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Didactic Foundations of Ecologization of Chemical Education in Higher Education Institutions

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ABSTRACT: The study addresses the need to enhance the didactic foundations of university-level chemical education by incorporating ecological principles. Its purpose is to develop a model that fosters ecological thinking among students. The primary research method used is diagnostic analysis. The article introduces a model designed to instill environmental values in students. This model evaluates the impact of chemical disciplines on environmental factors such as air, water, soil, atmosphere, climate, and vegetation. It employs cognitive and informational criteria to analyze and model responses to questions about these interactions. This study addresses the need to enhance the ecological focus in chemical education at universities by developing a didactic model that fosters environmental thinking among students. The research aims to create a framework that integrates ecological values into chemical disciplines by examining their impact on natural components such as air, water, and soil. The diagnostic method was used to design and test the model, which emphasizes cognitive and informational criteria. Key findings demonstrate that this approach helps students understand the environmental implications of chemical processes, equipping them to apply this knowledge in their future professional activities. The results highlight practical strategies for integrating ecological awareness into higher education curricula.

Keywords: chemistry course; didactic foundations; ecological thinking; higher education.

I. INTRODUCTION

Currently, in the field of education, its modernization is observed from the standpoint of the environmental orientation of the studied knowledge, so the interaction between human and nature becomes closer and more important for students to understand it at a deeper level, based on the importance of preserving the environmental factor, depending on the application of the scientific component of disciplines in various areas of providing and production [1]. Ecologization in education will allow students to form ecological thinking, which will direct their motivational messages to intensify actions in the framework of nature and ecology conservation. Chemical education at the present stage of development of society plays an important role in comparing the facts of the natural-science part of life, where many processes in the environment that have a great influence on human life and the world around are explained from the chemical point of view [2]. Also, the factor of various chemical technologies largely affects the natural level of the environmental component, changing it through the insertion of various chemical elements, reactions, and processes, which in turn change the natural structure of natural objects when interacting with the developed chemical elements, and this determines the great role of chemistry in human life, and therefore all scientific research in this area must proceed from the position of preserving the environment, and for this, it is necessary to create a base of chemical knowledge that would allow providing humanity with the necessary things against the background of preserving the natural environment and atmosphere [3]. Thus, the discipline under consideration is relevant in the ecologization of the revision of the methodological component of the educational process, in which, by improving the didactic foundations towards environmental safety, it will allow presenting the theoretical and practical part of chemical education at the level of preserving and restoring the environment [4].

The study of the factors that exist in chemical education that affect the environment, and the reorientation of this towards the restoration of the ecosystem, will allow students to initially receive chemical knowledge from

the standpoint of environmental safety. The didactic foundations contain the moments of studying the influence and from the reverse, which will allow us to talk about the currently existing chemical components, and as part of the revision of knowledge dictated by the ecologization of the educational process, there is a need for a detailed study of the environmental impact of existing chemical technologies from the perspective of considering their impact on the natural environment based on the conditions in which they operate with the positions of determining the intermediate and final result with the basis of environmental safety as an early, and the long-term period, taking into account the existing level of accumulation of various substances in natural environments [5]. So the study of the full-fledged process of applying chemistry in practice will make it possible to revise its cognitive part for studying it in higher schools at the level of obtaining chemical education, and there should be a change in the pedagogical orientation towards environmental safety of presenting the knowledge that currently exists within the framework of the chemistry course based on their practical application, which will allow creating a course based on chemical capabilities with a priority of their application in practice, taking into account the preservation of the environment [6].

Considering that the educational environment depends on the level and position of studying the information component of the discipline and this allows students to form their thinking, in the field of colorization under consideration, it is important to initially purposeful study of chemistry, taking into account the allocated knowledge that carries environmental safety when applied in practice in various industrial, technological spheres of human activity. The reference point to the position under consideration will allow us to identify the main didactic directions for the successful and relevant colorization of chemical education in higher education schools. This study aims to address this gap by developing and testing a didactic model that reorients chemical education toward ecologization. The primary objectives are to:

1. Analyze the factors within chemical education that influence environmental sustainability.
2. Develop a framework that integrates ecological safety into the theoretical and practical aspects of chemical curricula.
3. Equip students with the knowledge and skills necessary to apply chemical principles while prioritizing environmental preservation in their future careers.

