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Research on the Talent Profile of Computer Science New Engineering Teachers in Application-oriented Undergraduate Colleges and Universities Based on Competency Model

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ABSTRACT
To meet the demand for new engineering talents in computer-related fields in the digital economy era, this paper takes the School of Industry of University B as an example to construct a competency model for applied undergraduate computer program teachers. The analytic hierarchy process (AHP) is used to determine indicator weights, and data are collected and analyzed through questionnaires. The research results show that the model encompasses five dimensions: professional knowledge and skills, engineering practice ability, teaching ability, innovation ability, and professional ethics, with a total of 18 specific indicators. Among these, engineering practice ability holds the highest weight. Based on this, a talent profile for teachers is outlined, providing a reference for the selection, training, and evaluation of new engineering teachers in industrial colleges of applied undergraduate universities.

Keywords: *Competency model, Application-oriented undergraduate colleges and universities, School of Industry, New engineering teachers, Talent profile.*

1. INTRODUCTION

In the era of building a digital power, the digital economy is flourishing, and the demand for new engineering talents in computer science is showing significant characteristics such as rapid iteration, industry leadership, cross-disciplinary integration, and intelligent thinking. To actively respond to this demand, application-oriented undergraduate colleges and universities and enterprises jointly establish industrial colleges to explore new engineering talent training models. In the production-education integration, double-qualified teachers are the core element of talent cultivation, and their competence affects the quality of talent cultivation. Therefore, building a competency model for new engineering teachers in application-oriented undergraduate colleges and universities and depicting the talent profile of teachers is of great significance for improving the quality of teachers and talent cultivation. In recent years, digital profiles of teachers have received attention, and a comprehensive description of teacher characteristics plays an important role in assisting in the diagnosis of teachers' abilities and competencies. With the deepening development of digital education, process and outcome data related to teacher teaching and research can be collected and analyzed on a large scale, providing a data foundation for constructing teacher competency models and depicting teacher talent portraits.

2. CONSTRUCTION OF COMPETENCY MODEL FOR APPLICATION-ORIENTED UNDERGRADUATE MAJORS IN COMPUTER SCIENCE

2.1 Theoretical Basis for Model Construction

The concept of competency model was first proposed by American psychologist David McClelland in 1973. It refers to the deep level characteristics of individuals who can distinguish outstanding achievers from ordinary people in a certain job. These characteristics can cover multiple aspects such as motivation, traits, self-image, attitude or values, knowledge in a certain field, cognitive or behavioral skills, etc., and can be reliably measured or counted to significantly distinguish excellent from average performance. In the field of education, competency models have been widely applied in teacher evaluation and training, becoming an important tool for improving teachers' teaching quality and professional competence.

2.2 Principles of Model Construction

2.2.1 Scientificity Principle

The construction of the model must be based on scientific theories and methods. Therefore, in the process of selecting indicators, relevant educational theory research results should be fully referred to, and scientific data analysis methods should be used to verify and optimize the indicators to ensure that the model can accurately reflect the competency characteristics of teachers.

2.2.2 Targeted Principle

Based on the unique characteristics of applied undergraduate majors in computer science and the specific requirements of industrial colleges for teachers, a highly targeted competency model is constructed. Considering the rapid technological updates in the computer industry, the model should focus on teachers' mastery and application abilities of cutting-edge technologies; In response to the demand for practical teaching in industrial colleges, emphasis should be placed on the engineering practice ability and enterprise project experience of teachers.

2.2.3 Operability Principle

The set indicators should have measurability and accessibility, so that data can be collected smoothly in practical applications. This article obtains relevant data through various methods such as questionnaire surveys and online data collection to ensure that the model can play a role in actual teacher management and evaluation work.

2.2.4 Dynamism Principle

Given the continuous advancement of educational reform and the constantly changing demands of industrial development, the model needs to have a certain degree of dynamism and be able to adjust and improve in a timely manner. With the emergence of new educational concepts and teaching methods, as well as the changing demand for talent in the industry, it is necessary to update the indicators and weights in the model in a timely manner, so that the model can always accurately reflect the requirements of teacher competence.

