Journal of Turkish Science Education, 2024, *21*(4), 749-774
DOI no: 10.36681/tused.2024.041

Journal of Turkish Science Education
http://www.tused.org
© ISSN: 1304-6020

Methodology for integrating socio-humanitarian safety into the training of future chemistry teachers

Nurzhanar Gaisatkyzy Galymova[1], Zhazira Sagatbekovna Mukatayeva[2], Nursulu Sarsenovna Zhussupbekova[3], Meruyert Argyngazievna Orazbayeva[4], Viktorya Eduardovna Aharodnik[5]

[1]*Faculty of Natural Sciences and Geography, Abai Kazakh National Pedagogical University, Kazakhstan, ORCID ID: 0009-0000-5887-2483*
[2]*Faculty of Natural Sciences and Geography, Abai Kazakh National Pedagogical University, Kazakhstan, Corresponding author, jazira-1974@mail.ru, ORCID ID: 0000-0002-1584-5810*
[3]*Faculty of Natural Sciences and Geography, Abai Kazakh National Pedagogical University, Kazakhstan, ORCID ID: 0000-0003-4221-9863*
[4]*Faculty of Natural Sciences and Geography, Abai Kazakh National Pedagogical University, Kazakhstan, ORCID ID: 0000-0003-2667-5447*
[5]*Faculty of Natural Science, Belarusian State Pedagogical named after Maksim Tank University, Belarus, ORCID ID: 0009-0003-4075-4333*

* *The research article is a part of a doctoral dissertation*

ABSTRACT
This study explores the integration of socio-humanitarian safety components into the chemistry curriculum for secondary education, emphasizing how contextual and competency-based assessments can enhance the preparedness of future chemistry teachers. Employing a mixed-methods approach, the research evaluates the effectiveness of traditional, contextual, and competency-oriented assessment methods in measuring and fostering key competencies among 11th-grade chemistry students. Quantitative data were gathered from traditional assessments, contextual tasks, and the Unified National Testing (UNT), while qualitative insights were obtained from teacher interviews and classroom observations. The findings reveal significant discrepancies between traditional assessment scores and those from contextual and competency-based tasks, with weak correlations between traditional methods and both contextual ($r = 0.48$) and competency-oriented assessments ($r = 0.43$). A moderate correlation ($r = 0.65$) was observed between contextual tasks and competency-oriented tests, suggesting that these methods are more aligned with practical, application-based learning. While traditional assessments effectively evaluate theoretical knowledge and show a strong correlation with UNT scores ($r = 0.83$), they are insufficient for measuring higher-order competencies. The study underscores the necessity for a balanced assessment framework that incorporates both conventional and innovative methods to fully capture the spectrum of student competencies essential for socio-humanitarian safety in science education. These findings have significant implications for curriculum design, indicating that a diversified assessment approach can better prepare students for real-world challenges by fostering a comprehensive understanding of chemistry beyond rote memorization.

RESEARCH ARTICLE

ARTICLE INFORMATION
Received:
13.08.2024
Accepted:
28.11.2024
Available Online:
10.12.2024

KEYWORDS:
Assessment, socio-humanitarian safety, natural sciences, competence-based approach.

To cite this article: Galymova, N.G., Mukatayeva, Z. S., Zhussupbekova, N. S., Orazbayeva, M.A. & Aharodnik, V.E. (2024). Methodology for integrating socio-humanitarian safety into the training of future chemistry teachers. *Journal of Turkish Science Education, 21*(4), 749-774. http://doi.org/10.36681/tused.2024.041

Introduction

The effectiveness of natural science teachers has been extensively explored in educational research. Adu-Gyamfi (2020) and Ambusaidi Al-Hajri and Al-Mahrooqi (2021) have investigated the qualities of effective natural science educators. Magnusson, Krajcik, and Borko (1999) introduced the concept of Pedagogical Content Knowledge (PCK) to understand the specialized knowledge required by science teachers for effective teaching practices. Chan and Hume (2019) conducted a comprehensive review of empirical studies examining science teachers' PCK. The importance of "relevance" in science education and its implications for curriculum design have been discussed by Stuckey et al. (2013). Additionally, Hui Cao et al. (2017) analyzed methodologies for developing research activities in the training of future teachers using information resources.