The study's focus lies in transforming chemical education at the university level into a discipline that not only conveys scientific knowledge but also instills ecological values. By creating a pedagogical approach grounded in environmental safety, this research seeks to provide students with a deeper understanding of chemistry's role in both environmental degradation and restoration. This reorientation aims to ensure that students are better prepared to address ecological challenges in industrial, technological, and other human activity spheres.

II. MATERIALS AND METHODS

This study employed a diagnostic testing method to explore the motivational and cognitive factors influencing students' ecological thinking within chemical education. The research utilized a qualitative approach supplemented with quantitative analysis. The study was carried out using the method of diagnostic testing developed by I.S. Dombrovskaya "Motivation of educational activity: levels and types" using criteria that can determine the motivational set of actions, aimed in turn at the influence of the social part of life from the standpoint of its various relationships with the outside world in the framework of its preservation, based on one's future personal and professional influence on the environmental component, as well as external circumstances in the framework of the use of knowledge of chemical disciplines in a safe environmental direction, based on the presence of an internal need for this among the respondents.

Testing contains 30 statements showing emotional attitudes to various components of life, among which there are positions reflecting attitudes in nature and the preservation of the social component of well-being, which the subject after the study analyzes and notes the level of their importance based on the degree of personal interest in this, as in the manifestation of the considered characteristics with influence on the life around him, and based on personal interest in knowing the factor of this influence on the personal component. The noted criteria will make it possible to predict the direction of life activity based on the internal guidelines of value and educational motivation, which will allow, if necessary, to correct the data in the direction of ecologization the perception of the information component of the chemistry course within the framework of the educational process, which will be expressed at this stage in manifestation at the level of psychological reproduction of the personal behavioral reactions of the researcher, which in their totality make it possible to identify the level of the purposefulness of

cognitive motivation and its social definition in the context of the environmental safety of applying the knowledge of chemical education [7]. After counting and analyzing the answers, the results of diagnostic testing were systematized, and the data was calculated using ready-made keys that made it possible to determine the level of the cognitive and social motivational component from the standpoint of personal interest in the application of environmental safety.

Given the data, facts, and methods, it is a reliable and valid tool for studying motivational and psychological aspirations manifested in the appropriate creative behavior to preserve the environmental component, which is necessary for the subsequent creation of a model of didactic foundations for the ecologization of chemical education in teaching at higher schools.

We used a standard method of mathematical calculation and graphical representation for the overall study results. The pedagogical experiment was conducted based on the Abay Kazakh National University, the Republic of Kazakhstan. Diagnostic testing was conducted among 92 students of 2-4 courses of the university in the age category of 19 to 26 years. This problem was investigated in three stages. In the first stage, a theoretical analysis of the existing research and methodological literature on the problem under consideration was carried out as part of the development of a model for the formation of didactic foundations for the ecologization of chemical education, where the study identified the problem, purpose, research methods and created a plan of experimental work. In the second stage, diagnostic testing of students was carried out and experimental work was done with the analysis of the results and the conclusion formulation. In the third stage, the correctness and completeness of the conclusions were clarified and the results of the pedagogical experiment were systematized. The study was conducted in three stages:

1. Theoretical Analysis: A comprehensive review of existing research and literature was undertaken to identify gaps and formulate a research framework. This phase included the development of a model for integrating ecological principles into chemical education and creating an experimental plan.
2. Diagnostic Testing and Experimentation: The test was administered to 92 undergraduate students (aged 19-26) from Abay Kazakh National University, Kazakhstan. Participants were drawn from the 2nd to 4th-year cohorts. The testing evaluated the students' ecological motivations and cognitive orientations. Results were processed using standardized scoring keys, which identified levels of cognitive and social motivation related to environmental safety.
3. Result Validation and Systematization: The findings were analyzed to ensure reliability and validity. Standard mathematical and graphical methods were used to summarize the results, and conclusions were refined to develop the didactic model.

