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Research on the Talent Cultivation Mode of Basic Disciplines Based on Data-Driven

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Abstract: In view of the important role that basic disciplines play in the process of building a powerful nation in education, this paper analyzes the characteristics of basic disciplines and the special laws of their education. It also takes into account the issues regarding the discovery and cultivation of various talents, including those with innate gifts and those who develop their abilities later, and conducts an analysis of the talent cultivation paths. The elements based on three aspects, namely cultivation objectives, cultivation plans, and cultivation effectiveness. It explores the possibility and basic methods of a data-driven talent cultivation model for basic disciplines under the background of big data. Four basic links have realized a complete closed-loop system for the talent cultivation model based on objective data. Meanwhile, it introduces the phased practical methods and achievements of Beijing Information Science and Technology University in the talent cultivation of basic disciplines under the background of big data.

1. Introduction

In May 2023, when presiding over the fifth collective study session of the Political Bureau of the CPC Central Committee, General Secretary emphasized that building a powerful nation in education is a strategic precursor for fully building a modern socialist powerful nation, an important support for achieving high-level self-reliance and strength in science and technology, an effective path for promoting common prosperity for all the people, and a fundamental project for comprehensively promoting the great rejuvenation of the Chinese nation through the Chinese path to modernization. It was clearly pointed out that "In building a powerful nation in education, higher education plays a leading role." It is of the utmost importance to accelerate the construction of world-class universities with Chinese characteristics and advantageous disciplines. Great efforts should be made to strengthen

the construction of basic disciplines, emerging disciplines, and interdisciplinary disciplines, aim at the frontiers of global science and technology and major strategic needs of the country, promote scientific research and innovation, and continuously improve the capacity for original innovation and the quality of talent cultivation[1]. This has revealed the important role that basic disciplines play in the process of building a powerful nation in education.

However, with the rapid development of information technology, the country's demand for talents is constantly changing, and the traditional talent cultivation model has difficulty adapting to the rapidly developing social needs. In the traditional education system, teachers' experience and intuition largely determine the choice of teaching contents and methods[2]. Nevertheless, with the rapid development of information technology, big data has become an important force in promoting social progress. The field of education is also affected by this trend. Especially in the talent cultivation model, data-driven methods are gradually being valued and applied. This paper aims to explore how to construct a discipline talent cultivation model based on objective data to meet the needs of the new era.

2. Analysis on the Characteristics of Basic Disciplines and Cultivation Paths

From the perspective of knowledge classification, basic sciences are mainly divided into three major categories: natural sciences, social sciences, and humanities[3]. Among them, natural sciences mainly focus on the laws of natural phenomena and the material world; social sciences mainly study the structure, behaviors, cultures and other aspects of human society; the humanities mainly concentrate on human thoughts, cultures and artistic expressions. These three types of knowledge jointly form the foundation of the human academic system and provide theoretical and knowledge support for applied disciplines and more specialized fields.

The education of basic disciplines has its own special laws. First of all, basic disciplines are characterized by being conceptual, problem-oriented, interdisciplinary, and logical. Compared with other disciplines, the talent cultivation cycle in the field of basic disciplines is relatively long, and the talent success rate and social return rate are relatively low. Especially in the cultivation of top-notch talents based on basic disciplines, it has been found that most of these outstanding talents possess pure scientific curiosity, unrestrained thinking and imagination, the spirit of independent exploration with the courage to take risks, and an unusually persistent personality. These unique qualities cannot be trained in batches through standardized procedures. On the contrary, they are extremely easy to be obliterated by the educational model that adheres to rules and seeks conformity while eliminating differences. Meanwhile, there is also the issue of classified cultivation that takes into account both "talents with innate gifts" and "late-blooming talents". Therefore, when formulating and implementing the reform policies and measures for the cultivation of basic disciplines and top-notch talents, efforts should be made to cultivate talents with innate gifts with the goal of training leading figures, and to cultivate late-blooming talents with the goal of building solid abilities[4]. These unavoidable factors must be fully considered. It is essential to avoid being hasty, overcome utilitarian thoughts, refrain from impatience, respect students' personalities, interests and choices, and create a relatively relaxed and free growth environment for them to ensure the effective implementation of the reform work on the cultivation of basic disciplines and top-notch talents[5].