2.3 Indicator System of the Model

Based on this theory, combined with the characteristics of applied undergraduate majors in computer science, a competency model for teachers in applied undergraduate majors in computer science was constructed through extensive and in-depth literature research, interviews with industry experts and frontline teachers, and carefully designed questionnaire surveys. This model covers five dimensions: professional knowledge and skills, engineering practice ability, teaching ability, innovation ability, and professional ethics, with a total of 13 specific indicators. The details are shown in the “Table 1” below:

Table 1. Competency model for computer majors in application-oriented undergraduate colleges and universities

First level indicators	Weight	Second level indicators	Weight	Third level indicators	Weight
Professional background	0.2.	Mastery level of computer basic theoretical knowledge	0.4.	Mastering the core theories of the discipline	0.6.
				Staying informed about the latest developments in the discipline	0.4.
		The ability to integrate interdisciplinary knowledge	0.3.	Being familiar with relevant interdisciplinary fields	0.4.
				Mastering the content and methods of interdisciplinary teaching	0.6.
		Frontiers in the industry field	0.3.	Understanding the demands of the industry and sector	0.3.
				Mastering industry technical standards	0.7.
Teaching ability	0.3.	Main types of teaching	0.1.	Professional core courses	0.5.
				Professional cutting-edge practical courses	0.5.
		Practical teaching ability	0.5.	Practical operation skills	0.3.
				The ability to integrate technology and achievements	0.4.
				Practical teaching methods	0.3.
		Teaching practice ability	0.4.	Teaching design ability	0.4.
				Classroom organization and management ability	0.3.
				Classroom teaching effect	0.3.
Engineering practice ability	0.2.	Mastery of practical skills	0.4.	Professional practical skills	0.4.
				Cutting-edge technical skills and capabilities	0.6.
		The ability of industry-university-research collaboration	0.6.	The ability to conduct horizontal research projects	0.4.
				The ability of school-enterprise cooperation	0.3.
				Practical teaching guidance ability	0.3.
Scientific research and innovation ability	0.2.	Scientific achievements	0.3.	Academic achievements	0.4.
				Practical achievements	0.6.
		Knowledge update ability	0.7.	Awareness of lifelong learning	0.2.
				Digital abilities such as AI	0.4.
				Continuing education and online learning	0.4.
Professional quality	0.1.	Ideology and morality	0.7.	Professional ethics and quality	0.4.
				Teacher morality	0.6.
		Teamwork	0.3.	Teamwork awareness	0.4.
				Teamwork ability	0.3.
				Interschool cooperation	0.3.

In terms of professional knowledge and skills, the mastery of computer basic theory requires teachers to have a deep understanding and mastery of basic knowledge such as data structures, algorithm analysis, and operating systems, and be able to clearly impart them to students. At the same time, it is necessary to be proficient in using programming languages and development tools to better guide students in project practice.

Teaching ability includes teaching design ability, teaching practice ability, and practical teaching ability, that is, teachers can design reasonable teaching plans based on teaching objectives and student characteristics; Being able to effectively organize classroom teaching, create a good teaching atmosphere, and maintain classroom order; In practical teaching, various teaching methods such as project-based teaching and case teaching can be adopted to improve students' practical abilities and achieve good teaching results.

The dimension of engineering practice ability is crucial, and the experience of enterprise project development requires teachers to have practical participation in project development in enterprises, familiar with the process and standards of project development; The ability of industry university research collaboration is reflected in the ability to solve practical engineering problems, the ability to cooperate with enterprises, and the ability of teachers to effectively guide students in practical teaching activities such as experiments, curriculum design, and internships.

In the dimension of scientific research and innovation ability, it mainly includes scientific research achievements, the ability to transform achievements, and the ability to update knowledge. This is reflected in the ability of teachers to carry out scientific research projects, publish high-level academic papers, and promote the development of disciplines; At the same time, being able to effectively transform scientific research results not only reflects engineering practice and application capabilities, but also strengthens the cultivation of students' innovation and entrepreneurship abilities; The ability to update knowledge is also a requirement for teachers in computer related majors, especially in the application of digital technologies such as AI.