III. RESULTS

With a systematic and analytical approach in carrying out this experimental work, the data obtained as a result of diagnostic testing of the studied students were analyzed, and taking into account the elements reflecting the respondents' personality indicators, such as value-motivational and performance indicators, a detailed analysis of the identified characteristics of their personality was carried out, including a set of values of motivational elements with taking into account their influence on the prosperous component of social life with respect for nature with the prerequisites for environmental safety in personal and professional life. This will make it possible to draw a conclusion about their predisposition based on the presence of internal psychological qualities that will be expressed in their attitude to maintaining the ecological balance in their future professional activities in the framework of using the knowledge and skills acquired in chemical education [8]. Environmental safety in the direction of penalties from the information part of the discipline of chemistry allowing initially form skills at the discipline level based on the factors of conservation and restoration of the natural component of ecology in its natural manifestation when using various chemical technologies, research, development, which significantly raise the level of quality of life, but with taking into account their use while maintaining ecological motives of thinking, which will manifest themselves on the basis of personal intellectual-behavioral and emotional properties, and so this fact, when considered, refers to the motivational-target direction in terms of the social aspect of the impact on life, which will be reflected in general on its prosperous development and course, and taking into account the considered ecologization in this fact of studying the chemical field in the prevailing emphasis, the prerequisites for environmental values will be identified, which will be laid down at the level of education among students, forming in them an ecological thinking that will allow them to build their future

professional life, taking into account the influence knowledge of chemistry at the level of environmental safety [9].

The course of chemical education provides extensive knowledge that is used in many areas of production and human life, where professional activity itself is considered as a complex system that combines many factors and elements of different sets of actual theoretical and practical knowledge of the subject in interaction with its influence on other areas, which in general will have the value of ecologization, provided that the natural structure of natural objects, parts, elements is preserved, which in turn have a direct impact on human life, its prosperous component, taking into account the fact that human life proceeds and depends on the considered environmental safety in preserving nature, in its natural form of manifestation, as air, water, earth and other objects in which a person lives, fulfilling his physiological cultural and everyday needs necessary for life at the level of its natural course, which imperceptibly affects his existence, health in the conditions of finding natural spheres based on the degree of the ecological state of these natural factors, which, only if the ecological balance is maintained, can create conditions for a prosperous human life, which is the priority of all the main tasks that any sphere of production, science, education sets itself, taking into account the preservation of a successfully developing prosperous life [10]. Thus, the environmental safety of all elements of chemical education will generally preserve the above at the level of restoration and preservation of the natural ecological balance, and a detailed analysis of the test allows determining the main parameters and predict further results about students' perception of the process of ecologization of chemical education for further use of the knowledge of the chemistry course, taking into account their environmental safety, and with the formation of environmental thinking at the level of development of valuable environmental motivations [11]. Also, with the help of pedagogical observation and clarifications, prerequisites were created that made it possible to determine the boundaries of a more detailed understanding of environmental safety for students at the level of their perception with an understanding of how chemical knowledge in the general component affects the environment. The research indicates that the ecologization of chemical education can significantly impact students' intellectual and emotional development. This aligns with calls in the literature for integrating sustainability into educational practices to prepare students for addressing complex environmental challenges. The findings suggest that embedding environmental thinking into the curriculum enhances students' ability to apply their knowledge in ways that preserve ecological balance. Furthermore, the study highlights the importance of practical exercises, such as diagnostic testing and pedagogical observations, to assess and refine students' understanding of environmental safety.

These components of the study, in interaction, reveal the organization of the process of forming a model of didactic foundations for the ecologization of chemical education among students when studying at higher schools, from which highly qualified specialists come out and, based on the effectiveness of their work, significantly affect the level of the ecological state of the planet. The result of the study under consideration is the level of formation of the model of didactic foundations for the ecologization of chemical education in universities.

Research work with the created model of didactic foundations for studying the disciplines of the chemical field was introduced into the educational process in several stages, which involved determining the initial level of attitude, interest, and motivation in the study of chemical knowledge and the social prerequisites for their use in diagnostic testing, pedagogical observation and clarifications necessary for respondents, as well as further statistical processing of the results. In the next stage, there was the development and implementation of parameters for the development of environmental thinking based on the use of knowledge of the chemical field within the framework of environmental safety at the level of the formation of a model of didactic foundations for the ecologization of chemical education for its subsequent implementation in the field of practical education.

Thus, the study covered 92 students who studied a chemistry course at a higher educational institution, and the analysis of the results of diagnostic testing made it possible to conclude the degree of manifestation of personal cognitive motivation and the severity of social motives. Cognitive motivation, which is responsible for the desire to learn new things, shows internal aspirations for self-improvement of one's knowledge, and reflects a deeper understanding of the laws and phenomena of the chemical discipline was found in the majority of students (64.1%) at an average level, high and low levels, respectively, were determined 22.8% and 13.1% of respondents. In turn, the values of the severity of social motives differed significantly from educational motivation, and so the high level of its significance, which shows the desire to fulfill one's professional duty with an existing sense of responsibility for one's work, including for influencing the component of society in which ecology, in including occupies its niche was determined in 20.6%, the average level of formed internal awareness of their future professional activity in the framework of maintaining a prosperous component of life was

determined in 42.3% of students, the remaining 37.1% showed low indicators of social motives on a personal level. The identified indicators are shown in Figure 1.