Based on this, the research on the cultivation of innovative talents in basic disciplines can be carried out from the following three aspects. First, in terms of cultivation objectives, as basic disciplines are the source of the entire scientific system, the fundamental way to strengthen the cultivation of innovative talents in basic disciplines is to enhance the original innovation ability of talents. Therefore, the cultivation objectives for innovative talents in basic disciplines should be formulated with the common goal of "enhancing the original innovation ability", which aims to

improve students' thinking abilities and broaden their international horizons[6]. Second, in terms of cultivation plans, strengthening the cultivation of talents in basic disciplines is the foundation for achieving scientific and technological self-reliance. The key to mastering core technologies lies in the innovative breakthroughs in basic theories and fundamental principles. Therefore, corresponding cultivation plans should be formulated according to the knowledge of basic disciplines required by key core technologies. Third, in terms of cultivation effectiveness, the cultivation of talents in basic disciplines ultimately serves the economic construction and social development of the country. As for how basic discipline talents can be transformed into applied innovative talents, it is necessary to plan comprehensively the growth system for the cultivation of basic discipline talents, optimize the structural layout of talent cultivation, and build a high-quality talent cultivation system for basic disciplines[7].

3. The Talent Cultivation Model of Basic Disciplines under the Big Data

The development of big data technology and artificial intelligence has led to the digital traces left by students, teachers, schools and employers in the higher education space, which will form a huge behavior network. All behaviors can be tracked, recorded and stored, thus forming a large educational database covering the whole scene and the whole process, making data-driven possible. We have the opportunity to optimize the teaching process by collecting and analyzing students' learning data, teachers' teaching styles, employment needs of different enterprises and institutions, etc. This evidence-based decision-making method can more accurately identify students' learning needs, provide personalized teaching support, and thus improve the quality and efficiency of education.

3.1. Constructing a Comprehensive Electronic Archive

To achieve data-driven talent cultivation, it is first necessary to establish a comprehensive database for teaching and learning of both teachers and students. For example, a comprehensive student learning archive should be constructed, which includes students' basic information, academic performance, classroom participation, homework completion status and the results of any form of assessment. In addition, students' behavioral data should also be collected, such as activity records on online learning platforms and feedback information obtained through questionnaires. The accumulation of such data can provide abundant materials for subsequent analysis.

3.2. Gaining Insights into Learning Behaviors and Outcomes

After having sufficient data, the next step is to conduct in-depth data mining using methods like statistical analysis and machine learning. By analyzing students' learning trajectories, their strengths and weaknesses can be discovered, their future learning performance can be predicted, and even the difficulties they may encounter can be identified in advance. For instance, by analyzing the score distribution of students on different types of questions, teachers can figure out which knowledge points need to be emphasized in teaching; by monitoring students' online learning behaviors, it can be judged whether they have truly understood the course content.

3.3. Meeting Differentiated Learning Needs

Based on the results of data analysis, teachers can formulate personalized learning plans for each student. This means that the teaching content, difficulty level and progress will all be adjusted according to the actual situation of students. For students who master knowledge faster, more challenging materials can be provided; while for those who need additional help, more detailed

explanations or extra practice opportunities can be offered. Personalized teaching can not only enhance students' interest in learning but also effectively improve learning outcomes.

3.4. Sustainable Improvement

The data-driven talent cultivation model is not a one-time project but a continuous process. To ensure the effectiveness of the model, a feedback loop mechanism must be established. This means that it is necessary to regularly review and assess the effectiveness of teaching activities. Meanwhile, it also needs to adjust teaching strategies based on new data. Meanwhile, students should also be encouraged to participate in this process so that they can have more autonomy and a sense of responsibility for their own learning.

4. The Practice of Basic Discipline Talent Cultivation under the Big Data

As a university, Beijing University of Information Science and Technology closely follows the national call and social development in education and teaching. It strives to integrate innovative education and digital education into the entire process of educational activities. Taking the discipline cultivation in the School of Computer Science as an example, the university introduces its progress in the talent cultivation practice for basic disciplines under the big data context.