The professional ethics and style of teachers in the dimension of professional competence are the basic requirements of teachers' professional ethics. Teachers should be dedicated to their work, care for students, and educate and nurture students; The spirit of teamwork is reflected in the ability of teachers to effectively collaborate with colleagues, business personnel, and others to jointly complete teaching and research tasks.

3. ANALYSIS OF A SURVEY QUESTIONNAIRE ON TEACHER PROFILE OF APPLICATION-ORIENTED UNDERGRADUATE MAJORS IN COMPUTER SCIENCE

3.1 Survey Purpose

The core purpose of this survey is to comprehensively and deeply understand the current situation of undergraduate teachers in application-oriented undergraduate majors in computer science, and to widely collect their own evaluations of teacher competence, in order to construct a scientific and reasonable teacher competency model. By analyzing these data, it is possible to clarify the strengths and weaknesses of teachers in various aspects, and provide targeted suggestions for subsequent teacher training, evaluation, and development.

3.2 Survey Subjects

This survey selected teachers majoring in computer science from the School of Industry at B University as the research subjects. A total of 40 questionnaires were distributed in this survey, and 38 valid questionnaires were ultimately collected, with an effective response rate of 95%, ensuring the reliability and validity of the data.

3.3 Survey Content

The survey covers the basic information of teachers, such as age, education, teaching experience, professional title, professional background, etc., which helps to understand the overall structure of the teaching staff. At the same time, a detailed survey will be conducted focusing on the professional knowledge and skills, engineering practice ability, teaching ability, innovation ability, professional ethics, and other aspects of teachers, comprehensively examining their competency level from different dimensions.

3.4 Survey Result Analysis

3.4.1 Basic Information

Gender and age distribution: Among the surveyed teachers, male teachers accounted for 63.16% and female teachers accounted for 36.84%. In terms of age distribution, teachers aged 36-45 have the highest proportion, accounting for 65.79%, teachers aged 26-35 account for 23.68%, and teachers aged 46-55 account for 10.53%. This indicates that the teaching team in this field is mainly composed of middle-aged and young teachers with certain teaching experience.

Education and professional titles: Teachers with a master's degree account for the largest proportion, at 68.42%, those with a doctoral degree account for 23.68%, and those with a bachelor's degree account for 7.89%. In terms of professional titles, lecturers account for 44.74%, associate professors account for 36.84%, professors account for 13.16%, and other professional titles account for 5.26%. Most teachers have a high level of education, but the professional title structure still needs further optimization to enhance the overall strength of the teaching staff.

3.4.2 Professional Background

The survey shows that 65.79% of teachers study computer science and technology (including various directions) or software engineering, 23.68% of teachers study information technology related majors, and 10.53% of teachers study other majors. Some teachers have cross disciplinary learning experience, accounting for 34.21%. Their learning areas are mainly focused on popular fields such as artificial intelligence and big data, which reflects their attention to emerging technologies and their need for self-improvement, reflecting the trend of cross-disciplinary integration in computer science.

3.4.3 Teaching Courses

Professional core courses are the main type of courses taught by teachers, accounting for 84.21%; Next are professional basic courses and professional practical training courses, accounting for 73.68% and 65.79% respectively; Profession-related courses account for 65.78%; Public courses account for 36.84%. This indicates that teachers' teaching work mainly revolves around professional courses and focuses on cultivating students' professional abilities.

The proportion of practical teaching: Teachers whose practical teaching accounts for 31% -50% of the total teaching time have the highest proportion, at 57.89%; 51% -70% accounting for 28.95%; 30% or less accounts for 10.53%; More than 70% accounted for 2.63%, indicating that practical teaching has received certain attention in the curriculum system, but there is still room for improvement.

3.4.4 Engineering Practice Ability

Enterprise work experience: 65.79% of teachers have enterprise work experience, of which 34.21% have 5 years or more of work experience, 23.68% have 3-5 years of work experience, and 7.89% have 1-3 years of work experience. This indicates that some teachers have accumulated some practical experience in enterprises, but there are still some teachers with relatively insufficient practical experience.