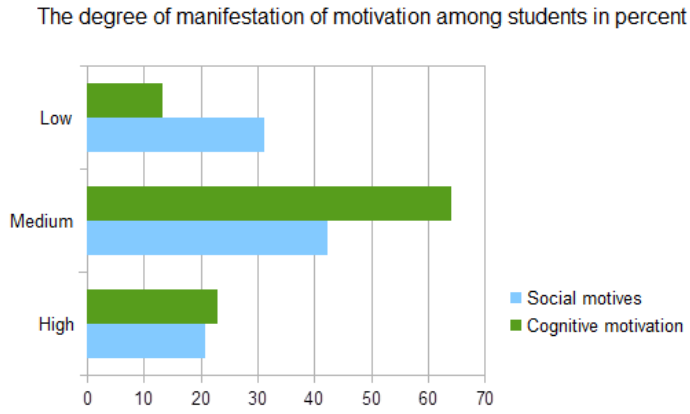

FIGURE 1. Distribution of students according to the degree of cognitive and social motivation after diagnostic testing.

A detailed analysis of the test results and pedagogical clarification on the importance of observing environmental standards during their future professional activities, which will ensure environmental safety in general, was determined at a level that showed that only a third of the respondents are consciously related to the restoration and conservation of the environment, and understand the importance of developing their scientific and active part of the work by studying the course of chemistry from the standpoint of ecologization, which will allow them to carry out their professional activities at the level of environmental safety in the future, as shown in Figure 2.

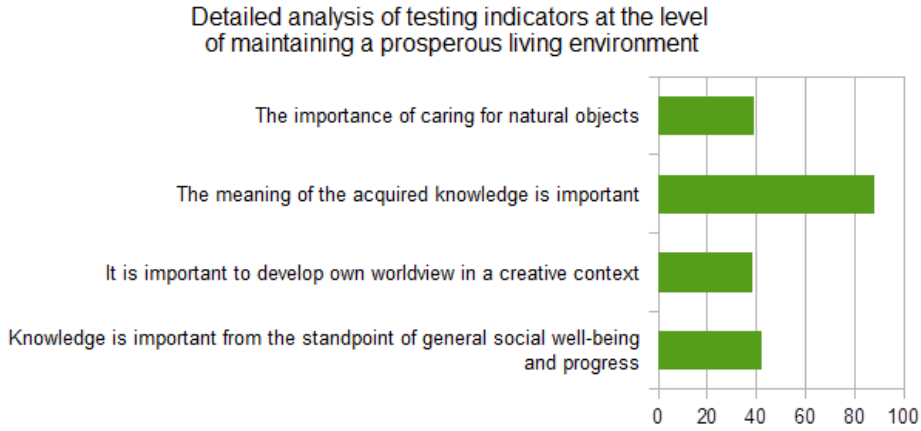

FIGURE 2. Distribution of students according to the severity of testing indicators based on the preservation of a favorable component of the living environment.

Taking into account the analysis of testing, it can be said that during the ecologization of education, didactic foundations should be developed in such a way that students understand the essence of the influence of the informational chemical component with its full impact on the environment, on which the prosperous life of society depends [6]. It also attracted attention that only 39% of respondents consciously understand the importance of preserving natural objects in their natural form, and this fact will be the basis for the environmental safety of applying the knowledge of the chemistry course. Also, during a conversation with respondents, when their attitude to nature, life with a focus on the well-being of society was being clarified, it was found that many

do not realize the dangers in violation of the ecological balance and the impact of chemical technologies on the natural habitat, nature and life in general, when well-being, which depends largely on the conservation of ecology. Thus, the results of the analysis and pedagogical clarification showed that only a third of the studied students have a sufficient level of understanding of the importance of observing the environmental safety of knowledge in the field of chemistry, possessing environmental thinking, on the basis of which they are able to make a positive contribution against the backdrop of caring for nature and the ecosystem.