4.1. Constructing a Curriculum System with Prominent Features and Strong Qualities

Based on the positioning of the economic development needs of the Beijing-Tianjin-Hebei region, continuous efforts have been made to promote the reform of the curriculum system. Under the premise of clarifying professional characteristics, on the basis of strengthening theoretical knowledge, the cultivation of humanities and scientific literacy has been strengthened, and the teaching platforms for public and professional basic courses have been broadened. The latest frontier knowledge has been introduced, and professional course groups have been constructed through digital teaching platforms such as Chaoxing and Ketangpai. Teachers with different professional backgrounds are encouraged to teach the same course to promote the mutual integration among different professional knowledge and different courses, and to strengthen the process assessment mechanism for all courses. Mini-semester courses have been added, allowing students to choose various courses inside and outside the university, or even choose overseas courses (Summer School website: https://summer.bistu.edu.cn/). This has expanded the knowledge dimension of students. Meanwhile, a number of "Qinxin Experimental Classes" with distinctive features have been established.

4.2. Constructing a Three-dimensional Practical Teaching System

The traditional single in-class experimental teaching mode has been reformed. Comprehensive and innovative experiments have been added, and the proportion of experimental courses has been increased and the experimental credits have been quantified. To enhance the awareness of innovation and improve the innovation ability, undergraduate students have been provided with different levels of scientific research practice project courses every academic year starting from their sophomore year. Students can choose the content of scientific research practice projects through two-way interaction with their instructors. All scientific research practice projects need to complete the tracking and inspection of each stage, including project proposal, mid-term and final defense. The management of college students' innovation projects has been strengthened, and all the procedures of project proposal, mid-term and final defense are completed within the digital platform. The undergraduate tutorial system and the enterprise tutorial system have been added. Students can make two-way choices

according to their own interests, and at the same time, the integrated cultivation of undergraduate and postgraduate education is encouraged to achieve in-depth professional direction cultivation. Students are encouraged to participate in various training and competition activities organized inside and outside the university. Meanwhile, the depth of the integration of industry and education has been enhanced, and the construction of practice bases inside and outside the university has been strengthened. The School of Computer Science has carried out in-depth cooperation with the 15th Research Institute of China Electronics Technology Group Corporation for decades. Professional people in the industry are invited to enter the classroom to conduct special reports, exchanges and interactions in the forms of experience sharing and knowledge transfer, so that students can understand the latest development trends in academia and industry.

4.3. Constructing a Diversified and Personalized Cultivation Mechanism

Through the investigation of the knowledge urgently needed by enterprises and institutions and the latest frontier scientific knowledge on various online platforms, a diversified curriculum system has been constructed, providing students with a large space for course selection, and a flexible and diverse personalized academic management system has been established. The credit system has been implemented, with credits limited but courses not limited. Especially in postgraduate education, the selection and learning of students' professional core courses are jointly determined by tutors and students. In general education, students can choose courses that meet their own development across majors, disciplines, colleges and universities.

4.4. Constructing a Teaching Evaluation and Feedback Mechanism

Table 1: Example of Teaching Effect Feedback Mechanism

<table>
<tr><th colspan="7">Basic Course Information</th></tr>
<tr><td>Course Code</td><td>0BH04908</td><td colspan="2">Course Name</td><td>Principles of Computer Composition</td><td>Credits</td><td>4</td></tr>
<tr><td>Total Class Hours</td><td>64</td><td colspan="2">Experimental/ Practical Class Hours</td><td>16</td><td>Semester Offered</td><td>2022-2023(2)</td></tr>
<tr><td>Class</td><td>Big Data 2101 - 02</td><td colspan="2">Number of Students Enrolled/ Sampled</td><td>52/52</td><td>Instructor</td><td>Minling Zhu</td></tr>
<tr><td colspan="7">Evaluation of Course Goal Achievement (Process Assessment Analysis)</td></tr>
<tr><td rowspan="3">Course Evaluation Basis Data</td><td>Content of Course Goal Evaluation</td><td>Regular Grades</td><td colspan="2">Experimental Grades</td><td>Final Exam Grades</td><td>Total Course Evaluation Score</td></tr>
<tr><td>Full Marks for Objectives</td><td>20</td><td colspan="2">20</td><td>60</td><td>100</td></tr>
<tr><td>Average Score of Students</td><td>17.52</td><td colspan="2">16.24</td><td>45</td><td>78.76</td></tr>
<tr><td>Notes</td><td colspan="6">Regular grades, experimental grades, and exam grades are all recorded in percentages. The total evaluation score is the weighted sum of various grades, and the above scores are weighted values.
Total Evaluation Score = Regular Grades * 20% + Experimental Grades * 20% + Exam Grades * 60%.</td></tr>
<tr><td>Explanation of Regular Grades</td><td colspan="6">Usual performance = 50% Assignment Scores + 50% Class Participation Performance.
Assignments: A total of 7 assignments were given, and all were graded with feedback provided. These grades constituted the assignment scores.
Class participation included attendance, spontaneous questions during class, and in-class exercises, etc.</td></tr>
</table>

