Curriculum and Teaching Methodology (2024)
Clausius Scientific Press, Canada

DOI: 10.23977/curtm.2024.070818
ISSN 2616-2261 Vol. 7 Num. 8

Exploration and Practice of Mutual Integration and Promotion of Scientific Research and Teaching in the Context of Undergraduate Talent Cultivation of "Engineers with Excellence"—Local Applied Research Universities as an Example

Huimin Shen[1,a,*], Kangming Liu[1,b]

[1]*School of Mechanical Engineering, University of Shanghai for Science and Technology, 516 No. Jungong Rd., Shanghai, China*
[a]*hmshen@usst.edu.cn*, [b]*223341577@st.usst.edu.cn*
[*]*Corresponding author*

Keywords: Scientific research and teaching integration, undergraduate talent cultivation, engineers with excellence, local applied research universities

Abstract: The "Engineer Excellence" has been given an important position of the national strategic talent force, and under the trend of the new round of scientific, technological and industrial revolutions. The new engineering disciplines, which are mainly characterized by new technologies, new business forms and new industries, are developing continuously. The integration of university education, research and teaching not only requires the organic combination of the two, but also requires the establishment of a new system, a new model and a new mechanism, as well as the establishment of a new type of education system that meets the needs of the new engineering disciplines. Local applied research universities, with the goal of building first-class in both industry and local, take applied research and cultivation of excellent talents as their important tasks, and focus on the needs of industry and local pillar industries, strategic emerging industries and social development to provide talent support and intellectual services. The development of this kind of universities should have both high level of undergraduate education and advanced level of scientific research achievements.

1. Introduction

Teaching is the foundation and prerequisite for scientific research in applied research universities, and scientific research is an effective path to improve the academic level of teachers and the driving force for the long-term and lasting development of applied research universities [1]. In the process of qualified assessment of undergraduate teaching work in colleges and universities of China, the indicators of scientific research work and scientific research achievements serving teaching occupy a large proportion, which also shows the important role of scientific research in undergraduate teaching. Organic combination of scientific research work and course teaching can improve the teaching level

of teachers, and it is also the way to cultivate innovative talents, and it is also an important measure to improve the level of running colleges and universities. At present, in order to further implement the spirit of the National Conference on Undergraduate Education in Colleges and Universities, these colleges and universities are facing the responsibility of cultivating undergraduate talents of "Engineer Excellence". It is imperative to carry out the exploration and practice of mutual accommodation and mutual promotion of scientific research and teaching, which is the inevitable trend of their teaching reform. How to realize the effective linkage of education chain, talent chain, industry chain and innovation chain? How to make the deep integration of engineering talent training and engineering practice? These have been problems that needs to be solved for the cultivation of engineering undergraduate talents in applied research universities.

2. Status and Main Problems in Current integration of teaching and scientific research

There are three functions for applied research universities, including the educating talents, scientific research and serving the local society. For the cultivation of engineering talents,

-The teaching process from teachers enables students to master basic knowledge principles, understand the interrelationships of disciplinary frameworks and knowledge systems, and have the ability to apply what they have learned.

-The exploring process of the unknown fields during scientific research led by teachers encourages students to apply the basic principles involved in the exploratory process in order to cultivate students' ability of combining theories and practices and to analyze and solve problems independently, as well as to form innovative ideas of inquiry.

By combining theory and practice, students can independently analyze and solve problems, and form innovative ideas of inquiry. In recent years, in order to continuously improve the quality and efficiency of engineering talents training, teachers have continuously infiltrated the advantages of scientific research into the advantages of teaching, realized the coordinated development of teaching and research, and finally transformed them into the advantages of students in solving complex engineering problems.

2.1 Development of integration of teaching and scientific research

The organic integration of teaching and scientific research has been an important way for applied research universities to improve the quality of talent cultivation. Therefore, if we can effectively utilize scientific research results in teaching, transform scientific research results into actual teaching resources, and feed teaching with scientific research, it will play a positive role in promoting understanding about the frontier discipline of the students. Furthermore, this will expand their knowledge background, developing scientific research thinking, and improving their learning motivation, and then effectively improve the quality of undergraduate education [2, 3].

At this stage, some high-level undergraduate colleges and universities at home and abroad have maturely adopted the teaching concept of combining undergraduate teaching with scientific research results. Students can participate in specialized extracurricular groups for scientific research during their undergraduate studies, and have abilities to carry out scientific research independently. Since the 1980s, China has gradually carried out research on the teaching reform of integrating scientific research achievements into undergraduate teaching. In the research on the complementary relationship between undergraduate teaching and scientific research, great attention has been attracted from educational scholars. However, limited to the situation that universities in China generally favor scientific research, there are more scientific research academic results every year, while the research on the transformation of research resources into undergraduate teaching is still less compared to the abundant scientific research output.

2.2 Problems in integrating teaching and research

■ **Teachers**

Some teachers pay more attention to scientific research, which distracts their investment in teaching and affects their enthusiasm and initiative in teaching. Normally, teachers invest more energy in scientific research, but leave the excellent results of the output unused. Few teachers design scientific research resources into the teaching process according to the teaching objectives in a targeted manner. Even if there are certain scientific research results into, but also more mechanical. Only when the specific content of the lecture and a strong correlation with a scientific research topic, the students do not have a deep impression with only a brief introduction. It is difficult to form a concrete thinking of scientific research work. The lack of scientific research results into the undergraduate teaching resources in order to enhance the comprehensive quality of the students' awareness.