A robust methodology is crucial for ensuring the socio-humanitarian safety of students in the training of future chemistry teachers. Integrating educational technologies, such as the Technological Pedagogical Content Knowledge (TPACK) framework, is essential for developing teachers' competence in using technology to enhance learning experiences (Zimmermann et al., 2021). Innovative teaching approaches, including project-based learning and STEM education philosophies, have been effective in engaging students and preparing them for professional careers in chemistry (Domenici, 2022). Addressing classroom diversity is another critical aspect, with training programs focusing on equipping teachers to effectively teach heterogeneous and diverse student populations (Tolsdorf et al., 2018). Continuous professional development is vital for chemistry teachers to remain current with best practices and innovative teaching methods, as demonstrated by research on green chemistry education (Cannon et al., 2023).

Based on a review of the literature, several key strategies have been identified:

1. Integration of Educational Technologies: Future chemistry teachers need to enhance their technological pedagogical content knowledge (TPACK) to improve learning experiences (Zimmermann et al., 2021). This includes developing self-efficacy, a positive attitude, and competence in lesson planning using educational technology.
2. Innovative Teaching Approaches: Employing project-based learning activities and STEM education philosophies effectively trains future chemistry teachers, enhancing their skills in engaging students and encouraging active learning (Domenici, 2022).
3. Addressing Classroom Diversity: Training programs should focus on preparing teachers to effectively teach heterogeneous and diverse classrooms, developing their informational and diagnostic competencies, and equipping them with skills to manage diverse student needs (Tolsdorf et al., 2018).
4. Professional Development: Continuous professional development is crucial for teachers to stay current with best practices and innovative teaching methods. Green chemistry teaching, sustainable practices, and formative assessment methods can enhance teaching and improve student outcomes (Cannon et al., 2023).
5. Safety: Ensuring that teachers are knowledgeable about and adhere to laboratory safety protocols is essential. Safety training, providing necessary equipment, and fostering a culture of safety contribute to the socio-humanitarian safety of students (Hussein & Shifera, 2022).
6. Contextual Learning: Integrating real-world contexts, such as pharmacology topics, into chemistry lessons makes the subject more interesting and relevant, improving learning for both teachers and students (Schwartz-Bloom et al., 2011; Marifa et al., 2023).
7. Building Resilience: Training future chemistry teachers to increase their resilience to adversity, especially in diverse social environments and resource-limited settings, equips them to handle challenges effectively (Palermo et al., 2021).

By integrating these approaches, a comprehensive methodology can be developed to ensure the socio-humanitarian safety of students in the preparation of future chemistry teachers. This methodology should encompass professional development, innovative teaching practices, diversity management, identity development, evidence-based education, contextual learning, and sustainability education to create a holistic curriculum for chemistry teachers.

Socio-humanitarian security has emerged as a significant area of study, with its components outlined in the United Nations Development Programme report (1994) and further explored by scholars such as Kazakov (2013), Zubarevich (2020), Baluev (2004), and Prokhorov (2010). However, there is a notable gap in the literature specifically addressing the socio-humanitarian security of Kazakh society. This gap highlights the critical need for studies focusing on the unique socio-humanitarian challenges faced by Kazakhstan. Therefore, this study aims to develop a scientifically grounded, pedagogical, multi-vector system tailored to the Kazakh educational environment. This system is designed to equip natural science teachers with the necessary skills and knowledge to incorporate socio-humanitarian security components into their professional activities, addressing an urgent and previously underexplored area of educational research.

In contemporary society, individuals consistently encounter a multitude of threats, ranging from explicit to covert. Considering the continual evolution of society and its processes of socialization and interaction, aspects of socio-humanitarian security become essential components imparted to successive generations. Consequently, the paramount aspect of preparing future professionals lies in ensuring personal security across all fields of their aspirations, facilitating the comprehensive development of their potential and professional competencies. Safeguarding and fostering resilience in students throughout their professional development are integral to their growth and educational journey, facilitating their harmonious integration into society and the preservation and transmission of their personal and communal values, as well as the safe use of chemicals (European Commission, 2011).

Before becoming professionals, individuals must transition from being goal-oriented students to highly motivated future specialists. Therefore, the role of the teacher is crucial in guiding and orienting students within contemporary, information-rich, and socially integrated societies. From the perspective of socio-humanitarian security, future educators should aid students in navigating their reality and contribute to creating conditions in which they can utilize the knowledge they have gained, both in selecting their professional pursuits and in promoting well-being within their community and environment.

