THE TECHNOLOGICAL-VARIABILITY MODEL FOR PREPARING FUTURE CHEMISTRY TEACHERS FOR PROFESSIONAL ACTIVITY BASED ON CLUSTER APPROACH

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Annotation: This article explores the development of chemistry teaching content through a cluster approach aimed at enhancing professional preparation for future chemistry teachers. The study outlines the theoretical, diagnostic, and experimental methods used to establish a pedagogical cluster model that integrates educational institutions, both state and non-state, into a unified system. It defines the “pedagogical cluster approach” as a mechanism that coordinates technological and human resources within a specific region to meet the demands for competitive teaching personnel. The article emphasizes the integration of chemical knowledge with variant programs and identifies core competencies necessary for professional activity, including subject-specific skills, scientific thinking, and cultural orientation. It discusses the didactic units of chemistry education—laws, theories, models, methods, and contributions of key scientists—while highlighting the structural principles of the educational cluster, such as innovation transfer, collaboration, and resource sharing. The cluster model also supports educational sustainability in Uzbekistan and fosters a comprehensive understanding of chemical concepts in real-life applications.

Keywords: cluster approach, chemistry education, pedagogical integration, educational innovation, teacher training, scientific thinking, variant programs, chemical competencies, educational cluster.

This research focuses on the development of the content of teaching chemistry through a cluster approach, providing the necessary means for adequate studying. The research methods include theoretical (analytical-statistical, comparative-comparative, modeling), diagnostic (surveys, interviews, questionnaires, observations, developed methodologies), prognostic (expert evaluation, generalization of independent evaluations), mathematical and pedagogical experiments (statistical data processing, graphical representation of results, etc.).

Based on the views expressed in scientific literature regarding the "Pedagogical Education Cluster," the following definition is proposed for the concept of "Pedagogical Cluster Approach": A pedagogical cluster approach is a

mechanism that strengthens the integration of technology and human resources of equal and independent subjects within a given geographical area, aiming to meet the needs of competitive pedagogical staff [70].

The process of developing the methodology to improve the content of chemistry teaching based on a cluster approach includes integrating the chemical knowledge process through variant programs and the system of educational institutions in the pedagogical education cluster. These include both state and non-state organizations that serve to enhance the educational, scientific, and methodological activities of institutions.

The precise goals and tasks of the pedagogical education cluster and the integration of chemistry teaching modules in an innovative way for a better understanding of the relationship between the subject's curriculum and its application in a professional context are identified.

As is known, chemistry studies the changes in substances and their structural composition, as well as their transformation. Chemical laws and theories significantly affect the development of other related natural and technical sciences. At the same time, chemistry is closely linked to solving social problems and fulfilling the needs of both individuals and society as a whole.

In the cluster approach, preparing future chemistry teachers for professional activities involves the implementation of technological variability at educational institutions such as "School-College-Lyceum-Technikum-University" and the development of variant programs in chemistry. These programs include the development of competencies in various aspects such as:

1. Forming and developing socially important orientations in the educational process, including cultural and personal development, the importance of chemistry education, a sense of responsibility, patriotism, social mobility, and adaptability to various life situations.
2. Forming and developing subject-specific (or related to a certain profession) competencies: chemical knowledge, skills, creativity, and experience in scientific activities, as well as the ability to independently obtain chemical knowledge.
3. Formation of systemic chemical knowledge in future professional activities, enabling continuous education and self-learning.

The cluster approach in educational institutions emphasizes the integrated study of basic chemical concepts, laws, and theories, which helps students develop a comprehensive understanding of the world and their general cultural

maturity. Chemical knowledge, including substance properties and chemical transformations, enhances students' life skills and develops their ability to work in various sectors, including chemistry and chemical technologies.

Chemical knowledge is based on the study of the composition, properties, and structures of substances, as well as the transmission of real materials, and the systematic study of basic chemical concepts, laws, and theories. This process includes development through teaching, chemical experiments, problem-solving, modeling, and acquiring chemical-technical thinking skills.

