

Development of Professional Qualifications for Secondary Level Natural Sciences Teachers Meeting the Requirement of Vietnam Education Innovation

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Abstract Science at the moment is at the cognitive level of theoretical model associated with the technological model. Hence, it's required that the science education in common school shall select the contents in a way to meet the formation of students with the most basic, core and common knowledge; and on the basis of that knowledge, students have the capacity to apply the scientific processes and principles to make personal decisions through resolving cognitive issues and life practices. The question is that what are professional qualifications the teachers need to teach natural sciences subject in common level. The article explains the reasons why it is necessary to develop professional qualifications for natural sciences teachers. Thereby, the author develops a professional development capacity framework for natural sciences teachers. Based on this capacity framework, a number of measures have been proposed for developing professional qualifications for secondary level natural sciences teachers in Vietnam. The proposed measures aim to the fact that the teachers have a broad knowledge base, are capable of integrated teaching and deep classification teaching for career orientation; meeting the requirements of ongoing education reform in Vietnam.

Keywords: *capacity, professional qualifications, capacity development, natural sciences, education reform in Vietnam*

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1. Introduction

In order to become a teacher who is adaptable to every change, the teacher needs a continuous experience accumulation process from the university years to the end of the career. Due to the fact that natural sciences knowledge has been changing rapidly and widely influential to the social issues, the teachers should have regular opportunities to improve their knowledge and professional qualifications. The United States and some countries have developed national standards for educational science, including professional development standards for science teachers [1]. They conceive that the professional development standards for science teachers emphasize the necessity to develop the teachers not only integrative generalized knowledge in addition to broad and deep knowledge about a major, but also capacity of organizing natural sciences teaching. Students can not achieve the learning ability at a high level without access to highly qualified teachers and proficient pedagogical skills. Based on professional development standards for teachers, on the one hand, the regulatory bodies annually develop the training programs to improve teacher qualifications and

assess at what level the teachers reach the standards, on the other hand, teachers improve their professional development capacity by their own in accordance to the standards in order to meet the education innovation requirements. In addition, in a report (2013) of OECD regarding the issue of supporting the teaching capacity development in Europe, the issue of teaching capacity development includes: (1) Identify the current status of pedagogical capacity; (2) Encourage active participation of teachers in effective learning and capacity development [2].

In fact, the work of professional development for teachers in general and natural sciences teachers in Vietnam in particular has been still facing many shortcomings [3,4,5]. The professional development for new teachers only comes from patched up training classes and seminars without a continuous system from the time when the teachers was still in university to during their practice. Before each education reform, a difficult problem always set is that when there is such a program change, whether the teachers with professional qualifications adapt to the performance of that program or not? In the current education reform in Vietnam, there are fundamental innovations in the development of the curriculum of science subjects; particularly, the natural sciences is established in the orientation of integration and capacity

development of learners [6], the issue of fostering and developing professional qualifications for natural sciences teachers is a difficult problem set for teacher training institutions and educational administrators and natural sciences teachers themselves. The article has developed a professional development capacity framework for natural sciences teachers; thereby propose a number of measures to develop the professional qualifications of natural sciences teachers in secondary school in Vietnam, meeting the requirements of current education reform.

2. Content

2.1. What is The Professional Development for Natural Sciences Teachers?

Professional development, in the broad sense, is the professional capacity development of a teacher. More specifically, "professional development is the growth of the profession that a teacher achieves, is a result of mastering the experiences and experiments of teaching activities of the teacher in a systematic manner" [7]. For many years, the professional development in a temporary manner has not become a sustainable career development strategy for teachers. Just for recent years, the professional development of new teachers has been seen as a long-term process, including the regular opportunities and experiences, has been planned in a systematic manner. This change is very impressive, many adjectives are used to evaluate this concept as a "new image" of the teacher staff's regular learning, which is a "new form" of teacher education, "revolution" in education, and even "new model" of professional development [8,9].

Professional development for natural sciences teachers includes targeted, systematic and continuous processes and activities designed to gradually improve the knowledge, skills and professional attitudes of teachers; thereby will improve the quality of natural sciences learning of students. The professional development for natural sciences teachers shall begin from the training process and then broaden the knowledge base in which the core contents are the principles and processes of natural exploration. On the basis of that knowledge base, the teachers are trained and fostered in teaching Natural sciences in the direction of the formation of common, core and fundamental knowledge in the stage of basic education; Physics, Chemistry and Biology will be in the direction of professional classification in high school. In addition, the professional development of natural sciences teachers must be accompanied by the development of natural sciences pedagogical professional knowledge development as well as development of life-time learning capacity for themselves to adapt to educational reforms in different periods [10].