Teachers of natural sciences—biology, geography, chemistry—possess skills in establishing patterns and identifying cause-and-effect relationships among the components of nature, society, and economy. Consequently, as professionals with broad expertise, they are particularly equipped to instill the foundations of socio-humanitarian security in students. However, achieving optimal outcomes in preparing future chemistry educators necessitates enhancements and refinements to the educational process. Specifically, it involves developing and implementing an educational model focused on equipping chemistry educators to adopt a competency-based approach to teaching, serving as a catalyst for socio-humanitarian security within the "nature-human-society" paradigm.

Modern education and the training of pedagogical students must be humanitarian-centric, integrating societal advancements alongside personal achievements, experiences, and subject-specific competencies. This approach serves as the foundation for ensuring developmental security, livelihood, and purposeful engagement in both professional and personal realms (State Program for Regional Development for 2020–2025 of the Republic of Kazakhstan, 2019). Therefore, developing a scientifically grounded, pedagogical, multi-vector system aimed at preparing natural science teachers to integrate socio-humanitarian security components into their professional practices is both relevant and necessary. This study aims to provide theoretical and methodological justification and support for a model of teacher training in natural sciences that implements the principles of socio-humanitarian safety within the "nature-human-society" paradigm in the educational process.

Review of the Current Literature

The integration of socio-humanitarian security into the training of future chemistry teachers is a multifaceted issue that requires addressing several key variables: educational technologies, innovative teaching approaches, class diversity, professional development, safety, and contextual learning.

The use of educational technologies in teaching is crucial for modern education. The TPACK framework, which integrates technological, pedagogical, and content knowledge, is fundamental for developing teachers' competence in using technology effectively (Mishra & Koehler, 2006). Studies have shown that technology-enhanced learning environments can significantly improve student engagement and learning outcomes (Koehler et al., 2013). For instance, Koehler and Mishra (2009) demonstrated that teachers who are proficient in TPACK can create more interactive and engaging lessons. Similarly, Chai, Koh, and Tsai (2013) emphasized the importance of developing teachers' technological pedagogical content knowledge to enhance their instructional practices. The integration of digital tools in teaching practices can also foster students' critical thinking and problem-solving skills (Hsu, 2016; Harris, Mishra, & Koehler, 2009).

Innovative teaching approaches, such as project-based learning and the STEM teaching philosophy, are effective in engaging students and preparing them for future professional activities. Project-based learning has been shown to enhance students' critical thinking, collaboration, and problem-solving skills (Bell, 2010; Thomas, 2000). The STEM approach, which integrates science, technology, engineering, and mathematics, encourages students to apply their knowledge in real-world contexts (Beers, 2011). Studies by Capraro, Capraro, and Morgan (2013) and Bybee (2010) highlight the benefits of STEM education in developing students' interest and proficiency in science and technology. Moreover, the use of inquiry-based learning, which involves students in the process of scientific investigation, has been found to improve their understanding of scientific concepts and processes (Hmelo-Silver, Duncan, & Chinn, 2007; Minner, Levy, & Century, 2010).

Addressing class diversity is essential for creating inclusive and equitable learning environments. Training programs should focus on preparing teachers to effectively teach heterogeneous and diverse classrooms. Differentiated instruction, which involves tailoring teaching methods to meet the diverse needs of students, has been shown to improve student learning outcomes (Tomlinson, 2001; Subban, 2006). Additionally, culturally responsive teaching, which recognizes and respects the cultural backgrounds of students, can enhance their engagement and academic achievement (Gay, 2010; Ladson-Billings, 1995). Research by Banks et al. (2001) and Nieto (2010) underscores the importance of multicultural education in promoting social justice and equity in schools.

Continuous professional development is vital for teachers to stay current with best practices and innovative teaching methods. Professional development programs that focus on reflective practice, collaboration, and ongoing learning can enhance teachers' instructional skills and knowledge (Darling-Hammond, Hyler, & Gardner, 2017). Studies have shown that effective professional development can lead to improved teaching practices and student learning outcomes (Desimone, 2009; Guskey, 2002). Research by Garet et al. (2001) and Loucks-Horsley et al. (2010) emphasizes the importance of sustained, collaborative, and content-focused professional development for teachers.

