A Model for Developing Professional and Methodological Skills of Science Teachers in Teaching Science

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Abstract:
In this article, the development of the model of the pedagogical activity of Science teachers has analyzed and confirmed the potential of achieving the effectiveness of continuous professional development of Science teachers through modeling.

Keywords: Science education, Motivation, Goal-setting, Conceptual, Person-oriented, Constructive, Creative.

Introduction
In the last few decades, one of the main goals of learning science courses in the world school education has been to improve knowledge and skills in Science (Holbrook J., & Rannikmae M). The teacher is one of the most effective factors for enhancing the quality of the students' achievement and their mastery in learning Science. In addition, teachers play the most important role in improving scientific literacy at all levels of education (Cakiroglu J., et.al, Demirel M., Caymaz B., Flores J. E). However, as a result of our research, we have observed that many Science teachers have less self-confidence in teaching Science. If we want to prepare literate people in Science according to the demands of the contemporary world and solve the problems related to it, first of all, we should enhance the knowledge and comprehension of Science teachers and upgrade their professional skills in teaching the subject effectively. Because the success of the reforms implemented in the sphere of improving teaching and learning of Science education depends on the continuous enrichment of the Science teacher self-efficacy (Flores J. E).

Literature Review
Thomas R. Guskey says that regardless of the perspective of teacher professional development, the outcome of the development activities is from teachers who have not changed their practice to diligently trying to take what they have learned in professional development courses to make positive changes in the classroom. emphasizes that teachers' professional development should lead to teacher change (Guskey T. R). A. A. Ibragimov said that the formation of teachers professional teaching skills at the level of modern requirements is inextricably linked not only to their basic education or attending professional development courses but also to the process of continuous improvement of their professional qualifications, which accompanies their entire activity, in which the course participant realizes the importance of developing educational programs based on needs and effective use of all (formal, informal) types of education as well as the professional difficulties and emphasizes (Ibragimov A.A.).

One of the ways to understand the teacher training process is to model it. The concept of
"modeling" refers to an epistemological category that describes one of the important ways of cognition. In a broad sense, modeling can be construed as a general form and way of representing the real world in the human mind (Loucks-Horsley S., Love N.).

Research Methodology

An equally complex object of study that needs to be modeled is to develop the methodological preparation of Science teachers for teaching Science, which remains an understudied concept.

Analysis and Results

The results of the conducted research provided an opportunity to create a model for the improvement of educational and methodical training of Science teachers and have valid evidence for describing its components. The model includes the components, such as motivational and goal-setting, conceptual, content-related, technological, and diagnostic-evaluative those are interrelated and entail each other.

All components of the development model of Science teachers' educational and methodical training are interrelated, and motivation and goal-setting serve as leading components for all other components. The social order consists of the National Curriculum, the state requirements for upgrading professional qualifications, the requirements for the quality of education in the globalization period, and the needs of educational institutions and teachers for the development of their professional careers serve as an important factor determining the purpose, tasks, main approaches and principles for developing educational methodical training of Science teachers (Ibragimov A.A., 132-135).

The main goal of the model is the constant development of a specialist based on the improvement of his educational methodical preparation. Determining the goal contributes not only to increasing the professional knowledge and skills of Science teachers according to their needs, to develop their creative and professional potential, but also contributes to teaching and upbringing of students, as well as forming their 21st-century skills.

The first stage of teacher training in the development of their teaching methodology should begin with planning and the identification of the goals to be achieved at the end of the training, which will provide a basis for how teachers should adapt to the process and the contributions to be made for their work (Ferah Özer, Nihal Doğan).

The development of professional and methodological preparation of Science teachers for teaching Science is not only the successful mastering of solving the problems of interdisciplinary integration, basic and general information, and, the content of Science. It is also related to the ability to accept and solve a certain range of tasks concerned with acquiring sufficient knowledge and improving the life skills of students in teaching, as well as the motivational preparation of teachers for this type of activity. After the training course, there is no guarantee that the teacher will be able to teach Science independently without methodological support, based on the transition from a traditional to a constructive approach. Therefore, the motivational problem is teachers' perception of the problem regarding the interdisciplinary integration, participation in the teaching of this subject as a co-creator of knowledge with students, discussing problems with them, cognition of the contexts that can be meaningful for students, understanding teaching as a personally important activity is one of the central issues in teacher training. Only motivation adequate to the goals of the activity aimed at effective teaching of Science guarantees the effectiveness of the implementation of this activity in the post-course period.