2.2. Why Professional Qualifications for Natural Sciences Teachers Shall be Developed

2.2.1. Function of a Teacher has Been Changed

The boom of information and communications technology has created new means of communication, broadened

learning opportunities and ability. Each person can learn in various forms according to their appropriate ability and conditions. The teaching in school hasn't been the only and primary source of information for everyone anymore. In this context, the school education still plays a decisive role, not only in the transfer of knowledge but also the sustainable development of self-learning, self-development and self-adaptation. The role of school education is to make the younger generation acquire targeted, selective and systematic knowledge. In the event the science, technique and technology has made rapid change in socio-economy that leads to a shift in value, the teachers not only transfer knowledge but also have a mission to develop emotion, attitudes, behaviors, capacity of mastering and applying that knowledge for solving practical problems of social life.

UNESCO believes that the role of the 21st century teachers has been changing in the direction of taking over more functions, taking greater responsibility for choosing educational contents, changing from the transfer of knowledge to the organization for students to act for gaining knowledge, attaching importance to the teaching in form of individual differentiation, making maximum use of diversified knowledge sources in society. They have to know to use information technology and technical means for teaching, self-study in order to constantly improve their professional qualifications. It's required to cooperate with colleagues more closely, have skills of teamwork, communication, behavior in social relationships, with parents, students, and social organizations. The teachers are needed to widely participate in the activities in and out of school... [11]. The Paris Conference on Higher Education summarizes the request for a "NEW TEACHER" that he/she shall master new information technology and communication environment and prepare psychologically for a basic change in their role". The role of teachers in modern school has been expanded, not only as an educator but also as a pragmatist in the practice of the school, social innovator and life-time learner. This suggests that promoting the professional development of teachers is a vital requirement of the school and the teaching profession as well as teachers themselves.

2.2.2. Development of Professional Qualifications for Teachers is a Continuous Process

The scientific knowledge of human beings has been constantly changing in quality and quantity. It is calculated that in the 1970s of the previous century, the human knowledge doubled in the cycle of 8 to 10 years, however, today the cycle is only about 4 years. This creates the contradiction that knowledge is taught to students at common school is not enough and quickly backward and in the future can be used little or hardly used by students. That contradiction is only resolved when, in their professional activities, the teachers not only serve as a communicator of knowledge but also those who organize, direct, suggest, arbitrate for activities of learning, exploring, help students to gain new knowledge by their own. Therefore, the teachers must inevitably self-develop, self-foster, self-train to supplement and update knowledge. In other words, teachers have to follow life-time learning for teaching career.

Professional development for teachers is considered as two periods of a continuous, life-long process of professional activity; including initial training at pedagogical universities and fostering and development of teachers during their practice [12]. In these two periods, initial training is a basis, laying a firm foundation for the gradual fostering and development of teachers later. In order to do this, the initial training must form the quality and capacity of self-study. During their practice, teachers must develop their profession by self-study including the process of detecting, recognizing the things they need for their career, then to find an appropriate learning method for self-fostering and improve their professional qualifications.

2.2.3. Professional Development for Natural Sciences Teachers Based on the Characteristics of Natural Sciences and to Meet the Requirements of New Common Education Curriculum in Vietnam

People have been currently immersing themselves in an environment of products of scientific research. These are concepts, principles, scientific doctrines; are diversified, increasingly variable and additional technological products, in which the products of natural sciences occupy the majority. The history of the natural sciences development of mankind can be divided into three periods: (1) Period of product descriptive science was recognizing, describing objects and phenomena; (2) Period of experimental science, mankind had scientific concepts, rules and theorems; (3) Period of top science, mankind established the most common and core concepts, categories, scientific principles; processes, models for world exploration and technological design; cognitive methods, universal methodological thinking. Hence, in natural sciences teaching, it's required to educate students to understand that the science is a continuous human activity that constantly changes and develops; it's needed to understand the nature of science, history of science attached with the history of scientific views, origins of science.