Socio-humanitarian security is a multidimensional concept that extends the traditional notion of security beyond military and political realms to include social, economic, environmental, and human rights dimensions (UNDP, 1994). It emphasizes the protection of individuals and communities from threats that undermine their well-being and dignity, such as poverty, disease, environmental degradation, and social injustice (Kazakov, 2013; Zubarevich, 2020). In the context of education, socio-humanitarian security involves equipping learners with the knowledge, skills, and values necessary to navigate complex societal challenges and contribute to the creation of a more just and sustainable world (Bourn, 2016). Research indicates that embedding socio-humanitarian themes into the curriculum enhances students' ability to critically analyze societal issues and develop a sense of global citizenship (Osler & Starkey, 2010). For example, integrating topics like sustainable development, social justice, and ethical implications of scientific advancements into science education can promote a more holistic understanding of the subject matter (Zeidler & Nichols, 2009). This approach aligns with the concept of education for sustainable development (ESD), which UNESCO (2017) advocates as a means to empower learners to take informed actions for environmental integrity, economic viability, and a just society. Safety in the laboratory and classroom is paramount, requiring comprehensive safety training for teachers. Teachers need to be knowledgeable about and follow laboratory safety protocols to ensure the well-being of their students (Hussein & Shifera, 2022). Research has shown that safety training can reduce the risk of accidents and injuries in the laboratory (Hill & Finster, 2016; Kuntzleman & Rohrer, 2017). Additionally, fostering a culture of safety in schools can promote students' awareness and understanding of safety practices (Carmichael, 2013; Viswanathan et al., 2016).

The contemporary conditions of life and activity have underscored the necessity for students to develop personal qualities conducive to their professional and social mobility within a dynamically evolving society. However, the preparedness level of graduates from schools and universities does not align with these demands. Today, the education and training of pedagogical students must be practice-oriented and integrative, based on the introduction into education not only the achievements of society but also the individual's own achievements, her object-subject experience, as the basis for the safety of development, vital activity, and goal-setting in work and life. That is why, starting from the modern requirements of society and the education system as an integral part of it, the issues of multi-vector scientifically based systematic training of a future chemistry teacher based on integrativity and interdisciplinarity are becoming increasingly relevant.

Contextual learning involves integrating real-world contexts into the curriculum to make learning more relevant and engaging for students. Studies have shown that contextual learning can improve students' understanding and retention of scientific concepts (Berns & Erickson, 2001; Johnson, 2002). For example, integrating pharmacology topics into chemistry lessons can make the subject more interesting and relevant for students (Schwartz-Bloom et al., 2011). Research by Herrington and Oliver (2000) and Brown, Collins, and Duguid (1989) emphasizes the importance of situated learning, where students learn through authentic activities in real-world contexts.

While significant research has been conducted on various aspects of teacher education and innovative teaching practices (Darling-Hammond, 2006; Guskey, 2002), there remains a notable gap in the literature concerning the integration of socio-humanitarian security into the training of future chemistry teachers. Although there is a growing focus on integrating socio-humanitarian security within educational frameworks in response to increasing global awareness of human security issues (UNDP, 1994), most studies have concentrated on specific teaching strategies or professional development programs without addressing the comprehensive incorporation of socio-humanitarian components (Gulikers et al., 2004; Shavelson et al., 2008). Scholars like Kazakov (2013) and Baluev (2004) have emphasized the need to embed social security concepts into education to prepare students for societal challenges, yet there remains a notable gap in addressing these components within teacher training, specifically in chemistry education. This gap underscores the critical need for research that develops a pedagogical model tailored to integrating socio-humanitarian security within the educational framework for chemistry teachers.

Studies have increasingly demonstrated the value of competency-based models for teacher education in achieving these goals. For instance, Gulikers et al. (2004) propose an authentic assessment framework to foster real-world application of knowledge, while Voogt and Roblin (2012) argue that integrating competencies related to social responsibility and security equips teachers with broader skills necessary for a globalized world. Such findings are supported by Darling-Hammond (2006), who asserts that comprehensive teacher education, which includes socio-humanitarian training, can prepare teachers to address complex, real-world issues in the classroom.

Despite these advancements, existing studies often focus on broad educational strategies without fully addressing the specific integration of socio-humanitarian security into chemistry education. This highlights a critical research gap, particularly in regions like Kazakhstan, where specific socio-humanitarian challenges are uniquely pronounced (Mukatayeva, 2023; Prokhorov, 2010). The limited research on Kazakhstan's socio-humanitarian context underscores the importance of developing specialized teacher training programs that integrate these components to address the country's unique educational and societal needs (Stuckey et al., 2013). A synthesis of these studies suggests that developing a pedagogical model tailored for chemistry teachers-focused on socio-humanitarian security-could significantly contribute to both educational quality and national stability, aligning with the goals set forth by global and regional educational frameworks.