Mastery of Engineering Practice Ability: Software development and programming skills are the most common engineering practice abilities possessed by teachers, accounting for 86.84%; Next are database design and management, and big data analysis and processing abilities, accounting for 68.42% and 65.79% respectively; The proportion of hardware system design and development and artificial intelligence application development abilities is relatively low, at 36.84% and 50% respectively. This reflects that teachers have outstanding practical abilities in software development and other basic areas, but their practical abilities in emerging technology fields need to be strengthened.

Hosting or participation in horizontal projects: Teachers who have participated in enterprise horizontal projects account for 76.32%, of which 39.47% have participated in 5 or more projects, 21.05% have participated in 3-5 projects, and 15.79% have participated in 1-3 projects, indicating that the majority of teachers actively participate in corporate projects, but there are differences in the degree of participation.

3.4.5 Expanding Learning Experience

Types of training and learning activities: The most frequently participated training or learning activity by teachers is professional skills training, accounting for 84.21%; Next are education and teaching method training and academic conferences, accounting for 68.42% and 63.16% respectively;

The proportion of online course learning and on-the-job training in enterprises is relatively low, at 47.37% and 21.05% respectively, indicating that teachers attach great importance to improving their professional skills, but there is still room for improvement in practical training and online learning.("Figure 4")

Frequency of training and learning activities: 50% of teachers participate in training or learning activities three or more times a year, 26.32% participate twice a year, 18.42% participate once a year, and 5.26% participate once or less every two years. The overall participation frequency is high, reflecting the strong learning enthusiasm of teachers.

Knowledge acquisition channels: Academic journals and professional websites are the main ways for teachers to obtain professional knowledge and the latest developments in technology, accounting for 84.21% and 78.95% respectively; Attending industry conferences and exchanging ideas with enterprise experts are also important ways, accounting for 68.42% and 63.16% respectively; The frequency of using emerging channels such as social media and professional forums is relatively low, accounting for 36.84% and 47.37% respectively, indicating that traditional knowledge acquisition channels still dominate.

3.4.6 Teaching and Research Situation

Teaching ability cognition: Practical teaching ability is considered the most important teaching ability for new computer science teachers, accounting for 100%; The proportion of cutting-edge technology tracking and teaching ability and teaching content updating ability is also relatively high, at 89.47% and 86.84% respectively; The proportion of inter-disciplinary teaching ability and team collaboration teaching ability is relatively low, at 68.42% and 65.79% respectively, reflecting teachers' high emphasis on practical and cutting-edge technology teaching, while interdisciplinary and team collaboration teaching ability needs to be improved.

Application of teaching methods: Project-driven teaching method and case-based teaching method are the most commonly used methods by teachers in teaching, accounting for 84.21% and 81.58% respectively; The frequency of using practical teaching method and lecture teaching method is also relatively high, accounting for 73.68% and 63.16% respectively; The proportion of problem-oriented teaching method is relatively low, at 47.37%, indicating that teachers focus on guiding students' learning through practice and case studies.Scientific research ability cognition and achievements: the ability to apply for and manage scientific research projects, the ability to write and publish academic papers, and the ability to transform scientific research achievements are the key abilities that teachers believe new engineering majors should possess in scientific research, accounting for 89.47%, 86.84%, and 84.21%, respectively. In terms of scientific research achievements, teachers who have published 3-5 academic papers in the past 5 years account for 36.84%, those who have published 1-3 papers account for 36.84%, those who have published 5 or more papers account for 21.05%, and those who have published less than 1 paper account for 5.26%; The proportion of teachers with engineering knowledge works is 34.21%, and the proportion of teachers who have obtained patents is 31.58%. The overall scientific research achievements have accumulated to some extent, but there is still room for improvement.

3.4.7 Construction of Course Resources

Participation in curriculum resource construction projects: 86.84% of teachers have participated in curriculum resource construction projects, of which 34.21% have participated in 5 or more projects, 26.32% have participated in 3-5 projects, and 26.32% have participated in 1-3 projects, indicating that the majority of teachers actively participate in curriculum resource construction.

The content of curriculum resource construction work: Collection and organization of teaching materials and curriculum teaching design are the main responsibilities of teachers in curriculum resource construction, accounting for 84.85% and 78.79% respectively; The proportion of teaching video recording and online course platform construction and maintenance is relatively low, at 54.55% and 45.45% respectively, indicating that in the construction of course resources, basic work is relatively concentrated, and the participation of technically advanced work needs to be improved.

