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The "Whole-Process" Education to College Students Based on A Scientific Investigation

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ABSTRACT
The concept of "three-whole" education proposed by the Chinese government has effectively promoted the education reformations in Chinese colleges and universities. However, very limited publications can be found on the positive experiences and how to elevate this activity to a higher level. In the present study, several merits are concluded from a "whole-process" education process, which was based on a scientific study and was taught to graduate and undergraduate students. The results demonstrate that the scientific study is not only an activity that is aimed to teach the students how to carry out scientific research, but also to provoke the students' interests on learning and innovation. What is more, the "whole-process" can be efficaciously explored for elevating the students' ideological or political levels. Certainly, this "whole-process" education can be melted with "whole-staff" education and "whole-range" education during the scientific investigation.
Keywords*: whole-process education; three-whole education; scientific investigations; college students; scientific study feeds teaching*

1. INTRODUCTION

In China, the "three-whole education" is an abbreviation of whole-staff education, whole-process education and all-round education, which is put forward in the "Opinions on Strengthening and Improving Ideological and Political Work in Colleges and Universities under the New Situation" by the CPC Central Committee and The State Council.

"Three-whole education" aims to a comprehensive reform on education, which is based on the thought of socialism with Chinese characteristics, adheres to and strengthens the overall leadership of the party in colleges and universities, closely forward around the fundamental task of strengthening moral education and cultivating people. To systematically carrying out the "three-whole" education, the ideological and political work system should be linked with the discipline system, the teaching system, the teaching material system and the management system, forming a pattern of all-round education for all students (including both undergraduate and postgraduate ones) and the whole process.

In fact, the impact of "three-whole" education on the students will depend more and more on how to effectively implement it during the education processes, besides a well grasp on its concept and a full comprehension of its spirits (Figure 1). To center around "moral education" as the fundamental task of colleges and universities, a wide variety of activities or elements can be effectively explored to conduct it, such as class lessons, practice education, management, culture, scientific research, and so on. Particularly, scientific study is very useful for carrying out the "whole-process" education, and also the "whole-staff" and all-around education.

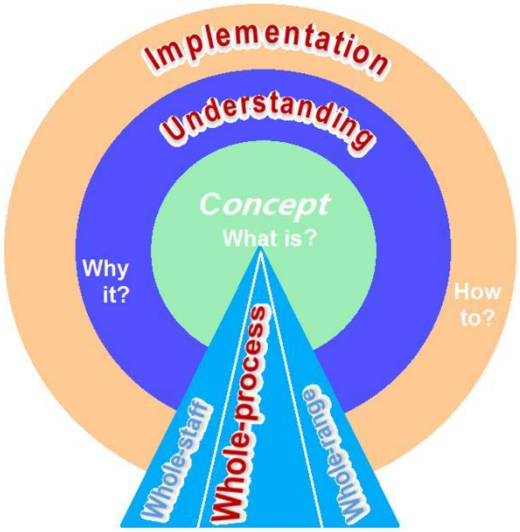

Figure 1. Implementing "three-whole education" in Chinese universities and colleges.

2. THE SCIENTIFIC STUDY FOR TEACHING THE STUDENTS TO CONDUCT SCIENTIFIC RESEARCH

Generally, scientific study refers to a series of activities such as investigation, experiment and trial production by means of scientific research and equipment in order to understand the inherent nature and movement rules of objective things, providing theoretical basis for the creation and invention of new products and technologies. Needless to say, the basic task of scientific research is to explore and understand the unknown. During the process of exploration, there are full of teaching materials that can be transferred to the students at different levels. These materials include not only those about how to carry out scientific research and the related theories, but also things can be exploited to provoke the students' interests on learning and innovation, and positive elements that are precious for elevating the students' ideological or political thoughts.

With "Materials Science and Engineering" study as an example in Figure 2, the key issues for teaching the students on how to carry out scientific research mainly include material preparation and material characterization. The former includes a series of activities such as raw material selection, material design, working methods, experimental parameters, optimization, and even after-treatment [1]. Whereas, the later includes analyses of morphology, inner structure, compatibility, physical state, stability, properties, performances and special applications [2]. These professional knowledge can be taught to the students both in the classroom lessons and also the scientific study processes, or their combinations. Particularly, a combination of scientific investigation and classroom lesson can be a more useful manner for a "whole-process" and a more efficacious knowledge converted process.