■ **Teaching Process**

Although, the teaching content of some courses has formed a more complete and mature system. The teaching ideas and teaching content lack of novelty. With the inherent teaching content, teaching methods and means to complete the teaching work, the attentions on the scientific research progress, professional frontiers, the students' ability to develop inquiry from the teachers is not enough. At the same time, the assessment method is not innovative enough, usually only uses the usual grades and final theoretical paper grades to quantify the learning effect of students. This can be failed to form a closed-loop feedback mechanism, and lack of adequate assessment of students' ability to solve problems and thinking in practice. The transformation of scientific research results for undergraduate teaching, and at the same time, scientific research results can be used to realize the secondary transformation, so as to achieve the purpose of innovative experimental teaching, enriching the connotation of lectures, and updating the content of teaching materials in undergraduate teaching.

■ **Students**

The main purpose of transforming scientific research results into teaching resources is to cultivate the ability to innovate and solve practical problems of students. In teaching activities, it is necessary for students to establish the awareness of the transformation of scientific research results into teaching resources. The interest of students in scientific research is an important factor that influences teachers to integrate scientific research into teaching. Students' learning and mastering of professional frontier knowledge and scientific research process can, on the one hand, promote the deepening of their understanding of the basic principles, and at the same time, make teachers more willing to integrate scientific research results in teaching.

3. Reform Program for the Integration of Research and Teaching

3.1 Research updates enrich teaching and learning

Teachers teach students the cutting-edge science and technology and the latest progress in their field of specialization by incorporating the new results obtained from the progress of scientific research projects into the classroom design. On the one hand, it can promote teachers to deepen their understanding of specialized knowledge, establish a systematic knowledge system, and pay attention to the important and difficult problems in the progress of scientific research. On the other hand, by using scientific research results and problems as examples in the classroom [4], teachers guide students to carry out exploratory learning, gradually improve the ability of cooperation among students, and promote the steady improvement of the teaching effect. This maximizes the enrichment of teaching content and compensates for the relatively outdated knowledge in textbooks. Teachers introduce their own scientific research projects into classroom teaching cases and guide students to

think about research methodologies, research contents, technical routes, etc., which helps students cultivate their professional practical application ability and innovation ability.

3.2 Reform the content of practice and innovate teaching forms based on research projects

Taking practical problems in scientific research as teaching materials for flipped classrooms [5] enables students to understand the latest progress in their majors. It also allows high-level scientific research teachers to give full play to their subjective initiative. The flipped classroom teaching of high-level scientific research teachers has outstanding results in teaching method reform and obvious characteristics in curriculum assessment method reform. Based on the OBE concept, it encourages students to participate in exploring scientific and technological problems and focuses on improving students' self-study and independent research abilities. It further arouses students' learning interests and improves teaching effects, making the imparting of originally boring professional knowledge more natural and vivid.

3.3 Explore the tutorial system for undergraduate students' scientific and technological innovation

By connecting high-level scientific research teachers with students, the teachers can act as mentors for students' academics, scientific and technological innovation, employment, etc.. Thus, they can provide help to the best of their ability in students' lives and psychology, which is the key to cultivating "excellent engineer" undergraduate talents. The mission of the school and the responsibility of teachers lies in cultivating national pillars with strong humanistic feelings and humanistic spirit. Teachers should not only "preach and teach and solve doubts", but also guide students to establish the spirit of "self-responsibility". This can attract undergraduates to enter the scientific research laboratory by participating in the scientific research training of tutors, deepen the understanding of professional theoretical knowledge. Then, the implementation of professional skills practice can enhance the ability of students in scientific research and practical innovation.

4. Conclusion

By constantly contacting the cutting-edge science and technology in the field of their profession, college teachers can keep abreast of the research progress of their major, update the courseware in time in classroom teaching, inject knowledge that is not in the textbook, and ensure the continuous improvement of teaching quality and level. The scientific research achievements and scientific research experience of teachers can be applied to the case development of classroom teaching, integrated into the compilation of teaching materials, guiding students' practical teaching, enriching the theoretical teaching content, promoting the reform of teaching methods, means and talent training models, boosting the construction of majors and disciplines, and improving the curriculum teaching system. Research and teaching are indispensable links of a high-level applied research university, and only when both are developed can we truly cultivate "excellent engineer" undergraduate talents with strong hands-on ability and ability to solve complex engineering problems.

Acknowledgement

This work is supported by “2024 Teacher Development Research Project of USST” and “Shanghai University Key Course Construction project ‘Fundamentals of Mechanical Testing and Control’ ”.

References

[1] GENG S., HOU H., DONG L., CHEN L., YIN J. (2021) Some Considerations and Suggestions on Improvement of Undergraduate Education through Scientific Research in Local Application-oriented Undergraduate Universities, The Science Education Article Collects, 550, 12-14.
[2] ZHANG X., WANG H., YAO A., ZHANG C. (2021) The Preliminary Study of Promoting Teaching with Scientific Research in Universities of Applied Engineering: Taking the Thermal Engineering Course as an Example, The Science Education Article Collects, 528, 81-85.
[3] ZHU H., ZHANG Z., XU K., LIU Y. (2023) Experimental Teaching Optimization and Reform of Non-traditional Machining Course by Introducing Latest Research Achievements—An Experiment of Laser-Controlled Electrochemical Dissolution of Germanium Wafer, Guangdong Chemistry, 50(8), 236-238.
[4] YAN L., HAN Y., DAI C., LIANG B. (2023) Promoting Inorganic Chemistry Blended Teaching with Research Innovation Cases, Higher education in chemical engineering, 40(2), 101-107.
[5] JIN Y., WEI D., CHEN R., XU X., LI M., YU Q., WU W. (2024) Application of flipped classroom in Microbiology Experiment teaching: a case study of bacterial identification based on physiological and biochemical tests, Microbiology China, 51(4), 1314-1320.