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Strategies and techniques for creating educational programs for teachers of natural science subjects

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ABSTRACT

The relevance of the study is based on the current educational reforms in the Republic of Kazakhstan, which is implemented under the conditions of humanization and integration at different levels. This is based on the development of the informatization and technologization of current science and practice, the trend towards the interpenetration of certain fields of knowledge into others, the exploration of interdisciplinary approaches in explaining the current world view, which is itself multidimensional, persistent, impartial and integrative. The purpose of this study is to provide a theoretical framework, developing a model for the training of modern natural science teachers and investigate the main stages of curriculum development for future teachers. The objectives of the study are aimed at disseminating knowledge about the development of effective educational programs. Objective methods included theoretical analysis, analysis of future teachers' activities, synthesis of philosophical and educational psychology literature, modelling and observation. The study investigated and systematized approaches to the methodological design of educational programs and identified all types of professional competence using the method of analysis.

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1. INTRODUCTION

One of the constant requirements for preparing a future teacher is to be prepared for children's environmental education, and all nature conservation activities [1]. Such qualities as an environmentally friendly attitude, environmentally oriented value judgements, and social engagement organized around a system of environmental opinions and attitudes are essential qualities for natural science teachers [2]. An indicator of the high environmental culture of students of educational institutions can be the following: availability of fundamental knowledge and ideas in the field of natural sciences; establishment of a system of beliefs and values that characterize the attitude of a person to nature; ability to conduct scientific research on environmental issues using the knowledge of natural sciences; actualize the ecological importance of education and research work; the constant need to communicate with nature, to identify changes that occur in the environment, in its relation to the laws of physics, chemistry, biology, geography; the need (reasons and reasons) towards implementing a healthy lifestyle and improving the environment, as well as the aesthetic appreciation of nature [3].

The educational potential of natural science disciplines studied in higher education institutions, such as physics, chemistry, biology, and geography, is crucial in preparing future natural science teachers to foster students' environmental culture. It is important to consider the development of environmental science culture

in students of educational institutions through disciplines such as mathematics, physics, chemistry, geography, and biology. Physics is a fundamental natural science that relies on rigorous research, sophisticated mathematics, and logical and intuitive methods of knowledge generation. It offers a unique perspective on phenomena and processes, which can help explain ecological crises. One of the primary goals of teaching physics is to develop students' comprehension of the physical world and to elucidate the fundamental laws of nature [4], [5]. Chemistry results are widely used in industry as chemical reactions form the basis of many technological processes. In addition, they make it possible to understand and master the laboratory experience of the living organism [6]. A chemistry course centered around eco-logos provides an opportunity to highlight the special role of this science in combating environmental ignorance [7].

Geography is the only discipline that provides an integrated and systematic view of the Earth as a planet of people, promoting the principle of "thinking globally and acting locally". Physical geography is a fundamental contemporary science within the broader field of geography. Currently, human activities have impacted the entire planet's ecosystem, affecting the sustenance of human society. Therefore, this situation is one of the main priorities of contemporary environmental education that should be emphasized [8]. The effectiveness of the educational process is complicated by the diversity of lifestyles. Achieving this effectiveness is a complex task that requires a high level of ideological and educational skill. However, it is absolutely necessary for modern environmental education in the field of natural sciences. Biology establishes the general and special laws inherent in all manifestations and properties of life, including metabolism, reproduction, heredity, variability, and adaptation of the organism. It is a study of a more perfect and living form of matter. Ecology is founded on the evolutionary doctrine, which considers the development of evolution as a specific form of life in its interaction with nature. Evolutionary and ecological concepts form the fundamental theoretical basis of biological knowledge [9]. Biology lessons cover the general properties of living matter, including metabolism, energy and information, growth and development, dynamic equilibrium and self-regulation, species diversity and relationships, and environmental factors related to daily and seasonal changes [10].

Although the science disciplines studied in higher education institutions have considerable educational potential, they need to be further established and developed. The purpose of this study is to provide a theoretical framework, developing a coherent model for teacher education in natural science subjects. This study provides an alternative approach to developing a vocational education program in "Natural Science Education" tailored to the socio-economic and educational context of Kazakhstan. It proposes an innovative model and methodology for training science teachers.