The practical and general cultural components of chemical education are defined by the value of substances and the changes they undergo in human life. Understanding chemical changes forms the basis for creating and managing various fields. Chemical technologies are developing in areas such as chemistry and petrochemicals, black and non-ferrous metallurgy, building materials, light industry, food, pharmaceuticals, and agriculture.

In the context of a cluster approach, the preparation of future chemistry teachers for professional activities focuses on technological variability. The content of chemical education is directed towards helping students understand the properties of the most important substances in daily life, nature, and industry, as well as the essence of chemical transformations, emphasizing the development of a rational activity culture.

A characteristic feature of the chemistry course in the cluster approach is that, based on the materials of the subject, students gain experience in how to correctly use substances and materials from a chemical perspective in daily life. These factors help prepare students to implement the national strategy for sustainable development in the Republic of Uzbekistan.

Within the cluster approach, general methods for implementing chemical knowledge in the "School-college-lyceum-technical school-university" educational system have been defined. The concept for improving the chemistry education system in educational institutions has been developed, taking into account possible methodological solutions for teaching chemistry [Appendix 3].

At the secondary education level, chemical education should include the following: a system of knowledge in the field of chemistry; a system of skills formed during the study of chemistry (intellectual, general scientific, and specialized skills).

The accumulated practical experience in this field, based on well-formed value orientations, leads to a positive attitude towards humans and the world around them.

The aforementioned components of chemical education have been implemented throughout the entire duration of the chemistry course using the cluster approach, and the educational environment has been shaped [52].

In the context of the cluster approach, the professional preparation of future chemistry teachers is based on the scientific and theoretical foundations of chemical education content, which includes the following key theoretical concepts and laws:

Principles of the functioning of the educational cluster – is an integrated educational, scientific, and innovative process related to the economy and social sectors; it involves the coordination of the continuous education process and various levels of educational modules; it ensures educational-methodological, organizational, informational, and scientific cooperation between all subjects of the educational cluster.

Thus, in the cluster approach, to prepare future chemistry teachers for professional activities, it is necessary to integrate the basic principles of the content of chemical education with the principles of the educational cluster. E.R. Skornyakova outlines the following advantages of the educational cluster:

1. **For educational institutions**, joining a more organized system (cluster) becomes a growth point, and other organizations begin to join it.
2. The primary focus of cluster formation is on organizations, with the close cooperation between cluster members being considered the "useful" market mechanism.
3. The process of forming the cluster is based on the exchange of information among partners about needs, resources, and technologies. The cluster allows for free information exchange and the quick dissemination of innovations through various channels.
4. **Scientific-research organizations** and their relations with the cluster contribute to diversity and innovations, which are important factors for the development of the cluster.
5. The **efficient use of internal resources** by partners in different sectors (within the cluster) is of great significance.
6. The cluster plays a positive role in attracting investment to the educational system [103].

According to Ye.I. Sokolova's view, an innovative educational cluster is not simply the mechanical unification of a certain group of scientific and educational institutions, but rather it demonstrates their close cooperation and interdependence. This results in a change in the quality of the individual parts of

the cluster and the cluster as a whole, which is necessary to create a new quality product [103].

In the cluster approach, when preparing future chemistry teachers for professional activity, the technological-variability model is developed, initially based on the social order of society and the ideal or conceptual results presented in the State Educational Standards (DTS). In developing this component, we rely on the following initial principles:

1. The main goal of education is to develop the personality of the future specialist in the teaching process.
2. A high level of development of professional thinking skills is considered a key professional quality of the teacher's personality.

In our research, the content of teaching the subject of chemistry is divided into two parts: invariant and variant parts (see Figure 2.1.1).

Conclusion. The term **"Vocational Education Technology"** refers to the educational, developmental, and organizational approaches, principles, methods, techniques, and forms used to shape a person in the context of vocational education. It includes a set of social and pedagogical technologies characterized by consistency, repetition, and productivity.

References

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