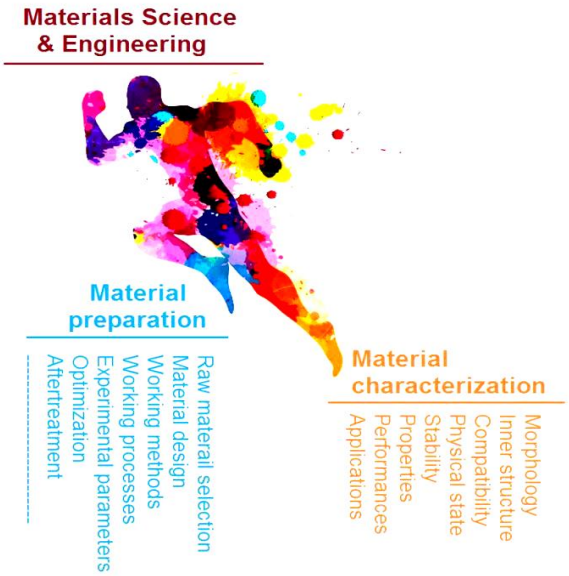

Figure 2. The key issues for teaching students on how to carry out scientific research based on the discipline of "Materials Science and Engineering".

3. THE SCIENTIFIC STUDY FOR PROVOKING THE STUDENTS' INTERESTS ON LEARNING AND INNOVATION

With electrohydrodynamic atomization (EHDA) methods for preparing new materials as examples, the usefulness of scientific investigations for implementing "whole-process" education can be clearer and more concrete. Firstly, the professional knowledge about EHDA methods (particularly the new concepts) can be taught to the students both in the classroom, such as electrospinning [3-8], electrospraying [9,10] and e-jet printing (Figure 3). And also, their developments (such as that electrospinning is divided into 1-fluid blending process [11], 2-fluid coaxial [12] and side-by-side processes [13, 14], and 3-fluid tri-layer coaxial [15] or other complicated processes [16, 17]) and working apparatuses can be explained clearly in the classroom.

Secondly, some small experiments under a scientific investigation can be arranged for the students. During the experimental processes, not only that knowledge taught in the classroom can be recalled, new contents that are difficult to explain in the classroom can be explained clearly and concretely with the real apparatus and real electrospinning preparations. What is more, the scientific experiments and investigations can be fully explored to provoke the students' learning interests about their professional knowledge.

Thirdly, during learning and practice processes, the students can be encouraged to implement the experiments according to their owns' thoughts, which often lead to astonished innovations. For example, a Master student was familiar with both coaxial electrospinning and side-by-side electrospinning. One day, he conducted the experiments with the core capillary deviated from the center of sheath capillary. This occasional experiment led to a brand-new side-by-side spinneret, i.e. the eccentric spinneret (Figure 3). Certainly, all the coaxial electrospinning and coaxial electrospraying processes can be compared for provoking new ideas [18, 19]. In a word, the EHDA-based scientific investigations can comprise an effective "whole-process" education from learning new material preparation concept, to scientific investigation practices, to comprehensive applications, and to innovations.

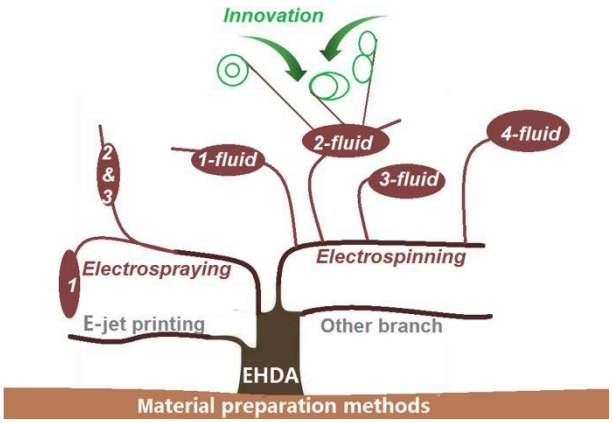

Figure 3. A diagram showing the divisions of EHDA methods, and the evolution process for "whole-process" education.