The implementation of the research conditions in the process of developing a model of didactic foundations for the colorization of chemical education with the formation of ecological thinking required methodical work on the data obtained during the pedagogical experiment. A step-by-step analysis of the results made it possible to single out the main components of this process and determine the main ones, depending on the level of formation of environmental thinking, which ensures the use of chemical knowledge in their future professional activities within the framework of environmental safety to ensure the preservation and restoration of the environment as a whole, and so taking into account the main value motivations with a sociological bias towards creative activity in relation to a careful behavioral and active factor in preserving the natural environment of the world, based on the understanding and awareness of personal behavior, that based on personal life within the framework of scientific or professional work will have an impact on the ecological balance, this will allow for level of thinking to create the prerequisites for the colorization of the knowledge obtained, taking into account the initially shown criteria in the educational process of studying chemical disciplines from the standpoint of environmental safety of presenting the information component of the subject [12].

Taking into account all the details of the study and the above, a model of didactic foundations for the colorization of chemical education was developed, which will allow the formation of environmental thinking among students of higher schools, including the study of cognitive and informational data of chemical disciplines based on their safe environmental impact on the main natural components, such as air, earth, water, flora, atmosphere, temperature factor and others in the field of modeling issues such as the studied chemical phenomena, elements, reactions, technologies, and the data will affect them in the early and distant periods, due to the properties of accumulation and interaction with various environments, which can be catalysts for many phenomena, and taking this into account, how everything together will be reflected in the ecological balance and whether it has ecological safety, which at the level of the educational process will contribute to the formation of ecological thinking, which will be a guarantor of understanding at a deep level the impact of knowledge chemical course of study on ecology.

Further, at the control stage of the pedagogical experimental study, within the framework of the dynamics, the data were identified, taking into account the results obtained during re-testing after testing this model of colorization based on didactic methods of cognition from the standpoint of the impact of the chemical component on the main natural components of the biosphere, in fact, the spheres of human life, like water, air and others, which allowed students at the dative level to understand the importance of maintaining the ecological norm of the state of various natural objects that make up an ecosystem, and separately, if the natural structure or composition is disturbed, a significant violation occurs in the ecological balance, which, given the scale of the planet and geographical areas on the level of natural phenomena change the ecological component leading to its deterioration. Thus, a detailed understanding of the factors of chemical introduction and interference in natural environments allows a deeper understanding of the significance of even the slightest impact on the natural balance, which in aggregate will be ecological [13].

Reasoning based on the detailed study of the information part of the chemistry course will allow the formation of environmental thinking, which in the future will be reflected in the future specialists at the level of their professional activities, in which they, according to the studied example, will analyze in detail from the standpoint of early and separate changes that they can make to their actions within the framework of chemical technologies or other impacts, based on the impact at the level of each element or reaction on the natural state of natural parts, objects and the ecosystem as a whole, the natural balance, which depends on any part of it [14]. Thus, approbation of the former model of didactic foundations in the study of chemical disciplines made it possible to identify a positive trend of increasing the motivational component of education at the level of both its cognitive and social parts, and the prevailing majority of students (88%) showed an increase in motivation to study chemistry to its high level, and only 12% of the indicators were at the level of the average degree of severity of the cognitive part of motivation, and significant changes in social motivational criteria were obtained, which in the majority (91%) increased to a high level of motivation, in 7% of the respondents its average parameter was revealed, and only 2% of students had a low score, as shown in Figure 3.

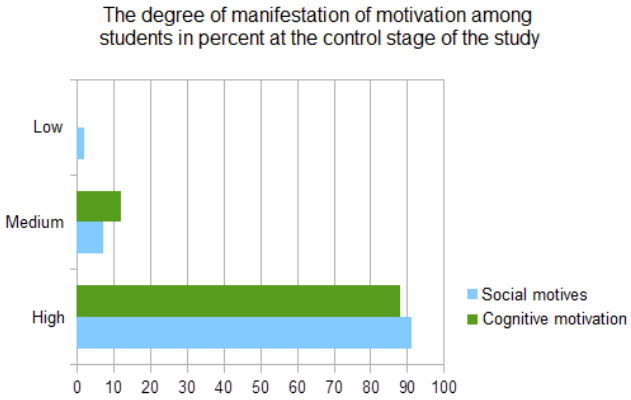

FIGURE 3. Distribution of students according to the degree of cognitive and social motivation at the control stage of the study.