The main problems in curriculum resource construction are insufficient funding and untimely resource updates, accounting for 78.79% and 72.73% respectively; The problems of lack of professional technical support and disconnection from the actual needs of the industry are also prominent, accounting for 57.58% and 54.55% respectively; The proportion of teachers with low participation enthusiasm is 39.39%, which restricts the quality and effectiveness of curriculum resource construction.

3.4.8 Team Collaboration and Communication

Team participation: 86.84% of teachers have participated in teaching or research teams related to computer related majors, of which 63.64% are ordinary team members, 23.26% are team leaders, and 13.16% have not participated, indicating that most teachers have experience in team collaboration.

Team collaboration issues: Unclear division of labor among members and inconsistent research directions or teaching objectives are the most common problems in team collaboration, accounting for 72.73% and 63.64% respectively; The problems of poor communication and unreasonable resource allocation are also quite common, accounting for 51.52% and 51.52% respectively; 39.39% of the team lacks cohesion, which affects the efficiency of team collaboration.

Interschool communication situation: 97.37% of teachers in computer majors from other universities have exchanges and cooperation, of which 28.95% have regular exchanges (3 times or more per year), 50% have occasional exchanges (1-2 times per year), 18.42% have very few exchanges (once every 2-3 years), and 2.63% have never exchanged. Inter school communication is relatively common and has a positive impact on teaching and research, such as broadening teaching ideas and sharing teaching resources.

3.4.9 Overall Evaluation of Competence of Computer Science Teachers in Application-oriented Undergraduate Colleges and Universities Based on Questionnaire Survey

Based on the teacher competency model, the author conducted quantitative transformation analysis on the survey questionnaire and obtained the professional teacher competency rating, as shown in “Table 2”. The overall evaluation of the competence of computer science teachers in application-oriented undergraduate colleges and universities is 3.885 points (out of 5 points) based on the scores in the “Table 2”, indicating that the overall quality needs to be improved.

Table 2. Evaluation of specific competencies of computer science teachers in application-oriented undergraduate colleges and universities

First level indicators	Weight	Second level indicators	Weight	Average score	Third level indicators	Weight	Score
Professional background	0.2.	Mastery level of computer basic theoretical knowledge	0.4.	4.214.	Mastering the core theories of the discipline	0.6.	4.41.
					Staying informed about the latest developments in the discipline	0.4.	3.92.
		The ability to integrate interdisciplinary knowledge	0.3.	3.604.	Being familiar with relevant interdisciplinary fields	0.4.	4.03.
					Mastering the content and methods of interdisciplinary teaching	0.6.	3.32.
		Frontiers in the industry field	0.3.	3.813.	Understanding the demands of the industry and sector	0.3.	3.68.
					Mastering industry technical standards	0.7.	3.87.
Teaching ability	0.3.	Main types of teaching	0.1.	3.740.	Professional core courses	0.5.	3.74.
					Professional cutting-edge practical courses	0.5.	3.74.
		Practical teaching ability	0.5.	4.451.	Practical operation skills	0.3.	4.45.
					The ability to integrate technology and achievements	0.4.	4.61.
					Practical teaching methods	0.3.	4.24.
		Teaching practice ability	0.4.	3.673.	Teaching design ability	0.4.	3.61.
					Classroom organization and management ability	0.3.	4.32.
					Classroom teaching effect	0.3.	3.11.

First level indicators	Weight	Second level indicators	Weight	Average score	Third level indicators	Weight	Score
Engineering practice ability	0.2.	Mastery of practical skills	0.4.	3.900.	Professional practical skills	0.4.	3.87.
					Cutting-edge technical skills and capabilities	0.6.	3.92.
		The ability of industry-university-research collaboration	0.6.	3.842.	The ability to conduct horizontal research projects	0.4.	3.68.
					The ability of school-enterprise cooperation	0.3.	3.45.
					Practical teaching guidance ability	0.3.	4.45.
Scientific research and innovation ability	0.2.	Scientific achievements	0.3.	3.360.	Academic achievements	0.4.	3.39.
					Practical achievements	0.6.	3.34.
		Knowledge update ability	0.7.	3.284.	Awareness of lifelong learning	0.2.	3.72.
					Digital abilities such as AI	0.4.	3.03.
					Continuing education and online learning	0.4.	3.32.
Professional quality	0.1.	Ideology and morality	0.7.	4.302.	Professional ethics and quality	0.4.	4.38.
					Teacher morality	0.6.	4.25.
		Ideology and morality	0.3.	3.889.	Teamwork awareness	0.4.	4.24.
					Teamwork ability	0.3.	3.26.
					Interschool cooperation	0.3.	4.05.

