

Investigation into the Coherence and Feasibility of Undergraduate and Master's Degree Training in Water Science and Engineering

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Abstract:

This paper discusses the problems of coherence and feasibility of undergraduate and master's training in water science and engineering, and proposes some solution strategies. The paper firstly analyses the coherence between undergraduate and master's training, and then identifies the problems in curriculum, practical teaching, scientific research ability and professional ability training. Finally, strategies such as strengthening the basic course curriculum, establishing a progressive practical teaching system, increasing the undergraduate advancement of postgraduate courses and inviting industry experts for career planning guidance are proposed in the hope of providing a reference for the coherence between undergraduate and master's training in water science and engineering.

Keywords:

Water Science and Engineering, Undergraduate, Master's Coherence, Feasibility

1. Introduction

In recent years, China's urbanization process has accelerated, and the field of water science and engineering is facing more and more challenges. Therefore, it has become imperative to cultivate water supply and drainage professionals with high quality, innovative ability and practical experience. As an important stage for cultivating water supply and drainage professionals, the quality and consistency of the undergraduate and master's level are crucial. The issue of articulation between undergraduate and master's degree is an important educational issue, and its coherence and feasibility directly affect students' academic development and career prospects. In the following, this issue will be discussed and corresponding solution strategies will be proposed.

2. Coherence and Feasibility Analysis of the Convergence of Undergraduate and Master's Cultivation in Water Science and Engineering (WSE)

Today's higher education system has been seeking how to better achieve the coherence of undergraduate education and master's education and make it feasible. This issue is particularly important in the field of water science and engineering as a multidisciplinary cross-discipline.

Coherence refers to the smooth transition of students to the master's level after completing undergraduate studies, which requires a certain degree of correspondence between undergraduate and master's programmes in terms of knowledge systems, teaching methods and assessment criteria. Education at the undergraduate level needs to lay a solid foundation for specialised research at the master's level, while education at the master's level needs to deepen and expand this basic knowledge and develop students' independent research abilities. However, achieving coherence is not easy. The education system needs to be carefully designed to ensure that the knowledge and skills acquired by students at the undergraduate level can be smoothly articulated to the master's level. At the same time, teachers need to continuously update and improve the curriculum to keep pace with changing disciplinary developments and industry needs.

Feasibility refers to the fact that in practice, education at undergraduate and master's levels can be seamlessly integrated, and students can make a smooth transition from undergraduate to master's level. This requires, on the one hand, that educational institutions provide appropriate resources and support, such as offering research opportunities and providing pre-requisite courses for master's programmes; on the other hand, it also requires that students have the ability to adapt to master's level study, such as independent research skills and critical thinking skills. The challenge in achieving viability is that different students have different needs and abilities. The education system needs to take full account of these differences and provide flexible learning pathways and personalised learning support to ensure that all students can make a successful transition to master's level.

3. Problems in the Interface Between Undergraduate and Master's Training in Water Science and Engineering Programmes

3.1. Inconsistency between undergraduate and master's programmes

In the profession of water science and engineering, the coherence of undergraduate and master's curriculum is the key to ensure the smooth transition of students and deepen their professional knowledge and skills. However, in practice, the problem of incoherence between the undergraduate and master's curricula has led to a series of disturbances. The content of undergraduate and master's programmes may be duplicated or disconnected in some cases. At the undergraduate level, students learn basic theories and skills, while at the master's level, it should be the deepening and expanding of these knowledge and skills. However, in the actual teaching process, sometimes the master's programme repeats the content that has been learnt in the undergraduate programme, or there is a brand new content in the master's programme that has not been covered in the undergraduate programme, which leads to students not being able to successfully complete the knowledge progression learning. In addition, the teaching objectives and evaluation standards of the undergraduate

programme and the master's programme are not the same. The main objective of the undergraduate programme is to enable students to master the basic theories and skills, while the master's programme places more emphasis on the cultivation of independent research and practical ability. If there is no clear articulation and shift in the teaching objectives and evaluation criteria between the two stages, students may encounter difficulties at the master's level. In addition, there may be a lack of flexibility in the design of the programmes, making the transition between the undergraduate and master's levels difficult for some students. For example, some undergraduate programmes may not provide students with enough elective courses so that they can choose different directions of study according to their interests and career goals.

3.2. Disconnection between undergraduate and master practical teaching links

In the major of water science and engineering, the practical teaching link is crucial to cultivate students' practical skills and the ability to solve practical problems. However, there is currently a disconnect between practical teaching at undergraduate and master's level, which has a certain impact on the development of students' abilities. Practical teaching at the undergraduate level is often carried out in the form of course experiments and laboratory internships, aiming at enabling students to master basic experimental skills and operational procedures. However, sometimes there is a large gap between this practical teaching and the practical skills required at the master's level. Practical teaching at the master's level tends to focus more on independent research projects, which requires students to have independent thinking, problem-solving ability and a certain innovative spirit. If practice teaching at undergraduate level is not well prepared for practice teaching at master's level, students may face challenges in practice teaching at master's level. Meanwhile, practice teaching at the undergraduate and master's level often lacks effective articulation. For example, there may be no clear correspondence between the content of practice teaching at undergraduate level and that at master's level, or the results of practice teaching at undergraduate level cannot be directly used for practice teaching at master's level. This situation may result in students needing to start over in practice teaching at master's level, and not being able to effectively utilize the results of practice teaching at undergraduate level.