2. METHOD

The most important method in this study was the method of analysis, which was used as a method of scientific inquiry, and also as one of the stages of the research. The method of scientific cognition provided involves a process of mentally dividing an object into its components to examine them in detail according to various criteria. In the course of the analysis, the core concepts of the study were analyzed, such as "educational programs", "natural science", "methodological system", and "natural science concepts", the structure and basic principles of the development of teacher training programs in natural science subjects, which are reflected in the sections of the study. A list of forthcoming outcomes of the material studied was also compiled, which was subsequently compared with the current outcomes.

The method of analysis allowed for the implementation of a specific research objective, namely to argue for the feasibility of training natural science teachers to work in schools on an appropriate educational program; the structure and content of the modular technology for retraining natural science teachers were also developed. The methodology for teacher training in natural science subjects on the educational program of professional training was developed and approved; the content and educational-methodological complex of the educational program was formed. The choice of technology was substantiated, which will provide the required level of the subject and professional competence of a school science teacher in the process of training.

3. RESULTS AND DISCUSSION

A modern education system requires specialists who are knowledgeable in the integration of natural science disciplines and who can elevate the level of education in the "Natural Sciences" course. However, it has been demonstrated that there have only been attempts to include a natural science course in the list of educational institutions, as there are no specialists trained in teacher training institutions to teach the subject. For instance, refresher courses only qualify chemistry, physics, and biology teachers to teach natural science, but do not address the issue of their complete and up-to-date professional education. In most educational

institutions, students study mathematics, physics, chemistry, and biology based on thematic education, following the unified state educational standard of higher professional education in the field of education "Teacher Education" with a bachelor's degree. Among the various skills that future graduates should possess, two teachers of natural and necessary sciences, specifically cultural competence, stand out: the ability to use knowledge of the modern scientific picture of the world in educational and professional activities, to apply methods of mathematical processing of information, theoretical and experimental research; professional competence in the field of teaching: the ability to implement the basic and elective curriculum in different educational institutions [11].

The positions and methods of developing educational programs for teacher training in natural science subjects have been the subject of research by Aavik *et al*. [12]. Researchers studied the influence of landscape context on morph ratio in the plant Primula veris in Estonia using citizen science data. It was found that morphemes are more likely to deviate from equilibrium in semi-natural grasslands in regions with high population density. In such meadows, the S-morph was also observed to be predominant. Smaller populations are more susceptible to generalized morph deviations. The results indicate that habitat fragmentation and anthropogenic impacts can shift morphological equilibrium in heterozygous plants. Abdulaeva *et al*. [13] studied the use of social media to enhance the learning process of future teachers. A survey of students and a pedagogical experiment using the VKontakte social network were conducted, and the advantages and problems of their use were analyzed. The results showed that social networks increase motivation, and promote individualization of learning, teamwork and continuity of the educational process. Thus, their use is relevant and promising for the organization of educational activities of future teachers. Khaled *et al.* [14] studied the impact of an epilepsy training course on the knowledge and attitudes of teachers and counsellors in Lebanese schools. A total of 73 participants completed a pre-and post-intervention survey. The results showed a positive impact of the training on understanding the impact of epilepsy on learning, seizure manifestations, psychological effects, first aid and surgical treatment options. Most participants did not show discriminatory attitudes towards people with epilepsy.

The study demonstrated the positive effect of epilepsy education among school teachers. Research by Abidin *et al*. [15] analyzed changes in the pedagogical content knowledge of future biology teachers based on concept maps. The six participants created concept maps on the topic of speciation at the beginning of their studies, after microteaching and pedagogical practice. The results showed that concept maps became more complex, meaningful and understandable. The conclusion is that the pedagogical content knowledge of future teachers changes with the experience of learning and teaching. Abós *et al*. [16] studied the motivational profiles of physical education teachers and their relationship to job satisfaction and emotional burnout. Using cluster analysis, four motivational profiles of teachers were identified based on the level of autonomous motivation, controlled motivation and motivation. The group with high autonomous motivation showed the most adaptive pattern of results. The study confirms the self-determination theory that more motivation is not always better if it is controlled rather than the development of contemporary natural science reflects the diversity of the material world through its laws and categories. To ensure the information function of natural science knowledge, its content must be constantly renewed and its composition revised depending on the level of scientific knowledge in physics, chemistry, biology, and other sciences [17]. According to the research analysis, the current content of the natural sciences cycle does not adequately expose future masters of science to the interrelation of physical, biological, and chemical phenomena, general basic concepts, laws, theories, and general methods of scientific research. As a result, future teachers may not develop a unified natural science picture of the world. In multigrade training, there is a lack of cross-disciplinary study, as biology and chemistry students do not study physics, and physics students do not study chemistry and biology.