4. CONCLUSIONS AND PROSPECTS

4.1 Main Conclusions

This study constructs a competency model and talent profile for applied undergraduate teachers in computer science, and combines case analysis and questionnaire survey data from B University to draw the following core conclusions:

First, the structure of the teaching staff presents characteristics of youthfulness and high education, but the structure of professional titles needs to be optimized.

Research shows that computer science teachers at B University are mainly composed of middle-aged and young people aged 36-45 (accounting for 65.79%), with 92.11% holding a master's degree or above, possessing strong learning abilities and development potential. However, in the professional title structure, professors account for only 13.16%, while lecturers and associate professors together account for 81.58%, showing a characteristic of "large in the middle and small at both ends". The leading role of senior professional title teachers in subject construction needs to be strengthened.

Second, solid professional foundation and clear practical orientation, but there are shortcomings in emerging technological capabilities.

86.84% of teachers have relevant professional backgrounds in computer science and technology, software engineering, etc. 65.79% have work experience in enterprises, 34.21% have participated in more than 5 enterprise horizontal projects, and 57.89% of teachers have practical teaching accounting for 31% -50%, reflecting their application-oriented positioning. However, in emerging technology fields such as artificial intelligence application development (50%) and hardware system design (36.84%), teachers' practical abilities are clearly insufficient, and there is a gap with the industry's demand for cultivating composite talents.

Third, the teaching methods are tailored to application-oriented needs, but the interdisciplinary teaching ability is insufficient.

Project-driven teaching method (84.21%) and case-based teaching method (81.58%) have become mainstream teaching methods, and 100% of teachers recognize the core position of practical teaching ability. However, only 68.42% of teachers have interdisciplinary teaching abilities, which is difficult to meet the requirements of the new engineering disciplines for interdisciplinary integration and restricts the quality of cultivating composite talents.

Fourth, there are obvious shortcomings in scientific research and team collaboration.

In the past five years, only 31.58% of teachers have obtained patents, and their ability to transform scientific research achievements is weak; In team collaboration, 72.73% of teachers reported unclear division of labor, 63.64% believed that team goals were inconsistent, and although intercollegiate communication was common (97.37%), there was insufficient normalized deep cooperation (only 28.95% communicated more than three times a year).

4.2 Research Limitations and Prospects

This study takes B University as a case study and investigates its own teachers and cooperative teachers from its industrial college. The sample is relatively concentrated and may not fully reflect the overall characteristics of computer science teachers in applied undergraduate universities nationwide. The universality of the conclusions needs further verification. In addition, the teacher portrait is constructed based on the current survey data, without considering the dynamic impact of technology iteration and industrial demand changes on the teacher's ability, lacking long-term tracking analysis. Although quantitative data has been collected through questionnaires, the weight assignment of each dimension of teacher's competency still needs to be optimized in combination with more college cases and expert assessments.

Subsequent research can select applied undergraduate universities from different regions and levels as samples to compare and analyze regional differences and type characteristics, in order to enhance the universality of the conclusions. At the same time, by combining multimodal data such as teaching videos, research project progress, and industry cooperation dynamics, a real-time updated teacher portrait system is established to dynamically track changes in teacher abilities, and further deepen quantitative research to quantitatively analyze the impact path of various competency dimensions on teaching quality and research results, providing more accurate guidance for teacher development. In addition, expert interviews and peer review should be introduced to enrich qualitative research and ensure the multidimensional comprehensiveness of data. By establishing a dynamic feedback mechanism and adjusting teacher training strategies in a timely manner, the practical value of research can be enhanced.

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