3.3. Insufficient Cultivation of Undergraduate and Master's Research Ability

For students of water science and engineering, research ability is one of the very important abilities for them at master's level. However, there are many deficiencies in the cultivation of research ability at the undergraduate and master's level, which constitutes a certain obstacle to the development of students' research ability and their future academic career. The curriculum design and teaching methods at the undergraduate level do not adequately take into account the development of research ability. In many cases, the teaching at undergraduate level focuses on enabling students to master basic theories and techniques, while the training of scientific research methods and the cultivation of scientific research thinking are relatively lacking. This makes students face the challenges of scientific research work such as how to conduct independent research and how to analyse and solve complex problems when they enter the master's level. Meanwhile, there are insufficient opportunities for research training at the undergraduate level. Although some universities provide undergraduate students with opportunities for research training, such as course design,

laboratory internships, and graduation design, these opportunities are often insufficient in number and involve research problems that may be simple and do not involve real scientific research problems. This leaves students without sufficient research training at the undergraduate level and with an inadequate understanding of research methods and processes [1].

3.4. Inadequate development of vocational competencies at undergraduate and master's level

In water science and engineering, the development of vocational competence is the key to students' success in the job market. However, the current undergraduate and master's level vocational ability training is insufficient, which affects students' competitiveness in employment and career development. Teaching at the undergraduate level often pays too much attention to the teaching of theoretical knowledge and relatively neglects the cultivation of vocational skills and practical ability. The contents of classroom teaching, course design and experimental courses are often at a certain distance from the industry practice, which makes students lack of understanding of the actual working environment and work content when they enter the workplace after graduation. The teaching at master's level pays too much attention to the cultivation of academic research ability and not enough to the cultivation of vocational skills and practical working ability. Master's-level programmes may focus on theoretical research and lack the training of practical skills, which makes students face the challenge of entering the workplace after graduation.

4. Coherence and Feasibility Strategy for the Articulation of Undergraduate and Master's Degree Training in Water Science and Engineering Programme

4.1. Enhancement of the team's undergraduate basic course curriculum

For students majoring in water science and engineering, the basic curriculum at the undergraduate level is the cornerstone of their future academic development and professional achievements. The current curriculum may have some deficiencies and needs to be improved to better meet the learning needs of students and the needs of industry development. There is a need to strengthen the basic theory curriculum, which is the foundation for students' understanding of professional knowledge and advanced learning. For example, basic theory courses such as hydraulics, water chemistry and environmental microbiology are important for understanding the theory and practice of water supply and drainage engineering. Improving the teaching quality and depth of these basic theory courses can help students build a solid theoretical foundation at the undergraduate level. There is also a need to strengthen the curriculum of basic practical skills courses. Basic practical skills courses are the key for students to master vocational skills and cope with practical work. For example, basic skills courses such as experimental technology, engineering design, computer simulation, etc. play an important role in cultivating students' practical skills and their ability to solve practical problems. Improving the teaching quality and depth of these basic practical skills courses can help students master the necessary practical skills at the undergraduate level. In addition, the curriculum of basic research methods courses needs to be strengthened. Basic research methods courses are the foundation for students to conduct advanced research and develop their research ability. For example, basic research methods courses such as scientific research methods, data analysis, and

thesis writing play an important role in developing students' scientific research ability and critical thinking skills. Improving the teaching quality and depth of these basic research methods courses can help students master the basic methods of scientific research at the undergraduate level [2]. In Beijing University of Civil Engineering and Architecture, professional teachers of WSE have established three professional teams, sewage, rainwater and water-saving, to strengthen corresponding professional courses.

4.2. Establishment of progressive articulated practical teaching system

For the major of water science and engineering, practical teaching is an extremely important part, which allows students to transform theoretical knowledge into practical skills and enhance the ability to solve practical problems. In order to solve the problem of disconnection between practical teaching at undergraduate and master's level, it is very necessary to establish a progressive and articulated practical teaching system. Practical teaching should be set up as a step-by-step process. In the undergraduate stage, it should focus on cultivating students' basic practical skills, such as experimental operations, basic data processing skills, etc., and give them the opportunity to carry out preliminary practical activities, such as course design and experimental courses. The goal at this stage should be to familiarise students with basic practical processes and develop their hands-on skills. Then, at the Master's level, practical teaching should be more in-depth and complex in order to develop students' independent research skills. Practical teaching at the Master's level may include independent research projects, supervised experiments, and internships. The goal of this stage is to enable students to carry out practical activities independently and to develop their independent thinking and problem-solving skills. At the same time, some special bridge courses can be designed in order to better connect the practical teaching at the undergraduate level with that at the master's level. For example, some pre-study courses can be set up to allow undergraduate students to get in touch with the practical content of the master's level in advance; or some joint projects can be set up to allow undergraduate students and master's students to carry out practical activities together, so that undergraduates can better transition to the master's level [3]. In Beijing University of Civil Engineering and Architecture, the System of Academic Advisor has been established, so each undergraduate student follows their academic advisor into the research group.