Based on the results of scientific research on the modeling of the process of improving the professional quality of Science teachers to implement interdisciplinary integration, it is determined that the conceptual component of the model consists of the following theoretical approaches and principles that are the basis for
modeling the development of teachers' methodological preparation.

Goals are determined by motives, which in turn determine dominant needs. Individuality of thoughts, creative thinking, independence in decision-making, ability to convince students of the necessity to gain knowledge based on a **constructive approach** in teaching Science, and the ability to prove - all these can be seen in the necessary activities implemented in accordance to interdisciplinary integration as a teacher. In the minds of teachers, the importance of the latter should be axiological in the process of preparing them for the implementation of interdisciplinary integration in teaching Science. **The axiological approach** is the basis for the development of teacher's professional values in the post-university education system.

The activity of teachers is unique and consists of interrelated parts. In the process of teaching Science, we relied on the **systematic and structural-functional approaches**, which are now widely covered in the science of pedagogy and psychology and have been raised to the level of a methodological principle. The structural-functional approach is defined by the methodology of the systematic approach, which is a general scientific method for analyzing and studying all factors of a phenomenon or process, including pedagogical factors. A systematic approach to the reflection of any reality is based on the concept of a system.

In building a model for developing methodological preparation of Science teachers in teaching Sciences, we also relied on **student-centered/person-oriented** and activity-based approaches to teaching.

**Person-oriented** education is carried out through activities that not only have the attributes of external compatibility, but also include cooperation with internal content, self-development of all subjects in the educational process, and the manifestation of personal qualities. The activity of the teacher is determined by the development of his personal qualities, values, socio-cultural and pedagogical experience. In the process of preparing Science teachers for the implementation of interdisciplinary integration, "it is necessary to create conditions for forming a new system of individual models of the professional activity, to acquire a fundamentally new educational experience, to revise his professional worldview, to forms a new professional attitude of a teacher."

In developing an effective professional development system for Science teachers, it is important to recognize and understand the diversity of teachers in the workforce to support their individual needs. In this sense, the professional development training programs for teachers should be differentiated depending on the background and experience of each Science teacher, as well as personal and professional goals, wishes, and needs (Mensah F. M.).

One of the methodological bases for the development of teachers' methodical training is an **individual creative approach**. The essence of this approach is that it allows the introduction of general and professional self-development mechanisms of the teacher. At the same time, the main goal of the individual creative approach is to create conditions for the self-realization of the individual, to build the author's career technology for realizing creative opportunities, professional positions, and interdisciplinary integration. In addition, the individual-creative approach includes the awareness of each teacher as a creative individual and the identification of their professional and personal qualities that require improvement and adjustment. The need to search for new means of self-expression creatively, constantly improve his professional skills, and most important motivate the professional growth and progress of a teacher.

**Andrologic approach.** Today, in the conditions of the transformation period in the education system, the development of adult education in our country, the understanding and regulation of the existing organizational forms of adult education, and the development of methodological foundations, and scientific and methodological tools are some of the most urgent issues. According to the "Belen Actions" standard, adopted at UNESCO's Sixth International Conference on Adult Education
(CONFINTEA VI) held in December 2009, states that "Adult learning and education enable people to realize their human rights. provides an opportunity to acquire the necessary knowledge, skills, virtues, and values to develop realize, and become the owners of their destiny. At the same time, adult learning and education is an absolute necessity to achieve justice and inclusion, reduce poverty, and create a just, resilient, and sustainable society based on literacy" (David Archer, Maja Avramovska).

It is important to organize Professional development courses for Science teachers based on the andragogy approach, which is the theory of adult education. That is, in the organization of the courses it is crucial to create an educational environment based on cooperation and respect, a Science teacher who is improving his skills, who respects his experiences, knowledge, mutual open communication, active participation and mutual thrive in an environment that encourages respect. A safe environment should be created where adults can exchange ideas, share their perspectives, and freely ask questions.