Thus, the obtained data from repeated diagnostic testing of 92 students made it possible to conclude that the developed model of didactic foundations for the ecologization of chemical education was successful and effective. Also, during the pedagogical clarification, the majority of students noted that the level of their understanding and awareness of the importance of caring for nature and the entire ecosystem had increased, and they understood the factors of influence of the information component of the chemical course on natural parts and objects, taking into account their impact on the environment and the prosperous life of society. Figure 4 shows the general attitude of students to the ecologization of chemical education, which had a significant impact on the formation of value-based environmental thinking among respondents against the background of the ecologization of the practical application of knowledge of chemical disciplines within the framework of environmental safety, the importance of awareness, which is also reflected in Figure 4.

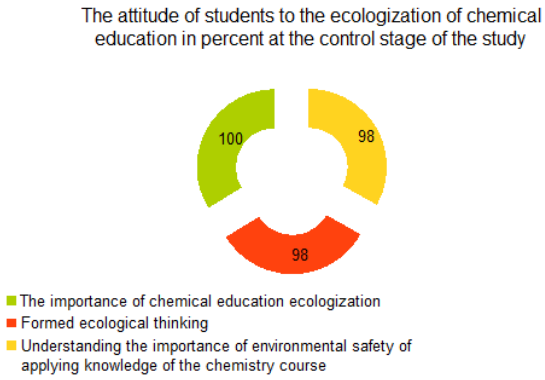

FIGURE 4. The attitude of students to the colorization of chemistry education in percent at the control stage of the study.

IV. DISCUSSION

Thus, the data obtained made it possible to reveal the effectiveness of this model of didactic foundations for the colorization of chemical education among students studying in higher educational institutions. The correctness of the study was ensured by the fact that the characteristics and data parameters of the test and the developed didactic foundations were comparable in the study correctly. The analysis of the results of the study made it possible to determine that the developed model of the didactic foundations of environmentally oriented chemical education, which includes the ecological direction of the cognitive and informational aspects of the

knowledge of the discipline, based on the modeling of answers to the questions of the influence of the studied components of chemistry, taking into account their impact on natural parts and objects, such as air, water, land, flora, and others, which allows forming ecological thinking at a qualitative level, which will allow the application of chemical knowledge at the level of environmental safety, which is an important parameter for the conservation and restoration of nature, the ecosystem and the improvement of the environment as a whole.

It is known that one of the important components in the education and formation of worldview concepts is the learning environment, where students spend a lot of time learning and acquiring new knowledge and skills that they will use in their lives, just as the pedagogical area has an impact on understanding important aspects in life that will be a guide for students in their future life, where there is a place for the manifestation of all formed personal parameters learned and understood during the educational process at different levels of life, both personal and professional, which will also affect the general development of social foundations, concepts and principles of life, influencing the prosperous component of the development of society [15]. Thanks to the colorization of education, the formation of the student's personality occurs with the influence on his behavioral criteria and worldview at the level of maintaining a favorable component of ecology, which at the active level manifests itself as ecological thinking, which will allow the future specialist to perform his work within the framework of environmental safety [16].

Thus created ecological environment for the perception of knowledge of the subject creates conditions for the course of the learning process along with possible actions in the field of knowledge of the chemical discipline, where there is an awareness of the possibility of adverse results from their application, which is unacceptable in the conditions of the modern world, where the environmental component is in a state of critical factor, which needs to be restored to the framework of the natural balance at the level of the planet's biosphere, and so this study from the considered position will allow to restore the ecology, and further maintain it at a natural harmonious level, which is possible due to the formation of ecological thinking among the young generation, future specialists, which will allow them to exclude adverse anthropogenic impacts on various components of the biosphere, which together are responsible for the ecological balance [17]. In the context under consideration, the undertaken colorization of chemical education with the formed didactic foundations is also expressed in its practical application against the background of acquiring environmental knowledge of the course of chemistry and understanding the importance of maintaining ecology at a high level, as an internally formed conviction based on the formation of a value motivation for caring for nature and preserving environmental safety factor in the framework of the formation of practical skills and abilities in the field of chemistry. Modern education dictates the importance of training personnel with professional competencies in environmental conservation, which will make it possible to improve the ecological state of the biosphere and the ecosystem as a whole shortly. The role of the former model of didactic foundations with a motivational-value ecological approach to a careful, respectful attitude to the natural environment of nature allows for creating conditions for the successful development of a prosperous human life against the backdrop of any life activity [18].

