

“Scientific Research Nurtures Teaching” Based on Coaxial Electrospaying

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ABSTRACT

The effective implementations of “Scientific Research Nurtures Teaching” to students can benefit the fostering of professional talents from universities. The metabolism of professional knowledge renewing determines that the key role of professional education and the formation of students practical ability in their university life, and also the abundant professional research topics can ensure fruitful teaching materials. With scientific researches on coaxial electrospaying as an example, this paper has explained how to efficaciously implement “Scientific Research Nurtures Teaching” to both undergraduate and postgraduate students. Under the wise instructions of “three-all education” spirits, 1) all-process of coaxial electrospaying can be useful materials for nurturing teaching such as the raw materials and experimental conditions, implementation of the coaxial electrospaying processes, analyses of the resulted in nano products, and the writing of patents or research articles; 2) all-staff around the coaxial electrospaying can take an active part in the teaching, such as the supervisors, the instructor, the administrative staff, the academic visitor, and safety officers; 3) all-round education can be carried out for nurturing teaching and fostering the students’ abilities of practical ability, organization and management ability, crisis resolution ability, innovation ability, organization skills, the spirit of unity and cooperation besides professional ability.

Keywords: teaching materials; scientific research; coaxial electrospaying; undergraduate students; postgraduate students

1. THE METABOLISM OF PROFESSIONAL KNOWLEDGE RENEWING REQUESTS “SCIENTIFIC RESEARCH NURTURES TEACHING”

Knowledge never stops its step of moving forward. Shown in Figure 1 is a diagram about the renewing mechanism of professional knowledge. The fundamental knowledge that is well known to all professional talents has been edited into teaching materials. These teaching materials are imparted to the students majoring in this field all over the world in different languages and in different organization formats through classroom lessons, and often with some separate scientific experiments.

After a well grasp of the fundamental professional knowledge, the students (often the PhD or Master postgraduate students but also some undergraduate students) will also need to read some scientific papers to follow the cutting-edge knowledge of their speciality. Later, they can begin their innovative investigations on new topics or even new projects under the guidance of their supervisors.



Figure 1. The metabolism of professional knowledge renewing

Based on the theoretical learning about professional knowledge and also the experimental exploration of professional practices. The students will be able to write their research articles for publication in international journals. After enough learning accumulations, the students and also their supervisors may write reviews about a certain professional topic. In a special professional field, the new speciality teaching materials can be published after more and more topics are reviewed and gradual systematization.

This renewing metabolism determines that it may need several decades of years for a complete renewing of the professional cutting-edge knowledge. Meanwhile, it also points out that the professional exploration processes are precious teaching materials, which provide a strong platform for implementing “Scientific Research Nurtures Teaching” to students including bachelor, master and PhD students.

However, in many colleges and universities, the professional teaching materials remain the same as those utilized 20 or even 30 years before. Those old professional teaching materials should be renewed for a better teaching effect and for well fostering the students’ capability of innovation. In this paper, under the spirit of “three-all education” and based on the coaxial electrospaying, how to effectively implement “Scientific Research Nurtures Teaching” to students is discussed.

2. THE KEY ROLE OF PROFESSIONAL EDUCATION AND THE FORMATION OF STUDENTS PRACTICAL ABILITY REQUIRE “SCIENTIFIC RESEARCH NURTURES TEACHING”

University is place where the students gradually transfer their study from the classroom and from the teachers in the rostrums, to the self-practices and own’s perception. During their growth from primary school, to junior high school, to senior high school and to university, the students are familiar with achieving the fundamental knowledge from the text books through classroom learning (as shown in Figure 2).

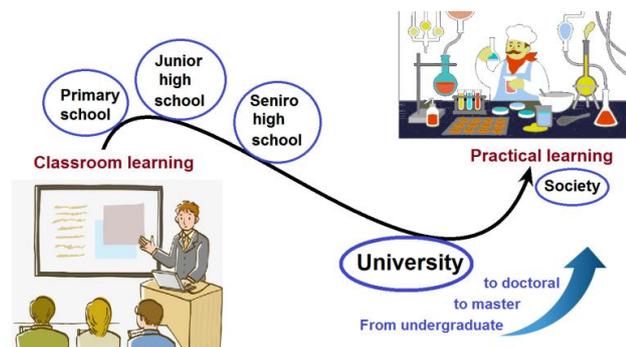


Figure 2. The core of university professional teaching and the formation of students' professional ability

However, after entering the university, where they can grow from undergraduate students to master and doctoral students, the ratios of getting knowledge from their practices increase gradually. Particularly, their professional knowledge, which is totally different with the fundamental knowledge for all the people, need more and more experiments to deepen and to broaden. And they can update the professional cognition through the cutting-edge studies. In a word, the core role of university professional

teaching should be the formation of students' professional ability, particularly the ability studying from their self-practice and from the real world. Needless to say, implementations of “Scientific Research Nurtures Teaching” to the students can benefit the professional teaching and also the formation of the students’ practice ability.