By organizing professional development training for Science teachers based on an andragogy approach, it is possible to create a dynamic and effective educational environment for them, develop their educational and methodological preparation, and improve teaching practice.

By taking a constructive approach in the process of teacher training, it is possible to prepare Science teachers for teaching the subject effectively and to develop the competence of creating practical and social situations aimed at forming life skills in students.

Through this approach, teachers will have a full understanding of the content of Science and concepts of interdisciplinary integration in the teaching of the subject of Science.

Bulunuz and Jarrett suggested including constructivist educational activities in undergraduate subjects of higher education and teacher training courses. Organization based on such an approach to the development of the teacher’s professional, methodological preparation can further develop not only his content knowledge but also his pedagogical knowledge. Howard, in his training, shows that for teachers, to learn constructivism and use it in their teaching career, they should participate in the constructivist process (Michelle Caton, 23). As a result of the research, it can be concluded that there is a need to increase the knowledge of Science teachers on the development of activities that include this educational approach to apply constructivism in their classrooms.

During the research, the following principles were identified in the process of developing professional teaching and methodological skills of Science teachers:

1) The process of developing the teaching-methodical preparation of Science teachers, the need for Science education in the formation of the natural-scientific view of the world in the minds of students, to develop dialectical thinking, to apply knowledge independently in all aspects for solving the problems connected with Sciences, to educate a natural-scientific literate person, to form 21st century skills in them.

2) The effectiveness of the process of developing the professional and methodological preparation of Science teachers, their motivation and cognitive interest, and the need to increase their professional level in teaching Science, depends on methodological, organizational, and technical support.

3) The effectiveness of the process of development of educational and methodological training of Science teachers depends on the unity of action of all its subjects.

4) The tasks of training Science teachers are determined according to the teacher’s pedagogical experience, professional experience, and level of knowledge in Science, as well as a specialty profile.

5) The methods, means, and forms of organizing activities in Professional Development courses are determined by the content and tasks of the training.

6) The development of professional and methodological preparation of Science teachers
depends on their understanding of the importance of learning and teaching Science based on the establishment of interdisciplinary integration between school subjects.

7) Interdependence of all components of the development of teaching-methodical preparation of teachers for implementing interdisciplinary integration in teaching Science in general secondary schools ensures achievement of results following the established goal.

Based on the above-mentioned regulations, defined the main teaching-methodical principles for developing the professional skills of Science teachers.

The following educational principles can be implemented in the development of professional and methodological preparation of Science teachers.

The principle of democratization refers to the existence of the content, types, and forms of teaching and their variety, time, and duration to develop their professional and methodological preparation based on the professional needs and interests of Science teachers. The teaching process based on the principle of democratization of Science teacher training allows us to overcome the stereotype that exists in the training system when the activity of the course participant-subject opposes the activity of the course participant-object. That is, the participant should turn from an "obedient and diligent student" into an active "co-author" and equal participant in his development. The principle of democratization ensures the possibility of professional development of the teacher in the way he wants (independent reading of educational materials, creative exercise, assignments, development of project work).

The principle of continuity is considered as a process that continuously develops the professional potential of a teacher throughout his life which is directed towards a specific goal. Implementation of this principle is based on preserving the initial professional pedagogical knowledge and skills, changing them, updating them, establishing a connection between old and new knowledge, and synthesizing them into a single, more perfect system by Jean Piaget's theory of cognitive constructivism.

The principle of differentiation and individualization. Science teachers differ from each other according to various criteria: by specialty, by the types of schools they work in, by the duration and specifics of their professional activity, by the category of qualifications, and by the implementation of interdisciplinary integration, their different motivations. These differences require the implementation of the principle of differentiation. It takes into account the needs and requirements of teachers, work experience on the problem of interdisciplinary integration in teaching Science, individual characteristics, and pedagogical knowledge of the content of Sciences, the creativity of each teacher allows organize the development of professional and methodological training of teachers following educational plans and programs aimed at enhancement.

The principle of continuity is to take into account the construction of knowledge by teachers themselves in the development of professional and methodological preparation of Science teachers in professional development organizations, in which the teacher becomes an active participant in the process, works in cooperation with teachers, and exchanges mutual experience, implies that lessons are organized based on live problems and their solution.