Today, modern natural sciences has the following characteristics: (1) The advancement of theoretical research attached with technological progress or narrowing the gap of applied inventions; (2) Trend of integrating many fields in both theoretical and applied researches (boundary between fields of science is not clear anymore); (3) Specific understanding and concepts become cause and effect. Thus, the contents of natural sciences education in the common school shall shift from the specialized knowledge in the single subjects to formation of generalized concepts that in essence reflect the most general principles of the natural world and the natural exploration ability through the integration of different knowledge and skills in the context of solving cognitive and practical issues [13]. This shift reflects the shift in the scientific development of humanity: the period of the descriptive science –period of experimental science – period of the science forming generalized models that reflect the natural principles. Understanding the natural principles, the process of natural exploration including the activities such as: observing, asking questions, stating assumptions, performing the exploring plans and reporting the results, applying such study results for practical circumstance,... are the structure of scientific capacity that

science education in modern school needed to form for students.

Therefore, the professional development of natural sciences teachers shall be based on the characteristics of natural sciences. Moreover, Vietnam's issued general common education program emphasizes on establishing the the program in an orientation of developing qualities and competencies of students, creating a learning and practicing environment to help students harmonious physical and mental development [6],... In secondary level school, the natural sciences is a compulsory subject taught from grade 6 to grade 9 with a total of 140 lessons/school year. The natural sciences curriculum aims to educate the fundamental and core knowledge that is needed for everyone as a foundation for learning, career differentiation and orientation at the high school level. In elementary and secondary school, the contents aren't differentiated early because these ages avoid the deep, narrow differentiation for students to have a unified and general understanding of the natural world. In order to meet this goal, natural sciences content will be defined as the basic principles of nature: structure, system, diversity, interactivity, mobility and variability. The specific contents shall be designed specifically based on these principles for 9 major themes as mentioned above. The contents of Physics, Chemistry, Biology, the Earth and the sky are integrated according to these natural principles. In simple terms, it is possible to understand: the knowledge of Physics, Chemistry, Biology, the Earth and the sky are evidences clarifying natural principles, materials for connection in various logics in organizing the process of natural exploration; in resolving cognitive and technological issues; issues affecting personal and social life.

With the need for innovation, the education sector in Vietnam must train and foster professional development for the teachers teaching the subject of natural sciences (called natural sciences teachers) so that they can teach through contents and curricula of natural sciences subject.

2.2.4. Professional Development for Teachers Teaching the Subjects under the Field of Natural Sciences in Vietnam Still Faces Many Shortcomings

Currently, in the common education program of Vietnam, the field of natural sciences includes three subjects: Physics, Chemistry, Biology. The teaching of these subjects is usually undertaken by three specially trained teachers. Therefore, the contents for fostering only focus on new and difficult issues in school but not yet foster the connective and integrative topics among three subjects.

The professional development for teachers in general and natural sciences teachers in particular has traditionally been imposed by macro-level administrators; failing to meet the needs of teachers by region and the needs of each level; It is still patchy and not systematic to ensure sustainable development. The process of frequent self-fostering in school for teachers is provided mainly through professional activities by groups and grades and in a way of performing the lesson units in the curriculum ; however, the fostering methods are not attractive ; The quality and effectiveness of regular fostering classes are not high. There is no no differentiations related to

objectives, content and manner of regular training for teachers in the different qualifications [14].

The set question is, in coming educational reform period, how we have to do in order to overcome the limitations and inadequacies in the work of professional development for natural sciences teachers from the direction of the education industry on this work to the perception and actual actions of the teachers.

2.3. Establishment of Professional Development Capacity Framework for Natural Sciences Teachers of Secondary School

The scientific argument for building a professional development capacity framework for natural sciences teachers is: a teacher teaching natural sciences can not fail to have a broad and general knowledge of the principles, natural processes; In addition, they must have an in-depth knowledge in a broad knowledge base. Understanding a scientific and technological major shall go beyond the scope of the scientific specialty, is a requirement of modern science and technology. Because, broad understanding with the general scope to deeply find out specialized contents and dig deeper to have broad knowledge of cause - effect, is a quality "2 in 1" of scientists; is the must-have indispensable capacity of science teachers in the high school of industrial era 4.0 when STEM, STEAM integrated education is a new educational trend.

