

Research on Classified Framework of Undergraduate Engineering Education Based on The Perspective of Talent Cultivation

Wuxi Jiang, zhuohua Yu

Nanchang Jiaotong Institute, Nanchang 330100, Jiangxi

Abstract: With economic expansion having moderated to a “new normal” pace, the relationship between the supply and demand of talents has undergone profound changes, while the homogeneity of higher education tends to be serious, and the structural contradictions are more prominent. Based on the perspective of talent cultivation, taking undergraduate engineering education as the foothold, and taking talent classification as the theoretical basis for the classification of higher education, this paper clarifies the classification framework of academic, applied and vocational undergraduate engineering education, which provides favorable conditions for the reform of different types of engineering education.

Key words: Undergraduate engineering education, Cultivation of innovative talents, Classification of education, Educational evaluation.

Introduction

In the past decades, the largest higher education system in the world has been built in China, making great contributions to modernization drive. However, with the economic expansion having moderated to a “new normal” pace, the relationship between talent supply and demand has undergone profound changes. Facing the profound adjustment of the economic structure, the accelerated pace of industrial upgrading, and the continuous promotion of social and cultural construction, especially the implementation of the innovation-driven development strategy, the structural contradictions of higher education have become more prominent, the homogenization tendency is serious, the problem of difficult employment and low employment quality of graduates has not been effectively alleviated, and the production and service frontline is in short supply of innovative, complex. The mechanism of applied talent training is not yet mature, and the structure and quality of talent training are not yet suitable for the requirements of economic restructuring and industrial upgrading. In 2015, the Ministry of Education, the National Development and Reform Commission and the Ministry of Finance jointly issued the Guiding Opinions on Guiding Some Local Ordinary Undergraduate Universities to Transform into applied Universities, to promote the cultivation of applied talents by guiding the construction of applied universities. In order to meet the challenge of the new era to the training of innovative and applied talents in engineering discipline, it is urgent to accelerate the construction and reform of engineering education.

1. Current situation of classification of higher education

For a long time, the classification of colleges and universities has been a difficult point in education evaluation and education management around the world. There are many colleges and universities in China, and there are differences in target positioning, national and local needs, development stages and other aspects. Scientific classification of higher education can effectively promote the distinctive and high-quality development of universities in different fields and at different levels.

The theory of higher education classification is the basic problem of higher education classification. H. R. Bowen believed that colleges and universities are classified mainly based on the relative emphasis on the functions of higher education. Ma Luting believes that the macro theoretical basis of university classification is the theory of effective allocation of resources with the goal of optimal income, and the micro theoretical basis is the theory of scope economy with the goal of sharing information to reduce costs.

The classification method of higher education is the fundamental problem of higher education classification. Huisman J discusses the diversity of colleges and universities from the dimensions of school size, school power control form, subject coverage, degree awarding and learning mode, and proposes that three skills such as cluster analysis, ranking and index calculation are powerful means of classification. The classification standard of Chinese universities put forward by Wu Shulian is composed of two parts: category and type. The category reflects the characteristics of university disciplines and is based on the division of disciplines by the Ministry of Education; Based on the size of scientific research, existing universities are divided into 13 categories, including comprehensive, liberal arts and science, and science, and 4 types, including research, research and teaching, teaching and research, and teaching.

Carnegie’s classification standard of colleges and universities is a relatively authoritative classification method in the world’s higher education sector, which better adapts to the process of the transformation of American elite higher education to popular higher education, and is an important reference basis for the allocation of resources in American colleges and universities, scholars engaged in educational research, and the acquisition of university funds, as well as an important reference basis for the research of China’s college classification reform. However, because Carnegie classification does not carry out parallel education evaluation for the classification results, its basic classification results are generally alienated as university rankings in public perception, rather than equal university classification.

In China, under the current economic new normal and supply-side structural reform, the demand for innovative and applied talents is increasing rapidly. It is urgent to strengthen the quality of higher education in the social service function. In 2021, focusing on the diversified needs of higher education at the popularization stage, the Ministry of Education’s Implementation Plan for the Review and Evaluation of

Undergraduate Education in General Colleges and Universities (2021-2025) adopted a flexible classification method and provided two types and four “evaluation packages”. The first type of assessment is applicable to colleges and universities with world-class school-running objectives, first-class teaching staff and education platform, training top-notch innovative talents, and serving the major strategic needs of the country. The second type of evaluation is divided into three types, which are respectively applicable to colleges and universities that focus on academic talent training, colleges and universities that focus on applied talent training, and colleges and universities that participate in the review and evaluation for the first time. Colleges and universities can make their own choices to further identify their coordinates and development direction.

This paper classifies undergraduate engineering education based on the perspective of talent training, taking undergraduate engineering education as the foothold, taking talent classification as the theoretical basis of higher education classification, and combining the degree awarding level.