Science education renewal involves a systemic transformation that requires exploring ways to align its content with contemporary needs. It is important to consider its role in environmental education and the modern scientific and technological progress of society. Additionally, students should be introduced to the scientific basics of modern technologies based on the progress of natural sciences. The need for revival is also driven by various factors, including the country's development, resource scarcity, changes in educational culture, societal stratification, and dissatisfaction with graduate education quality [15], [18]. As a result, the roles of teaching staff in science disciplines are also evolving. The teacher's role is not limited to teaching students how to think independently and find answers to questions based on existing knowledge. It also involves fostering curiosity and creativity based on acquired knowledge and developing a broader perspective on scientific facts. There is an urgent need to address the contradiction between the contemporary requirements for the professional training of science teachers and their current level in modern teaching institutes. The purpose of this study is to develop a concept and program for innovative vocational education in the natural sciences and the conditions necessary for its implementation in a teaching institute [19].

The study focuses on the professional training of teachers in natural sciences at a modern teaching institute. It examines the forms, methods, and techniques used to align the content of this training with modern societal and state requirements. One current trend in the construction and design of scientific subjects

is identifying basic ideas that integrate specific knowledge about nature. These ideas include the relationship between physical, biological, and chemical forms of matter movement, the interaction and transformation of metabolism, energy exchange, and the fundamental structure of the world. Additionally, the interrelationship of animate and inanimate nature is fundamental to the human concept of the world [20]. The natural sciences employ various forms and methods to attain truth. A fundamental education in this field requires mastery of physical, biological, and chemical concepts, as well as the development of a natural science worldview appropriate to the current level of development. The introduction of fundamental ideas from natural science enhances students' cognitive abilities, promotes comprehension of the learning material, and eliminates the need to memorize large amounts of loosely related information. Thus, a system of interrelated dialectical objectives develops. The objectives include increasing the scientific level of knowledge, developing the cognitive and research independence of students, and fostering a high level of morality and culture of behavior [21].

This paper therefore explores the principles of science renewal from a content, activity and axiological perspective. The approaches to science teacher education discussed here are still under development and present a challenge in the functional and structural organization of future teacher education. The issue at hand is multifaceted and concerns teacher training institutions. These institutions currently possess a significant degree of autonomy and are free to choose innovative programs and curricula [4]. The development of renewed content is based on criteria and principles of information selection and subject structure within the science cycle. It aims to create a unified approach to forming fundamental concepts, learning skills, and cognitive functions common to subjects in the natural cycle. This approach is based on activity theory. In this department, the teaching of natural cycle subjects does not always focus on forming a vision of the world through natural sciences. The models investigated in each discipline may not always align with a worldview that prioritizes the conservation and sustainable development of society and the environment. Eliminating this division and ensuring that each subject in the science cycle corresponds to its purpose in the process and outcome of science teaching is crucial for a significant renewal in the training of future teachers. The motion of matter can take various forms, including mechanical, electromagnetic, chemical, and biological. However, these forms cannot be reduced to one another due to their qualitative differences [8].