For each course, the achievement evaluation of course objectives is carried out through the process assessment analysis method to identify problems and make continuous improvements. For example, the course "Principles of Computer Composition" has set 4 achievement objectives, as shown in Table 1, which run through all aspects including daily study, experiments and final examinations. There are assessment points based on achievement objectives in each aspect, and all aspects are supported by objective data and have been electronized, down to how many points each student gets for each question and the calculation of the degree of achievement of corresponding course objectives, as shown in Figure 1. Finally, the achievement levels of all course objectives are summarized and analyzed, which provides basic data guarantee for personalized cultivation.

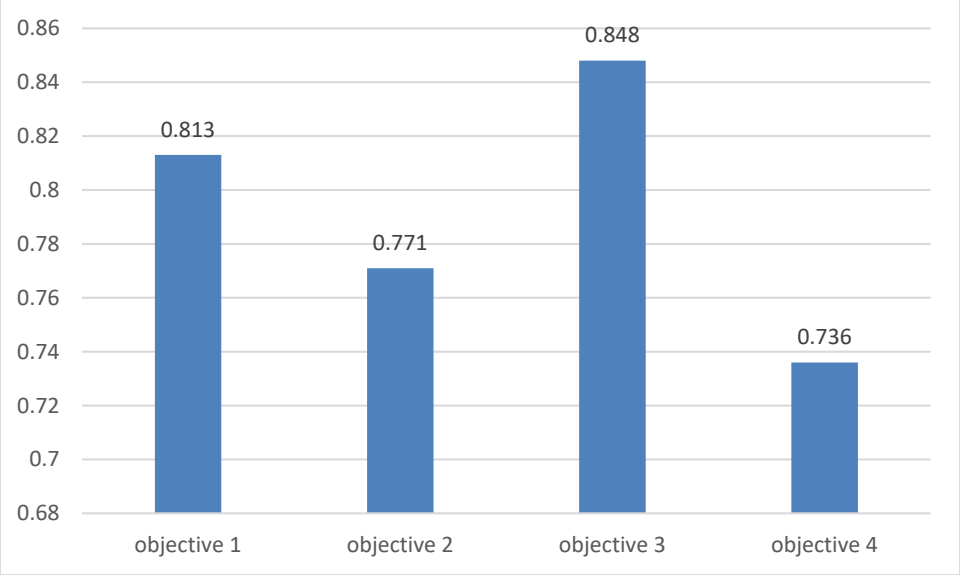

Figure 1: Case of Achieving the Course Training Objectives

5. Conclusions

All in all, the data-driven discipline talent cultivation model provides us with a brand-new perspective to view education. Beijing Information Science and Technology University is making efforts in this direction and striding towards a new era of intelligent education. It emphasizes the importance of data and advocates the use of scientific methods to guide teaching practice. Although the implementation of this model may encounter some challenges, such as data privacy protection and technological investment, its potential value cannot be ignored. With the continuous progress of technology and the renewal of educational concepts, we have reason to believe that more people will benefit from this objective and efficient educational approach in the future.

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2024 General Project: "Systematic Realization of Digital Education Legal Norms in the Education Code" (BAA240034), and by Beijing University of Posts and Telecommunications' University-Level Key Education and Teaching Reform Project: "Reform of Teaching Content and Methods for Generative Artificial Intelligence in the Era of Large Models (2024ZD33)."

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