4. THE PROCESS OF SCIENTIFIC STUDY CAN BE UTILIZED FOR CONDUCTING IDEOLOGICAL EDUCATION

The students' ideological education in classroom is often dull and tedious with only language explanations. However, a scientific investigation-based ideological education can be vivid and fruitful during the whole process.

Shown in Figure 4 is a schematic showing the ideological education from the "whole-process" scientific investigation. Taking the last stage of a scientific investigation - article writing as an example, several elements of spiritual quality can be strengthened for the students.

For consideration of publication of a scientific paper, three elements must be necessary, i.e. fine innovation, enough workload, and fluent reading. Correspondingly, these elements can be useful and process materials for training the students' spirits such as innovation spirit, diligent spirit and excellence spirit. Science is art and art strive for perfection. This is just also the scientific investigation and the writing of scientific article.

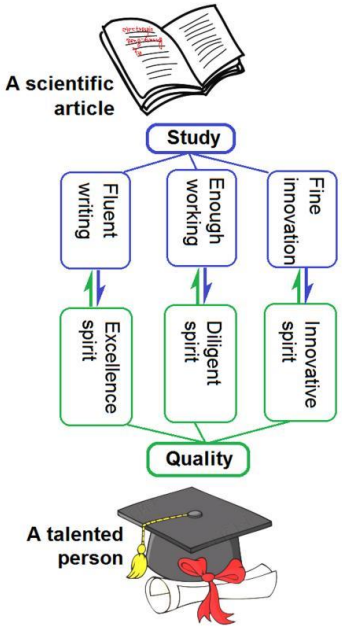

Figure 4. A schematic showing the ideological education from the "whole-process" scientific investigation.

5. THE "WHOLE-PROCESS" EDUCATION OF SCIENTIFIC STUDY CAN BE MELTED WITH "WHOLE-STAFF" AND "WHOLE-RANGE" EDUCATION

As indicated by the spirit of "Opinions on Strengthening and Improving Ideological and Political Work in Colleges and Universities under the New Situation", the "whole-process" education of scientific research is never a single element. It can be completely melted with "whole-staff" education and "whole-range" education during the scientific investigation processes.

A good scientific investigation process is a systematic training material for the students all-spirits, and a "scientific research feeds teaching" manner. Shown in Figure 5, it is obvious that the scientific investigations are full of learning, doing and thinking. These elements can be organized together for powerfully promoting the "whole-staff", "whole-process" and "whole-range" education. For example, the students can be learned not only from the teachers and their supervisors for professional knowledge, but also, they can learn knowledge of laboratory safety and management from laboratory safety and management personnel. What is more, senior and even junior fellow apprentices and classmates can all be sources for learning. Just as Confucius said, there must be a teacher in the company of three. All the contact people during the "whole-process" scientific investigation can be "whole-staff" teaching or learning, and also all-around learning or "whole-range" teaching. In a word, a "whole-process" scientific investigation can be a powerful place for implementing and melting the three-whole education.

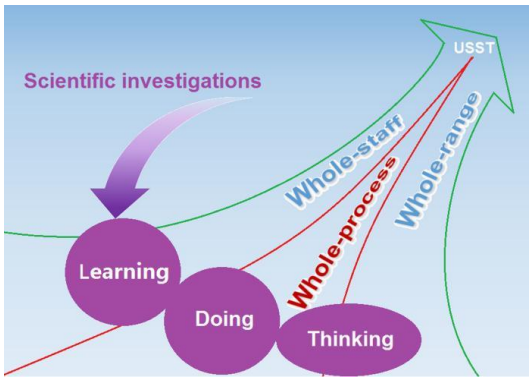

Figure 5. A diagram showing the melting of three-whole education based on the "whole-process" of scientific investigations.

6. CONCLUSIONS

Although the concept of "three-whole" education proposed by the Chinese government is familiar to all the colleges and universities, how to effectively carry out it for fostering talents still puzzles a lot of teachers. In this article, we show that scientific study is very useful for carrying out the "whole-process" education. The scientific study is not only useful for teaching the students how to carry out scientific research, but also can be explored for provoking the students' interests on learning and innovation, for implementing the students' ideological education. Meanwhile, the "whole-process" education of scientific research can be facilely melted with "whole-staff" education and "whole-range" education during the scientific investigation for training the students.

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