All material objects in the surrounding world have internal order and systematic organization. This order is evident in the regular movement and interaction of all elements of matter, which combine to form systems. The material unity of the world is identified through the general connection and mutual conditioning of objects and phenomena, as well as the possibility of mutual transformations of mobile forms of matter, and the mutual connection of all structural levels of matter. The theory and practice of intersubjective relations serve several objectives and functions, including coordinating academic disciplines, developing systems, ensuring continuity of learning, and fostering a scientific worldview [10], [22]. Understanding the connections and relationships between seemingly unrelated and often contradictory facts and phenomena in both animate and inanimate nature is aided by the use of modular heuristic complexes in teaching materials. These complexes are structured as systems based on the principles of integrity, structure, and hierarchy. Complexes in the form of modules implement informative and developmental functions in science education. They consider the mental development patterns of students and use heuristic methods to facilitate developmental learning. The content of a set of information for assimilation is a final product of someone else's experience, and certain actions are necessary to assimilate it. The process of this mission is conducted by the objective laws of human activity organization, in which the purposes, motives, and satisfying needs of the student are based on the systematization of scientific facts, the basic structural forms of matter, properties of bodies, and research methods [12].

The methods and techniques used are varied in both content and function. Some are described as rules for discovering the meaning of information, developing the ability to compare information and reach conclusions. Other methods and techniques focus on organizing the assimilation process rather than ensuring the assimilation of information in its tangible content [23]. Heuristic methods and techniques can help students become self-directed and provide a supportive environment for individualized learning. Heuristics are defined as prescriptions that specify strategies and tactics for searching for a problem solution. Therefore, heuristic methods are a system of rules and principles that establish the most probable rules of action to stimulate intuitive thinking and the generation of new ideas. Examples of heuristic methods include the heuristic question method, the multidimensional matrix method, and inversion methods. Heuristic methods are also widely used in education, such as debates, heuristic games, and dialogue conferences.

The second aspect of modernizing natural science education is related to enhancing the activity components. This involves increasing the level of education in basic concepts and the basic natural sciences to prepare each student for creative independence. Curriculum coordination based on interdisciplinary connections should ensure that the curriculum includes subjects that develop theoretical knowledge and

intellectual skills. The proposed research on modular heuristics, which will be implemented by students at specific experimental sites in secondary education institutions, is expected to make a significant contribution to this field. These studies may include the movement of forms of matter, properties of matter explored in chemistry and biology, characteristics of living matter, and the design of physical fields, their main types, and properties. Moreover, the organizational levels that ensure the implementation of interdisciplinary links are to develop innovative programs, tools, methodologies, textbooks, and teaching aids to enable the future teacher to establish a system of skills to implement communicative activities in school. The student designs an educational project, outlining the necessary steps to carry out the research work. Specific objectives should be included to indicate the role and place of each action, the time of deployment of these actions, their participants, and the conditions necessary for effectiveness. This will allow for the definition of the willingness of the student to implement scientific research on psychological and didactic problems. In addition, the ability to analyze educational assistance experience based on current scientific achievements should be developed. The article discusses training experience in various scientific research methods, including the enrichment of experience, scientific explanation, description, and systematization of innovative processes in the educational environment. It also covers the modelling experience of educational and project activities, as well as the basics of methods and stages of analyzing results of scientific research in education [24].

The third aspect of natural science education is establishing the student's values. This involves establishing a set of values for communicative activities that a future teacher should possess. This set is based on values-knowledge, which determines students' understanding of the relevant conceptual and terminological framework of natural science subjects, and values-qualities, which encompass many interrelated and complementary qualities of a future teacher's personality. The second component is value relationships, which encompasses the entirety of the relationship between students and teachers, as well as each individual's internal perception of themselves and their learning and cognitive activities. This is considered from psychological, informational, and functional perspectives. Therefore, it is possible to identify a sequence of implications [15], [25]. The first component is value-based knowledge, which is considered an information-education domain where learning can be managed. The second component is value-based knowledge functioning, which extends the information-education field in space and time and helps to establish students' vision of the natural science world. The third component is value-based transfer of knowledge, which involves the student's entry into the information and education area and engages them in evaluating and processing information from internal and external sources. This component also considers psychological aspects such as the ability to communicate effectively, independently process information, and utilize various sources of information. The natural science worldview, based on values, is the ultimate and highest achievement of science education.