The principle of complexity. At the current stage of educational development, the renewal of the educational system brings about changes in all its subsystems, including the improvement of the professional skills of Science teachers. The training system itself should have advanced development, respond quickly to changes in the education system, and restructure the process of teacher training taking into account the national curriculum.

The principle of integration implies the interconnection of all components of the training process, all elements of the system, and
communication between systems. It is the leader in the development of goal-setting, in determining the teaching content, its forms, and methods.

The principle of cooperative teaching implies that in the development of professional and methodological preparation of teachers, they increase their knowledge based on cooperation in a team, solving problems together, and implementing project work in a group. Improving the effectiveness of pedagogical activity is not only to complete learning tasks together but also to study and learn in cooperation and collaboration.

The principle of demonstrability implies the organization of the educational process in a demonstrative manner in the training of Science teachers. Perception of educational materials both by listening and showing them, their conscious and thorough assimilation is the basis for their ability to use the acquired knowledge in their teaching career. The principle of demonstrability helps teachers to use demonstrative experiences in teaching Sciences to raise the students' interest, develop their abilities to use knowledge in real-life situations, and strengthen their self-confidence.

The principle of reflexivity implies critical self-analysis of teachers, the ability to identify gaps in their professional area, design future activities based on identified gaps, and elaborate their self-development techniques.

The content component provides Science teachers with the necessary scientific-methodical information and best practices in teaching Science based on interdisciplinary integration. This component includes the training program of the training course aimed at developing the professional and methodological preparation of Science teachers including the educational methodological complex the methodological support of professional development, additional materials, and methodological recommendations.

The technological component includes the forms, tools, technologies, and methods of developing the professional and methodological training of Science teachers, and based on the needs and opportunities of Science teachers provided, targeted courses and training in distance (online training courses).

The diagnostic-assessment component is important for the development of the professional-methodological preparation of the Science teachers for teaching science, to satisfy their interest and needs for the system of educational activities. It is known that students' effective mastery of science, and acquisition of literacy skills in Science depends on the level of knowledge and the necessary professional skills of Science teachers in solving the problem.

We know that Science teachers differ from each other in their scientific outlook, thinking, level of professional knowledge, learning ability, professional competence, and others. This shows that the problem of diagnostics is particularly important in the process of preparing Science teachers to teach the subject based on interdisciplinary integration.

The diagnostic-assessment component consists of criteria on the level of readiness of teachers to implement interdisciplinary integration in the teaching of Science, and the levels of activity.

The following have been defined as evaluation criteria:

- the integration of Science teachers in natural sciences (physics, chemistry, biology, geography, astronomy, economics), the completeness and consistency of theoretical knowledge in the context of natural sciences (genealogical, social, historical, research);
- high level of knowledge of Science teachers in their specialty and interrelated subjects;
- the ability to integrate natural sciences (physics, chemistry, biology, geography, astronomy, economics) in teaching science and its effectiveness;
- cooperative, collaborative, creative, and communicative abilities of science teachers;
development of teachers' constructive, organizational ability, research, and reflective skills.

Conclusion and Recommendations

Based on the observation of the lessons of Science teachers in general secondary schools, the study of their teaching and the status of professional preparation and development of Science teachers in higher education institutions and regional training centers, and the analysis of scientific-methodical literature and evaluation criteria we had an opportunity to elucidate the description for levels of assessment (Fig. 1).

**Figure 1. Description of Levels of Assessment**

Based on the above-mentioned components and their sub-components created a didactic model for the Professional development training of Science teachers (Fig. 2).

The components of the educational activity aimed at developing the professional and methodological skills of Science teachers in teaching Sciences and the methods of its practical implementation, which we have identified compose a coherent, dynamic system.

We also determined the criteria and levels of formation of this type of activity with the help of its structure. The system of criteria has been developed based on the analysis of educational and methodological literature and the results of theoretical and experimental work that is manifested in the specific characteristics that we have proposed for the level of formation of teachers' activity.
Figure 2. Professional Development Model of Science Teachers in Teaching Science
References