Based on the above-mentioned views, we build professional development capacity framework for natural sciences teachers in secondary education, including the following three components:

2.3.1. Development of Natural Sciences Knowledge

- Clearly understand the nature of modern natural sciences.
- Master general knowledge with broad knowledge integration and link.
- Master in-depth knowledge in a major: Physics, Chemistry, Biology
- Design topics with broad link and intergration: (1) Group 1: topics that constitute the content of each subject (Physics, Chemistry, Biology in the field of natural sciences and History, Geography in the field of social sciences and humanity); (2) Group 2: Topics that require the application and link of multi-subject, multi-sector to study theoretical issues and solve the issues of the era such as sustainable development, environmental protection, clean energy strategy, climate change,...
- Apply knowledge of natural sciences when dealing with personal and social issues.
- Use the skill of natural sciences exploration in a proficient manner.
- Apply the process of finding out natural sciences.

2.3.2. Development of Pedagogical Knowledge

- Apply some specific learning theories of natural sciences.
- Organize the teaching of natural sciences in a way to attract the involvement of students in experiential activities.

- Apply a variety of natural sciences teaching methods, especially experimental method combined with various forms of teaching organization.

- Organize applied pedagogical scientific research on natural sciences

2.3.3. Development of Lifelong Learning Capacity

- Develop resources for professional development through existing media.
- Self-reflect on the results of teaching activities to improve the professional qualifications in the most effective way.
- Share experiences to provide professional development opportunities in the professional development community of the school and out of school.

2.4. Measures to Develop Professional Qualifications for Natural Sciences Teachers

The proposal of measures to develop professional qualifications for natural sciences teachers meeting the requirements of educational reform shall be based on the professional development capacity framework of natural sciences teachers. With the goal of supporting teachers to develop broad and deep knowledge in natural sciences as well as skills and methods of teaching natural sciences in the form of lifelong self-learning and self-development; We propose the following measures:

2.4.1. Equipment of Integrated Pedagogical Knowledge for Common Education Teachers

Today, science has developed at the level of theoretical modeling by integrating interdisciplinary and inter-field knowledge. Common education must also follow that trend. This inevitably requires teachers to have broad, generalized knowledge. Wide knowledge only understands the nature of the natural world, the nature of modern technology, which was formerly the result of integrated application of many scientific fields. Integrative education today is not simply understood as teaching methodology but as a principled approach in the common education curriculum in terms of capacity approach.

The equipment of integrated pedagogical knowledge into the teachers shall be core contents because integrated education is a means of forming capacity for students; is a positive load reduction way to enhance the knowledge quality and quantity for students; is a way of making the learning activities become active; is a basis for performing the common education program divided into two phases: basic education and vocational orientation education.

General formula [15] to form the capacity for students by integrated teaching is:

$$\text{Capacity} = \text{Knowledge} + \text{Skill} + \text{Attitude} + \text{Situation}$$

In which:

- + Knowledge is knowledge of nature , is a material;
- + Skill is the activity of intellectual processing to connect knowledge to a certain logic;
- + Attitude is a condition, psychological motivation of students to organize the application of knowledge, skill;
- + Situation is a cognitive task often expressed by questions, exercises, problems, learning projects.

Thus, a teacher having the capacity of integrated teaching is the person to know to choose knowledge, has skill to design cognitive situations to organize students to mobilize, choose to connect knowledge and skills in a certain logic to solve the problem satisfying the cognitive needs.

The range and variety of knowledge, skills to be mobilized, connected depends on specific cognitive situations or contexts. In principle, the wider the scope is, the greater the variety is, the more developed the integrated capacity of students are. The more contents the topic can include, the higher the capacity of intergrated organization is, and thereby the more active the load reduction is by refining the spreading core, eliminating fragmented information. In order to have a topic design skill that satisfies that requirement, the teachers must have broad, generalized knowledge. This is one of the reasons to train teachers the above mentioned natural principles. The teachers who have been trained in-depth a subject in the field of natural sciences on the basis of broad knowledge of natural principles have the ability to mobilize and select specialized knowledge contents to prove, clarify the natural principles and organize students to deepen the specialized contents. This is a basis for flexibly assigning a natural sciences teacher or three specialized teachers to teach the subject depending on specific conditions.

2.4.2. Professional Development for Teachers in the Context of Common Education; Establishment of a Professional Development Community to Provide Regular and Professional Support to the Teaching Staff of Natural Sciences in and Outside the School

Future natural sciences teachers should have the opportunity to become active participants in school activities through becoming student teacher, trainee and doing research. In common education schools, teachers need to coordinate with their colleagues to develop curricula, actively participate in professional and specialized training networks for trainees. The challenge in professional development for natural sciences teachers is to create situations of optimal learning cooperation in which connecting the experiences and demands of each teacher with the professional development community in each school.