3. THE ABUNDANT PROFESSIONAL RESEARCH TOPICS CAN ENSURE A FRUITFUL “SCIENTIFIC RESEARCH NURTURES TEACHING”

Professional knowledge growth is an inevitable requirement for disciplines to improve the effect of education. Teaching knowledge is the main way to cultivate talents. After the 18th century, the sharp differentiation of disciplines is an important reason for the rapid development of education. At the same time, the division of different disciplines and majors makes the concept of specialization and professional talents established, and higher education in the modern sense has really developed. The richness, hierarchy and renewal speed of a discipline's knowledge determine the professional level of training talents in a discipline. In many scientific fields, a common phenomenon is that the professional teaching can't follow the steps of knowledge growth rate. Thus, a combination of direct scientific research and classroom teaching can greatly promoting the growth of professional talents, nursing new teaching approaches.

In the specialty of “Materials Science and Engineering”, the students are often taught all kinds of materials preparation and characterization methods, and often the optimization and successful implementation comprise the mainstream of materials engineering. Among all types of advanced materials production methods, electrospaying is a popular one, which is easy to implement and effective in creating polymeric particles with a size from several decades of nano meters to several microns [1-4].

Electrospaying and electrospinning are two most important branches of electrohydrodynamic atomization (EHDA) methods, which takes the advantages of the easy interactions between the working fluids and the electrostatic energy [5-10]. After the popularity of electrospinning during the past three decades for creating a series of structural nanofibers, including core-shell [11], homogeneous [12-14], side-by-side [15, 16], tri-layer core-shell [17] and other complicated multiple-chamber ones [18], electrospaying is also becoming more and more popular in the laboratory experiments and also potential industrial applications. These advanced EHDA methods contain abundant materials for implementing “Scientific Research Nurtures Teaching”.

As the developments of electrospaying in creating particular materials, coaxial electrospaying is gradually projecting out for its powerful capability of generating core-shell structures. Sown in Figure 3 is a diagram of a

typical coaxial electro spraying process. An electro spraying system include four sections, i.e. the two syringe pumps for driving two working fluids, a power supply for offering the high voltage to the fluids, a concentric spinneret for guiding the two working fluids into the electrical fields in an organized manner, i.e. one surrounding another, and a grounded collector. These contents are fundamental teaching materials for the students to know how to carry out an electro spraying process. Certainly, the most useful materials that can be explored to nurse professional teaching should be the treatments of different kinds of working fluids for creating novel nanostructures. With coaxial electro spraying as a scientific research example, how to effectively implement “Scientific Research Nurtures Teaching” is explained as follows.

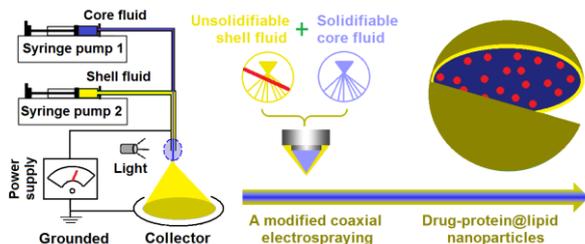


Figure 3. An example of extracting teaching materials from a common professional scientific research - coaxial electro spraying [1].

4. EFFECTIVE IMPLEMENTATIONS OF “SCIENTIFIC RESEARCH NURTURES TEACHING” UNDER THE DIRECTIONS OF “THREE-ALL” EDUCATION SPIRITS

During the implementations of “Scientific Research Nurtures Teaching”, the raw materials from scientific researches, on one hand, are an important issue. However, on the other hand, how to take advantage of those materials for teaching is another important concern, which maybe more important than the first one. Luckily, the “three-all education” spirits have given hints on how to conduct “Scientific Research Nurtures Teaching”.

In 2018, the Ministry of Education in China put forward the concept of "three-all education" for comprehensive reform of high education. "Three-all education" means all-staff education, all-process education and all-round education. The comprehensive reform of "three-all education" is not only the integration of current education projects, carriers and resources, but also the reconstruction of long-term personality education, system and standards. Through this pilot reform, an integrated personnel education system is expected to be built for running a socialist university with Chinese characteristics and cultivating socialist builders and successors with all-round development of morality, intelligence, physique, art and labor. Shown in the diagram of Figure 4, “three-all education” and “scientific research nurtures teaching” can

be completely combined together for fostering innovation talents in high education. With University of Shanghai for Science and Technology as an example, a series of methods are suggested for effectively implement “scientific research nurtures teaching” as follows.



Figure 4. “Three-all education” and “scientific research nurtures teaching” all highly combined for fostering innovation talents in high education.