The analysis of the current state of future teacher training in science subjects suggests that professional training primarily focuses on establishing the value of knowledge and its application in students. The remaining two sets of values are entrenched in the science education system [26]. The main outcome should be a set of socially relevant values based on the disciplinary structure of science education. To effectively manage the monitoring and evaluation activities of teachers and the self-monitoring of students' learning activities, a special measuring technology must be constructed. The methodological basis for establishing such a quality assessment technology is the transition to the concept of natural sciences disciplines as contributing to student development in an axiological aspect, establishing on this basis the worldview of natural sciences [27].

The production of science in developed countries necessitates specialists with a high level of professional culture and an established innovative mindset. Basic and multilevel training in the natural sciences is essential in today's technology-driven world. The analysis of the current system of higher teacher training in natural sciences has revealed significant external problems related to its modernization. These include the insufficient level of basic training for science education specialists, decreasing results of the unified state examination for graduates of general educational organizations, the need for school specialists with new innovative ideas in science education, and the shortage of teachers. Additionally, scientific programs of the department of natural sciences for innovative educational organizations have been identified as a concern [24]. Therefore, the modernization of higher vocational teacher education should result in an updated system of training for natural science education that meets the societal requirements for teaching staff in public higher vocational education institutions.

The innovative teacher training approach in science education aims to promote smooth interaction between new teachers and creative schools, encouraging the development of a higher standard in teacher education within the competitive field of natural sciences [12], [28]. To achieve this, it is necessary to understand the individual needs of scientific educators in different regions who possess innovative thinking and research skills, and to develop customized training programs accordingly. Developing a comprehensive educational program supported by a cohesive information management system and matrix organizational structure is crucial for successful natural science education and producing significant social effects. It is

essential to create distinctive educational curricula for the next wave of teachers, with a focus on promoting innovation in the evolving Russian school system and economy. Developing methodology and technology that incorporate research-based approaches is crucial for nurturing naturalists ready to engage in creative projects. Creating a dynamic educational setting that fosters socially responsible individuals who can contribute to an economy driven by innovation through high-quality science education is a key goal. A regional interdisciplinary center has been established in Russia to integrate natural sciences, education, analytics, and consulting. It serves as a cornerstone for Russia's shift towards an innovative developmental path, providing both theoretical insights and practical contributions to this transformative process [23].

The preparation of future teachers in the natural sciences requires methodological integrity. This includes understanding regularities and socio-educational fundamentals that define the importance of socio-educational interaction and the need for a space for learning about new school systems [29]. It also involves understanding basic concepts and construction principles for building a methodology and system, as well as a theoretical model of the professional training system for future teachers in this context. In addition, it includes the stages of the innovation process and the conditions for its implementation. The methodological and theoretical foundations for developing the innovative system for training future teachers in the context of science education are based on the general social design theory [30].

The methodological model of teaching degrees and masters was fully explored through the idea of integration, which considers the study of the object of the interactive search. The methodological training of bachelors and masters was considered as a systematic and central link in the entire organizational structure of the educational process in a teacher university. The methodological training of masters was improved through a comprehensive approach, achieved by selecting cycles and content of disciplines, and elective courses presented in three units: basic, theoretical, and practical. The basic unit comprises the methodological and theoretical foundations of methodological training, establishing the strategy and tactics for its development. The theoretical unit covers the main provisions, the structure of methodological education, and the model of methodological competence development. The practical unit is based on a methodological training package and its implementation mechanisms, with the idea of continuity allowing the concept to be implemented in several phases. The methodological training of graduates and teachers typically involves three main stages: theoretical training, practical training, and self-education and self-development. It is important to note that these stages are sequential and build upon each other.

