is the process of studying and summarizing data in detail in order to extract useful information and form conclusions. Data analysis can be divided into descriptive analysis, diagnostic analysis, predictive analysis, prescriptive analysis, etc. That answer the following questions separately: what happened, why it happened, what will happen, and what to do.)
3	I have learned about the definition and methods of data visualization: (Data visualization is the mapping of data vectors from a multidimensional information space to a visual symbol space. The methods are divided into multi-dimensional data, temporal data, hierarchical data, and network data visualization. The core process of visualization is the visual transformation of data and interface interaction.)
4	I have learned about the definition of the data model and how to do it: (A data model is an abstraction of real-world data features from the computer world. There are conceptual models, data models. The corresponding methods for description are ERD method and RS method.)
5	I have mastered the basic operation methods of Excel analysis tools: (Excel's data analysis tool library, simulation analysis, predictive analysis, planning solution and other analysis tools operation skills.)
6	I have mastered the basic operations of Tableau's data visualization: (Tableau's data import, field processing, view generation, dashboard designing, etc.)
7	I have mastered the basic operations of the data model tools as SQL and Access: (SQL language applications; Creation of Tables, manipulation of tuples, query of records, etc.)
8	I have mastered the trial-and-error method and experienced the significance of the method: (The 10% rule. Trial-and-error is an important process of logical cultivation.)
9	I have mastered the three-ask approach and experience the significance of the method: (Asking book is the basic method of learning; Asking networks are powerful aids; Asking classmates is the critical skill.)
10	I have experienced the value and significance of cooperation and mutual assistance among students: (Helping classmates is an important way to consolidate learning, and getting help from classmates is an important skill. The ability to work in a team is an important learning and working skill.)

The answer option for each question is 1 out of 5:A-strongly agree,B-agree;C-indefinable;D-Disagree; E-strongly disagree.

4.2 Survey results and analysis

After the completion of the examination at the end of the course, a questionnaire was sent to Shanghai Jian Qiao university students in seven classes using the "Xuexitong" application, and the number of valid responses was 103. The detailed numbers were shown in the following table of Table 3.

Table 3 Answers statistics for each questions

Question	A	B	C	D	E
1	77.8%	21.4%	1.0%	0%	0%
2	80.6%	17.5%	1.9%	0%	0%
3	79.6%	20.4%	0%	0%	0%
4	77.7%	21.4%	1.0%	0%	0%
5	70.9%	29.1%	0%	0%	0%
6	74.8%	20.4%	4.9%	0%	0%
7	72.8%	25.2%	1.9%	0%	0%
8	73.8%	24.3%	1.0%	1.0%	0%
9	74.8%	22.3%	1.9%	1.0%	0%
10	75.7%	22.3%	1.9%	0%	0%

According to the survey results, the overall average of students strongly agreed was 75.8%, the overall average of agreed was 22.4%, and the sum of the two was 98.2%. This result was visualized in the following pie view of Figure 2.

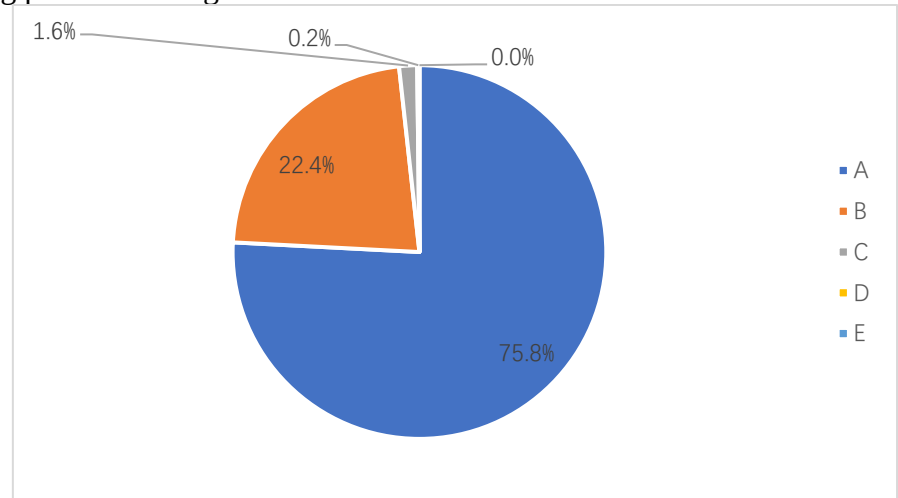

Figure 2 Overall Distribution for all questions

The distribution of answers for each questions are shown as following figure 3.

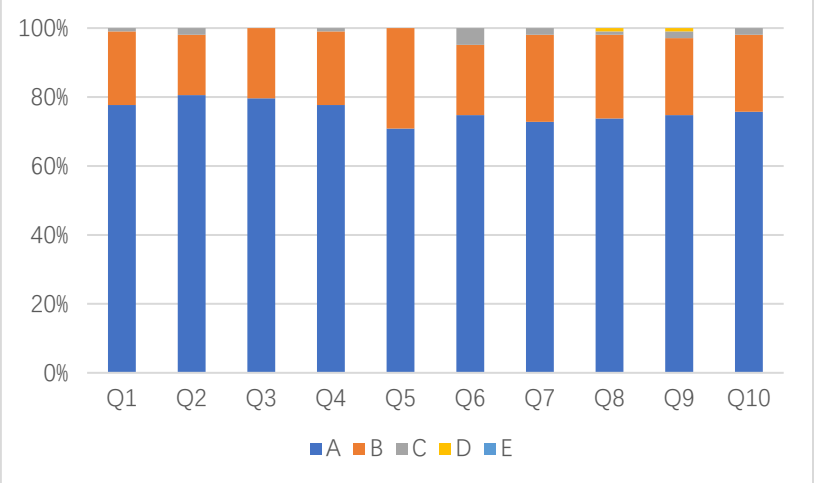

Figure 3 Specific distribution for each question

5. Discussion

The BRS model has high requirements for teachers, requiring teachers to have an in-depth understanding of curriculum knowledge from the perspective of logical thinking and content structure. Teachers are required to have an in-depth understanding and practical experience of the operation object structure and operation hierarchy of experimental tools. At the same time, teachers need to have strong empathy ability and guidance ability to guide students to think and operate.

6. Conclusion

The BRS model, an improved experimental teaching model based on the OBE concept, has the following positive effects: it significantly helps to guide students' learning focus on the experimental goal rather than the specific process; It helps students develop logical thinking and doing skills; Effectively avoid students' misunderstanding of the content and purpose of the course; Stimulate students' interest and motivation in learning.

The results show that students are more active, more engaged, and more interested in learning content in the classroom. The BRS model focuses on cultivating students' thinking ability and problem-solving ability. Students are able to develop comprehensive abilities in practice, so as to better adapt to the needs of future career development. Research shows that through the process of generating questions and solving problems through logical thinking, students can exercise their independent thinking, logical thinking and teamwork skills, thereby improving their understanding of knowledge and problem-solving skills.

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