2. Classification of higher education based on the perspective of talent cultivation

China’s modern education has been based on theoretical education for a long time, which meets the training needs of academic talents, but it is difficult to meet the needs of applied talents under the rapid economic development. The applied talents can be divided into engineering, technical and technical talents, with great differences in training direction. Therefore, clarifying the relationship between talent types and corresponding education levels and establishing the classification framework of undergraduate education in China are important prerequisites for formulating undergraduate education reform plans.

Table 1 Relationship between talent types and education types in China

Talent type		Type of education	
		Primary	Secondary
Academic		Academic postgraduate education	Academic undergraduate education
Applied	Engineering	Applied undergraduate education	Professional postgraduate education
	Technical	Higher vocational education	Vocational undergraduate education
	Skilled	Secondary vocational education	Higher vocational education

The classified evaluation of colleges and universities carried out by the Shanghai Higher Education Promotion Regulations provides four types of evaluation indicators for academic research, applied research, applied technology and applied skills. According to this analysis, the relationship between talent types and education types in China at this stage is shown in Table 1. It can be seen from Table 1 that undergraduate education also undertakes the task of reserving academic talents, directly cultivating engineering applied talents and technical applied talents. In fact, undergraduate education must give consideration to three tasks at the same time, and the classification purpose is to emphasize the application of different emphasis on basic scientific principles. Academic undergraduate education emphasizes the cultivation of the research ability of scientific principles, applied undergraduate education emphasizes the cultivation of the ability to use scientific principles to solve practical problems, and vocational undergraduate education emphasizes the cultivation of the ability to apply scientific principles in practice. At the same time, the planning proportion of different education types can also be adjusted according to the demand proportion of talent types to optimize the allocation plan of education resources. The National Standard for Teaching Quality of Undergraduate Specialty in General Colleges and Universities points out that colleges and universities should establish diversified talent training models to meet the needs of society for diverse talents and meet the different needs of students for further study and employment.

3. Classification of undergraduate engineering education based on professional quality evaluation

At present, in the training programs of engineering majors in most applied undergraduate colleges, the coverage of training objectives and graduation requirements is relatively comprehensive, which makes the overall training results show the characteristics of broad but not precise. Graduates generally lack targeted expertise in different employment or higher education directions. Therefore, according to three different types of undergraduate education, we can determine the corresponding training objectives and the focus of graduation requirements for different types of talents.

Table 2 Classification and evaluation index system of undergraduate engineering education quality

Primary indicators	Secondary indicators
Professional knowledge	Humanistic and social knowledge, Mathematical knowledge , Natural science knowledge
Professional ability	Experimental ability, Engineering analysis ability, Engineering design ability information retrieval ability, Modern tool application ability, Foreign language ability, Innovation ability

Social capacity	Humanistic quality, Physical quality, Moral cultivation, Communication and cooperation ability, Organization and management ability, Professional standard cognition, Industry development cognition, Lifelong learning ability
-----------------	---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------

The General Standard for Engineering Education Certification divides graduation requirements into 12 evaluation objectives according to the three elements of professional knowledge, professional ability and social ability: engineering knowledge, problem analysis, design/development of solutions, research, use of modern tools, project management, social ability, engineering and society, environment and sustainable development, professional norms, individuals and teams, communication, and lifelong learning. The National Standard for Teaching Quality of Undergraduate Major in General Colleges and Universities divides the talent training requirements of mechanical majors into ideological and political aspects, moral education, business aspects, and sports aspects. The business aspects are also divided into knowledge application ability, experiment and analysis ability, mechanical design ability, mechanical engineering problem modeling and solving ability, modern tool application ability, team cooperation and interpersonal communication ability, industry development cognitive ability Lifelong learning and sustainable development capacity. Based on the above contents, this paper classifies the evaluation index system of undergraduate engineering education quality into 3 first-level indicators and 18 second-level indicators, as shown in Table 2.

4. Classification of undergraduate engineering education based on the perspective of talent cultivation

Generally, the syllabus divides students' mastery of knowledge from low to high into three levels: understanding, familiarity and mastery. Using the method of combining qualitative and quantitative analysis, this paper preliminarily divides the professional knowledge into three levels: understanding (1 point), familiarity (2 points) and mastery (3 points), and also divides the professional ability and social ability into three levels according to the three-point system, and makes the basic requirements that the total score of different types of undergraduate education evaluation indicators must be consistent. After removing some indicators with consistent requirements, the classification framework of undergraduate engineering education can be obtained as shown in Table 3.