4.1. All-process education during scientific researches for nurturing teaching

A complete process for the scientific researches include many sections. In general, with coaxial electro spraying as an example, it has the preparation of raw materials and experimental conditions, implementation of the coaxial electro spraying processes, analyses of the resulted nano products, and the last but the most important part - summarizing experiment contents and writing the patent or research articles (Figure 5).

During these processes, different materials can be refined for teaching students at different levels. For example, the raw materials and experimental conditions, i.e. about how to carry out an electro spraying experiment can be explored to teach the undergraduate students to know how to prepare nanoparticles. However, during also the same processes, the postgraduate students for Master and PhD degree can be taught to how to design the targeted core-shell products based on their past experiences on scientific studies.

It is often a real engineering issue that how to optimize the experimental conditions for creating the desired structural nano particles. For nurturing teaching on undergraduate students, the parameters about coaxial electro spraying can be imparted to them one by one, such as the applied voltage, the fluid flow rate, the particle collection distance, and also the influences of the environmental conditions. However, for nurturing teaching on the postgraduate students, the systematic investigations of experimental parameters, the interaction of different parameters, and also the comparison between electro spinning and electro spraying can be useful materials for deepen and broaden the postgraduate students’ knowledge and practice experiences on the coaxial electro spraying [19].

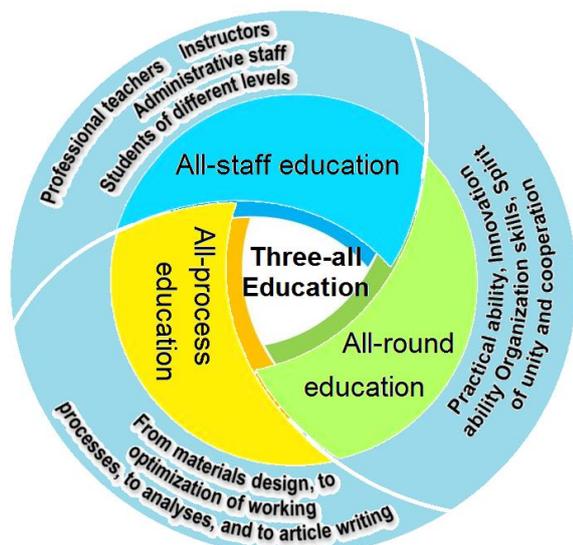


Figure 5. A schematic showing how to carrying out the “Scientific Research Nurtures Teaching” according to the spirit of “Three-All Education”

4.2. All-staff education during scientific researches for nurturing teaching

During the scientific researches, the students will contact all types of persons in the campus. These people include their supervisors, other teachers, the instructor, the administrative staff, the academic visitor, and even students of different levels and from different backgrounds (Figure 5).

Often the students’ supervisors are the mainstream for teaching. However, all the people that the students contact during the research processes can provide useful teaching on achieving knowledge and practice experiences. For example, the laboratory safety officer is very powerful in teaching the students (regardless of undergraduate or postgraduate) how to implement the coaxial electrospinning in a safe way, and keep them from all types of dangerous factors in the laboratories.

4.3. All-round education during scientific researches for nurturing teaching

Besides professional ability, a talent graduated from the university should also have the following basic professional abilities: technical ability, written expression ability, interpersonal communication ability, lifelong learning ability, logical thinking ability, practical ability, organization and management ability, crisis resolution ability, innovation ability, organization skills, the spirit of unity and cooperation and so on (Figure 5).

During the scientific researches on coaxial electrospinning, a wide variety of opportunities can be found for nurturing the above-mentioned abilities for the students. For example,

the characterizations of electrospayed core-shell nanoparticles need many expensive instruments, which are limited to all the students, for example the transmission electron microscope and the scanning electron microscope. The students can train their capability of organization and cooperation, by which samples from some students are organized together for measurements. This not only save the time and fee for conducting these samples from different persons, but also an opportunity for them to study from each other about how to prepare the samples subjected to the SEM and TEM observations.

5. CONCLUSION

“Scientific Research Nurtures Teaching” in universities is the request of the metabolism of professional knowledge renewing, the key role of professional education and the formation of students practical ability, and the abundant professional research topics as fruitful teaching materials. Under the spirits of “three-all education” by Ministry of Education in China, “Scientific Research Nurtures Teaching” can be effectively carried out based on examples of the scientific researches about coaxial electrospinning. All-process of coaxial electrospinning (such as the raw materials preparation, implementation of the coaxial electrospinning processes, analyses of the resulted products) can be useful materials. All-staff around the coaxial electrospinning including the supervisors, the instructor, the administrative staff, the academic visitor, and safety officers can take an active part in the teaching. The abilities of students such as professional and practical ability, organization and management ability, organization skills and spirit of unity and cooperation can be efficaciously trained.

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