Carrying out the guideline through the common education environment determines the contents, objectives and methods of training and fostering teachers. With that guideline, the common education schools shall be used in all professional development activities for natural sciences teachers. In summary, the professional development of natural sciences teachers in the field is being effectively applied in countries with developed education and the destination that Vietnam education looks forward to. The formation of community-based learning groups that jointly cooperate and share and move forward to the professional development of each individual and community is always more effective and practical than single activities of each individual in the field, which is the development trend of modern school.

2.4.3. Establishment of Professional Development Standard for Natural Sciences Teachers

In times of rapidly evolving science and technology, teachers must continuously develop their professional

qualifications for enough capacity to teach. Therefore, it is necessary to develop a set of standards for professional development for natural sciences teachers so that they can learn and develop in a lifelong manner. This is also the basis for teachers to self-assess themselves and for management levels to annually review the quality of teachers. At the same time, based on the standards, it is possible to develop training programs for students in pedagogical schools and to establish teacher fostering programs in common education level. It is also the basis to propose policy regimes for teachers. However, as stated above, the professional development for teachers is regular and continuous, hence it is not possible to divide the standards into the sub-standards for future teacher training and standards for professional development of teachers under practice. The establishment of standards should follow the purpose of linking initial training with regular fostering of in-service teachers under a process.

2.4.4. Professional Qualifications Development for Natural Sciences Teachers Must be Based on the Professional Development of the Teachers Themselves; Associated with the Regime of Preferential Treatment and Honor of the Society for Teaching Profession

Professional development for teachers in general and natural sciences teachers in particular is required to: (1) come from the objective requirements of the sector, the educational institution and other professional requirements; (2) based on the professional development demand of the teachers themselves. The top-down and bottom-up organic combination in professional development for natural sciences teachers makes the activity become balanced, harmonious and sustainable. The experience of other countries shows that when the professional qualifications development for teachers becomes their own needs, the forms of fostering will really come in handy and attract teachers to involve in a voluntary, active and creative manner. Moreover, the professional development for natural sciences teachers associated with quality improvement shall have a regime of recruiting, using, creating an environment for teachers to work autonomously and creatively; the preferential treatment and the honor of the society for the teaching profession and teachers themselves. The policies of honor of the society for the teachers are really the key to help teachers become proud of their career, thereby devoting themselves and actively cultivating and developing their career without any urge from administrative requirements.

3. Conclusion

As the contents of natural sciences knowledge have been constantly increasing rapidly and changing, the knowledge of science teachers needs to be updated continuously. Integrated education in the natural sciences has become an indispensable trend in the 4.0 revolution era, thus requiring natural sciences teachers to constantly update information in terms of theory and technological application. In addition, natural sciences teachers must participate in the development and adjustment of curriculum. All of these issues require that natural

sciences teachers shall continually develop their profession to catch up with the trend of theorizing the scientific principles integrated with modern technology. Natural sciences is the backbone field of education that meets the revolutionary requirements of 4.0 industry. STEM, STEAM education is an interdisciplinary model that addresses modern theoretical and technological issues. Therefore, natural sciences teachers must have broad knowledge as a basis for integrated teaching. To get that knowledge, teachers need to develop their own long-term professional development plans, beginning with their years in the pedagogical university, where they access knowledge and gain some experiences in teaching. After that, they experience in real situations in the first years of their class, working with other teachers, taking advantage of professional development opportunities and learning from their own and their peers' efforts. This sequential development process is reflected in the transition between the training of teachers in pedagogical schools and the generation of teachers teaching in common education level. The main responsibility for initial training is in the pedagogical schools, but the following training is from professional development community of common education schools. With regular training, the teacher community plays a major role in the professional development for teachers in general and natural sciences teachers in particular.

In order to reform the education of Vietnam in a basic and comprehensive manner with high efficiency, in addition to making plans, designing the programs, preparing facilities, etc., the teaching resources should be considered and put on the top priority, especially professional development for teachers. Professional development for natural sciences teachers shall be synchronized: assess the work of professional development of natural science teachers under the set standard; always put the professional development of natural science teachers in the context of working in schools; build community for regular support; It is based on the needs of professional development of the teachers, associated with the regime of preferential treatment and honor of the society for teaching profession.

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