Table 3 Classification framework of undergraduate engineering education

Undergraduate education type		Academic	Applied	Vocational
Professional knowledge	Mathematical knowledge	3	2	1
	Engineering knowledge	2	3	2
Professional ability	Experimental ability	3	2	3
	Engineering analysis ability	2	3	2
	Engineering design capability	1	3	2
	Information retrieval capability	3	2	2
	Ability to use modern tools	3	2	2
	Foreign language ability	3	2	1
	innovation ability	3	2	2
Social capacity	physical quality	1	1	3
	Communication and cooperation ability	2	3	3
	Organization and management ability	1	3	3
	Cognition of professional norms	1	2	3
	Industry development cognition	3	2	3
	Lifelong learning ability	3	2	2
Total points		34	34	34

The classification framework can reflect the focus of different types of undergraduate engineering education: Academic undergraduate education focuses on mathematical knowledge, information retrieval ability, and has higher requirements for lifelong learning ability; applied undergraduate education focuses on basic engineering ability and comprehensive social ability; Vocational undergraduate education focuses on engineering practical ability and social practical ability.

Among them, the requirements of different types of undergraduate education on innovation ability are differentiated by different types of innovation ability, not by the level of innovation ability. Academic undergraduate education needs to cultivate students' innovative ability to break through previous research, applied undergraduate education needs to cultivate students' innovative ability to solve practical problems with new methods, and vocational undergraduate education needs to cultivate students' innovative ability to break through their own cognition.

It should be noted that the overall development of students' quality must go through a stage of gradual improvement. The classification framework is based on the current education situation, and its credibility needs to be iterated by using the questionnaire method and the Delphi method, and constantly adjusted according to the practice and employment needs.

5. Conclusion

At present, the urgent demand for applied type of talents is increasing day by day, but applied higher education system is not mature enough in china. As a result, applied universities have not been universally recognized by the society. We should clarify the classification framework of undergraduate engineering education based on perspective of talent cultivation. It is conducive to promoting the construction of a higher education evaluation system with the characteristics of the times, highlighting Chinese characteristics and reflecting the world level, and is conducive to optimizing the reform direction of various undergraduate engineering education.

Acknowledge

This paper was supported by Science and Technology Research Project Funded by Jiangxi Provincial Department of Education (GJJ218417) and Teaching Reform Research Project Funded by Nanchang Jiaotong Institute (XJJG2022-12) is acknowledged.

References

- [1] Liu Xiaoyu. The characteristics and trend of higher education internationalization in the era of "limited globalization" and the path choice of Chinese universities [J] Heilongjiang Higher Education Research, 2022, 40 (8): 7.
- [2] Xu Jianhua, Li Ji. Analysis of the supply-side structure reform of higher vocational education in the context of the new economic normal [J] China Adult Education, 2019 (13): 3.
- [3] Chen Guolong, Lin Suchuan. Deepen the "four in one" transformation and reform and build an applied university running system [J] China Higher Education, 2017 (22): 4.
- [4] Diao Yuhua. Analysis of the high-quality development path of higher education in the popularization stage [J] China Higher Education, 2021 (2): 3.
- [5] H. R. Bowen, Fincher C. Is Higher Education Worth the Cost? : The Individual and Social Value of American Higher Education[M]. two thousand and eighteen, 2018.
- [6] Maluting. The structural system of higher education in the new era [J] China Higher Education Research, 2021 (9): 7.
- [7] Huisman J. The emergence of the higher education research field (1976–2018): preferential attachment, smallworldness and fragmentation in its collaboration networks[J]. Higher Education, 2020:1-17.
- [8] Li Xingguo, Zhao Xiaodong. Statistical test of the correlation and stability of the evaluation system of Chinese universities [J] Statistics and Decision Making, 2018 (23): 3.
- [9] Xu Xiangyun, Zhang Qian. Looking at the construction of first-class undergraduate majors from the perspective of the coexistence of undergraduate and graduate education -- a study based on the classified data of Carnegie universities in 2018 [J] China Higher Education Research, 2020 (7): 7.
- [10] Li Zhiyi. Key points for design and implementation of the new round of audit and evaluation scheme [J] Higher Engineering Education Research, 2021 (3): 7.
- [11] Huang Haiyang, Qin Jinyi. More open, more independent and more incentive - the first instance of the Shanghai Higher Education Promotion Regulations (Draft) [J] Shanghai People's Congress Monthly, 2017 (9): 2.
- [12] Gu Yong'an. The era of "specialty is king": how to deal with it in colleges and universities [J] Research on Education Development, 2018, 38 (19): 3.
- [13] Liu Siyuan. Professional certification and curriculum content construction of engineering education: practical demands, standards and mechanisms [J] Heilongjiang Higher Education Research, 2021, 39 (7): 5.
- [14] Feng Yaqing, Zhang Fengbao, Xia Shuqian. Establish national standards for teaching quality of chemical engineering majors and improve the quality of chemical talents training [J] China University Teaching, 2018 (1): 3.
- [15] Meng Ruizhen. Research on the reform and practice of market-oriented digital course of modern logistics foundation [J] Modern Marketing: Information Edition, 2019 (3): 2.

Correspondence to: Jiang Wuxi (1994-), male, lecturer, main research direction is the cultivation of engineering innovative talents.