In order to implement and concretize the ideas and schemes of this project, some conceptual issues will be considered. As part of the education system in a teacher training university, natural science specialists should develop their skills based on cultural paradigms and generally accepted humanities education [31]. This implies that the transition to person-centered, professionally-oriented training should reflect not only the main trends of school education in biological, chemical and physical sciences, but also ensure that national standards are implemented and focus on the strategic purpose of enhancing the intellectual potential of the younger generation. The theoretical model used for the professional training of teachers in natural sciences is based on a systematic, multilevel, and universal approach. It serves as a guide for the methodological implementation of the system of training students in experimental conditions. The model can provide a means of achieving the learning objectives with integrity, complexity, and success. To ensure a coherent development and specific implementation of ideas in educational practice, it is necessary to develop a methodical system of teaching and the conditions for its implementation. The design of the methodological system should be based on scientific concepts and theoretical models. It represents a gradual development, a shift in the components of this system to achieve the desired outcomes. The process involves purposeful, project-based, procedural, and efficient aspects. Systemic approaches and individualized activities are used to manage the process rationally and flexibly. A methodological system is used to perform research and implement the principles outlined in the concept. It provides a dynamic model for implementation under certain conditions. A specific methodology for enhancing methodological training at different levels of student education, based on its design, will allow for the practical implementation of the concept and the methodological system [32].

The methodological aspect of the concept is identified by substantiating the essence and forms of improvement of methodological training of students of educational institutions with a certain educational complex, educational sphere, scientific discipline on the basis of the educational standard [33]. The systemic nature and functional significance of methodological training in the context of scientific education are revealed. In terms of the study's limitations, it is important to note the scarcity of research on effective approaches and methodologies for science teacher education, particularly in the context of Kazakhstan. Furthermore, the traditional system of higher education has limitations in teacher training, which hinders the adequate preparation of teachers for teaching science in secondary schools. These limitations suggest areas for further research.

The framework includes valid approaches to purpose, content, activities, and effective characteristics [34], [35]. An innovative approach to professional training for teachers in natural science education has resulted in several activities. These activities involve defining concepts, laws, and theories common to all science disciplines and establishing the sequence for distributing their content. It involves ensuring that common concepts are interpreted consistently across subjects, while also highlighting their unique functions in each discipline through specific structural forms of organization and study methods. Additionally, there is a focus on maintaining continuity in establishing and developing basic concepts in natural sciences, as well as general pedagogical and cognitive skills. The approach identifies ways to present physical, biological, and chemical phenomena and recognizes the impact of these processes on the development of living organisms. It involves revising academic content to reflect recent scientific advancements and incorporating the biological significance of physical and chemical processes in the lives of living organisms. The approach involves improving methodological training for graduates and teachers in natural science education. This is accomplished through an integrated methodology that combines methodological ideas, approaches, and principles, taking into account contemporary trends in higher education development and drawing from both domestic and foreign experiences [36].

The results obtained in this study are consistent with previous research on effective approaches to science teacher education. Specifically, previous studies support the significance of developing fundamental concepts, conducting research activities, and utilizing heuristic methods. This paper's model incorporates unique features and considers the context of Kazakhstan. Certain units, namely basic, theoretical, and practical, can be identified through scientific analysis. These units serve as the motivating components of the innovative model for future teacher professional training in the context of natural science education. The model consists of five components: objective, motivational, substantive, procedural, and effective. This study presents a methodology for training natural science teachers in the Republic of Kazakhstan using this contemporary method. The need to address the issue of teacher training in natural science subjects in schools in Kazakhstan arises from the severe lack of professional training in this field in higher education institutions. The training of these professionals within the higher vocational education system is now restricted to certified professionals only. The lack of development in science teacher training for secondary schools, coupled with the limitations of the traditional teacher training system, has led to the provision of an alternative approach to training through a vocational education program in the field of “Natural Science Education”. This design was implemented based on the socio-economic and educational characteristics of the Republic of Kazakhstan, which were taken into consideration during the development of this study.

In the 21st century, teachers have become more generalist in nature. They possess knowledge of both humanities and sciences, as well as related and unrelated disciplines. They are able to understand different professional languages and participate in interdisciplinary interactions. This enables them to deal with complex objectives and progress professionally in various fields of practice. Professionals in education should receive training in both secondary and higher education [37]. As such, new requirements for the training of teachers are emerging. The modern era emphasizes reflexive approaches to knowledge acquisition. It is no longer sufficient to simply delve into a field; one must also understand the subtleties of its structure, areas of progress, and ways to integrate with different forms of knowledge. Any subject teacher should possess at least slightly more knowledge than a multi-subject teacher. In the case of scientific knowledge, specifically designed teacher training is necessary. The effective implementation of current scientific knowledge requires organizational techniques for gradually identifying and including elements of natural science in the teaching of general subjects. Teachers should identify the natural science concepts that are fundamental to the curriculum and design appropriate educational activities around them [38]. They should also conduct an initial examination of the students' readiness and then, after the system of teaching has been completed, they should examine the results obtained by the students and adjust the supplementary methodology.