Thus, at the level of psychological perception of the developed model with didactic foundations of modeling answers to the questions of the influence of chemical influences on parts of nature, such as earth, air, water, atmospheric components and other natural objects, they will create examples of mental activity with the inclinations of motivational-value behavior in relation to the entire ecosystem at the intellectual, cognitive and cognitive-informational levels to apply them in their life on the basis of the formed environmental criteria at the level of mental activity with an analysis of environmental safety against the backdrop of a creative approach to restore and preserve nature and ecology in the world, which will create a fundamental approach to the methodology information educational environment of chemical education to create a value-motivational and environmentally important integrative-personal attitude of students to the very process of education, in which the issues of caring for the environment will stand as the basis for educating and presenting information with the implementation of such an attitude in their future professional life, which will make an important contribution to the well-being of life and the preservation of a healthy component of the natural ecological balance of the entire ecosystem on the planet [19].

The created value motivation for the use of the information component in the field of chemistry within the framework of environmental safety at all levels of its application in all areas will be presented as an element of education when introducing the environmental factor of perception and cognition into chemical education at the level of the developed model of didactic foundations, which makes it possible to realize the importance of the influence of chemistry on natural environments in which a person lives and on which his well-being depends, and so at this level of the educational process, the environmental component will be perceived by the students in

the form of natural study with elements of environmental education, in which the student, the future specialist will understand his responsibility for the application of chemical knowledge on practices, taking into account their impact on the natural structure and function of natural components that ensure the ecological balance in the world [20].

While the developed didactic model for apologizing chemical education has demonstrated effectiveness in promoting ecological thinking and environmental awareness, there are some limitations and counter-arguments worth considering. One limitation could be the feasibility of fully integrating these environmental frameworks into existing educational structures, which may require significant curriculum adjustments and additional resources. Additionally, the emphasis on the environmental safety of chemical applications could overshadow the need for more interdisciplinary approaches, such as incorporating socio-economic factors or practical real-world applications of environmental chemistry, which could further enhance the effectiveness of such colorization efforts. Alternative approaches could involve the inclusion of more hands-on, experiential learning opportunities or the integration of community-based projects to foster a deeper, real-world understanding of environmental impact in chemical practices.

Thus, the developed model of didactic foundations for the ecologization of chemical education proved to be effective and allows the formation of environmental thinking with high knowledge of the course of chemistry at the level of their practical application, taking into account the environmental safety of implementation in the spheres of production and life support, which is of practical importance for the field of education and can be used in practice within the educational process.

V. CONCLUSIONS

This research makes a significant contribution to the field of chemical education by introducing a model of didactic foundations for the ecologization of the discipline, emphasizing the integration of environmental considerations into chemistry teaching. By highlighting the ecological impact of chemical processes on natural elements such as air, water, and land, this study advances the understanding of how chemical education can foster environmental thinking among future professionals. The long-term implications of this work include the potential for cultivating a generation of chemical industry specialists who are not only proficient in their field but also dedicated to ensuring environmental safety and sustainability in their practices.

Future research could explore additional areas of chemical education from an ecological perspective, such as the integration of sustainability principles into laboratory practices, the development of interdisciplinary courses that combine chemistry with environmental science, or the incorporation of global environmental challenges into chemistry curricula. Further exploration of how these ecologization models can be adapted for different educational levels or cultural contexts could also provide valuable insights for broader application in the global educational landscape.

The materials of this article are useful for workers in the field of education and chemical industries, and can be applied in practice, which will contribute to solving important problems in the field of education and environmental restoration.

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Author Contributions

- Conceptualization, L.M.; Methodology, L.M. and M.M.; Software, D.K.; Validation, K.Zh.; Formal Analysis, K.Zh.; Investigation, K.Zh.; Resources, D.K.;
- Data Curation, M.M.; Writing – Original Draft Preparation, L.M. and M.M.;
- Writing – Review & Editing, M.M.; Visualization, D.K.; Supervision, D.K.; Project Administration, D.K.; Funding Acquisition, D.K.

The authors confirm that neither the manuscript nor any part of its contents is currently under consideration or publication in another journal.

Conflicts of Interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Data Availability Statement

Data is unavailable due to privacy and ethical restrictions.

Declaration of competing interest

The authors declare that they have no any known financial or non-financial competing interests in any material discussed in this paper.

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