4.3. Increased progression to postgraduate programmes at undergraduate level

An increasingly popular strategy in higher education is to provide students with opportunities for advanced study in graduate programmes at the undergraduate level so that they are exposed to more advanced knowledge and skills earlier. This strategy is also valuable for students in water science and engineering. By adding advanced study in graduate programmes, students can be exposed to more in-depth expertise and more complex research problems beginning at the undergraduate level. This not only enhances their academic literacy, but also increases their interest in learning and motivation for research. For example, by pursuing postgraduate studies, students may discover a particular interest in a particular area of specialisation, leading to greater focus and commitment in their future studies and research. The addition of further study in a postgraduate programme also helps students to adapt to the learning environment and requirements of the Master's level in advance. Master's level study tends to place more emphasis on independent research and in-depth study, which requires a higher level of study and research ability. If students can familiarise

themselves with this mode of learning in advance through further studies in postgraduate programmes at undergraduate level, it will help them to achieve better results in their master's level studies. However, there are some issues that need to be kept in mind when adding further studies in postgraduate programmes. There is a need to ensure the quality of the curriculum and teaching of these courses, so that they do not become formalised requirements or additional burdens [4]. In Beijing University of Civil Engineering and Architecture, the course Theory and Technology of Water-saving is established for undergraduates, while the course New technology and Application of Water Conservation is for master students.

4.4. Inviting industry experts for career planning guidance

In the current increasingly fierce job market environment, career planning is increasingly important for college students. For undergraduates majoring in water science and engineering, if they can have a clear career direction and planning at the early stage, it will have a profound impact on their future development. For this reason, schools should invite industry experts to provide professional career planning guidance to undergraduates. Industry experts have rich professional knowledge and practical experience, as well as an in-depth understanding of industry trends and career opportunities, so their guidance will have a positive impact on students' career development. They can provide students with up-to-date information on industry trends, career opportunities and skills requirements, and help them formulate a reasonable career plan based on their interests and abilities. Inviting industry experts for career planning guidance can help students understand more clearly the application of their specialisation in the real world and provide specific advice on choosing career paths. Experts can share their career experience and exposure to help students understand the characteristics and requirements of different career paths and facilitate them to make informed career choices. In addition, guidance from industry experts can help students build connections to industry and expand their social networks. They can provide students with internship and employment opportunities to help them establish connections with the industry and enhance their competitiveness in employment. In Beijing University of Civil Engineering and Architecture, many chief engineers in engineering design and research institutes serve as tutors for both undergraduate in their graduation projects and graduate students.

5. Conclusions

In conclusion, the coherence and feasibility of undergraduate and master's degree training of water science and engineering are of great significance for cultivating high-quality professionals. By analyzing the problems existing in the current stage and putting forward the strategies of strengthening the curriculum, improving the practical teaching system, adapting to the postgraduate stage in advance and inviting industry experts to provide guidance on career planning, it is expected to improve the quality of cultivation in both undergraduate and master's stages. However, the enhancement of coherence and feasibility requires the joint efforts of all parties, including education departments, universities, industry enterprises and students themselves. In the future development, the water science and engineering major should continue to deepen the reform and continuously improve the talent training system like that in Beijing University of Civil Engineering and Architecture, so as to deliver more excellent talents for China's urban construction and water resources management field.

Conflicts of Interest

The author declares that there is no conflict of interest regarding the publication of this article.

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References

- [1] Fan, G.D. Construction and practice of sustainable cultivation system of innovation and entrepreneurship ability of undergraduate students majoring in water supply and drainage science and engineering. *Science and Education Literature*, 2021, 16, 4, DOI : 10.16871/j.cnki.kjwha.2021.06.028.
- [2] Fang, X.; Li, Z.; Liu, J.Y.; Wang, Z.Z.; Shao, H.Y. Exploration of practical teaching reform of water supply and drainage science and engineering under the concept of "new engineering. *Science Consulting*, 2022, 12, 13-16.
- [3] Zhou, S.L.; Lu, X.; Liu, Y.F, et al. Exploration and research on talent cultivation mode of water supply and drainage science and engineering in local colleges and universities based on “undergraduate tutorial system”. *Science and Technology Perspectives*, 2021, DOI: 10.19694/j.cnki.issn2095-2457.2021.09.06.
- [4] Chen, J.X.; Dai, C.Q.; Wang, H.Q, et al. Reform investigation of informative practical teaching method and assessment method of water supply and drainage science and engineering under the background of “double first-class”. *Education Informatisation Forum*, 2019, 3(9), 2.



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