This study considers the principles and methodologies for developing programs to prepare science teachers for secondary school work, with the aim of developing the basic skills teachers need to work in today's environment. An analysis of the information reveals that only a minority of teachers are aware of this innovation in education. The research has identified the problem of providing teachers with the necessary skills to implement the meta-disciplinary approach in the educational process. This problem can be addressed through teacher training in system refresher courses. As part of the natural science approach, the teacher should provide demonstrations of methods for the rational use of brain reserves and handling naturally occurring information. Opportunities for the student to learn independently and to move from passive forms of language (reading and listening) to active forms, such as speaking and writing. The professional development courses for science teachers implement both the theoretical and applied components of the meta-subject approach. Teacher training in meta-analysis is of practical importance.

This study presents a theoretical foundation and proposes a model for training modern science teachers. Specifically, it investigates the main stages of curriculum development for future science teachers and identifies the principles and methodologies for creating effective science teacher training programs based

on a literature analysis. A proposal is made for forming a community of fundamental concepts in natural sciences, organizing students' research activities, and integrating heuristic teaching methods into the training of future teachers. This will enhance the effectiveness of curricula and the quality of teacher training. Through an extensive discussion of the study's findings, the authors make multiple inferences that their proposed integrated approach to training science teachers will address limitations and improve upon traditional teacher education programs in Kazakhstan. Although statistical analysis is not directly presented, the author's framing of the current system's deficiencies, the expected benefits of their theoretical model, and the presentation of their methodology as an advancement over existing rigid programs imply that their innovative methodology will enhance the quality and effectiveness of science teacher training. These inferences are supported by the study's goals, literature review, and conceptual framework. In essence, the author suggests that their approach is a necessary advancement to transform science teacher education in Kazakhstan.

The study is limited by the lack of research on effective approaches and methodologies for developing science teacher education curricula, particularly in the context of Kazakhstan. Furthermore, the current teacher education system has limitations in adequately preparing secondary school science teachers. This study proposes an innovative approach to developing curricula for science teacher education in Kazakhstan. The proposed model considers the specific needs of the education system and has the potential to improve the quality of higher teacher education in natural sciences. The results have significant theoretical and practical implications.

4. CONCLUSION

This study introduces a novel methodology for training natural science teachers in Kazakhstan. The need for this approach arises from the absence of sufficient professional training programs in higher education institutions, which currently limit specialized science teacher education to certified teachers only. The limitations of traditional teacher training models underscore the need for reforms. The methodology proposed is customized to the socio-economic and educational context of Kazakhstan. It presents a theoretical foundation and model for the preparation of modern science teachers based on a systematic analysis of literature and best practices. The model includes key components such as objectives, motivations, content, procedures, and intended outcomes. The methodology's core aspects include integrating physics, chemistry, and biology to develop scientific worldviews, aligning content with contemporary requirements, fostering value-based education, and incorporating active learning approaches. The curriculum aims to develop communities of core concepts, organize experimental research, and integrate heuristic methods. This is expected to enhance student engagement and learning. The study contributes to scholarship by addressing a significant gap in research on effective science teacher education, particularly in Kazakhstan. It presents a strong framework and model for training programs that are tailored to local needs. This has significant theoretical and practical implications. The methodology presented in the study has the potential to revolutionize science teacher training if implemented correctly. The integrated, innovative, and value-based approach can equip teachers with the essential knowledge, competencies, and skills necessary to provide high-quality instruction. This approach can also overcome existing challenges in the preparation of science educators. Further empirical testing of the proposed methodology through pilots is recommended to refine the model. Teacher training institutions in Kazakhstan should consider adopting this approach to reform science education and meet the evolving needs of schools and society. With sufficient support, this methodology can develop competent and passionate science teachers.

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