The relevance of this research is underscored by substantial shifts in the requirements currently placed on graduates of both schools and universities by the professional community and educational as well as social environments (Kazakov, 2013). In contemporary circumstances, there is a growing imperative for students to cultivate personal qualities that foster their professional and social mobility. Therefore, the aim is not solely acquiring knowledge but also developing the readiness to perform particular roles, which stands as a key goal for both tertiary and secondary education systems (Zubarevich, 2020; Baluev, 2004; Prokhorov, 2010).

In order to systematically prepare future chemistry teachers for the implementation of components of socio-humanitarian security in their future professional activities, we believe it is necessary to examine these research questions:

1. What are the key components of socio-humanitarian security that need to be integrated into the training of future chemistry teachers?
2. How can a competency-based approach be effectively implemented to enhance socio-humanitarian security within the "nature-human-society" paradigm?
3. What are the most effective methodologies and practices for integrating socio-humanitarian security into the educational process for chemistry teachers?
4. How do future chemistry teachers perceive the importance and implementation of socio-humanitarian security in their professional practices?
5. What are the challenges and barriers faced by educators in integrating socio-humanitarian security components into their teaching?

Methodology

Research Design

This study employed a mixed-methods approach, integrating both qualitative and quantitative research methods to comprehensively assess the chemical competencies of students within the "School - Pedagogical University" system. Mixed-methods research is particularly suitable for this study as it allows for the collection and analysis of diverse types of data, providing a more holistic understanding of the educational outcomes (Creswell & Plano Clark, 2018). This approach enabled the triangulation of data, enhancing the validity and reliability of the findings. To assess the quality of the results of educational activities of students in the "school - pedagogical university" system, methods and tools were used to identify the results of mastering the educational program from the perspective of competence-oriented requirements for the quality of their training. As a result of the teacher's control and evaluation activities, the total rating score of students will be considered, on the basis of which the achieved level of chemical competencies was determined. At the stage of the search experiment, it was found that traditional methods and controls are insufficient to measure the competencies of students, and a methodological approach was used to obtain reliable results on the quality of preparedness of graduates of schools and universities.

The methodological approach allows for considering the results of both external and internal control, which is carried out by the teacher. At the same time, the teacher's controlling activity is realized through observation, oral and written assessment, analysis of the performance of contextual tasks, tests, and situational tasks.

Participants and Context

During the exploratory research phase, the existing system for assessing the educational outcomes of students and learners was analyzed to determine the professional readiness of graduates from pedagogical universities for their future careers and the preparedness of students from secondary schools to pursue further education (particularly in the field of chemistry). For the organization of control and assessment activities, a criteria base and diagnostic indicators were developed for teachers. Table 1 shows demographic information on the results of students' mastery of chemistry in the experimental groups.

Table 1

Information on the results of students' mastery of chemistry in the experimental groups

№	Academic Discipline	The number of students in the class	The number of students assessed on			The percentage of academic achievement	The Mean score	The percentage of students achieving grades "5" and "4"	The indicator of teaching effectiveness
			5	4	3				
1	Students of the 10th grade class A, Lyceum №12, Almaty	22	12	9	1	100	4,5	95	0,5
2	Students of the 10th grade class B, Lyceum №12, Almaty	18	8	8	2	100	4,3	88	0,46
3	Students of the 10th grade class V, Lyceum №12, Almaty	18	3	8	7	100	3,7	61	0,32
4	Students of the 10th grade class G, Lyceum №12, Almaty	24	10	5	9	100	4	62	0,69
5	Students of the 10th grade class A, Gymnasium №178, Almaty Region	21	4	9	8	100	3,8	62	0,34

Monitoring studies were conducted in the academic years 2021-2022 and 2022-2023. In 2021, an experimental group was formed, consisting of students from the 10th grade of School №12 in Almaty and School №178 with an emphasis on natural sciences in the Almaty region. In the academic year 2022-2023, this group of students was in the 11th grade, and at the end of this period, the level of formation of their chemical competencies was assessed. In the general practice, 103 students and 15 instructors participated, with ages ranging from under 35 years old to over 50 years old.

Research Instrument

The measurement and evaluation of chemical competencies were conducted using both conventional pedagogical methods and innovative assessment tools, followed by a comparison of the obtained data and their statistical analysis. Insignificant discrepancies between the control results obtained with traditional and innovative instruments suggest that they assess the same content elements, indicating consistency in the obtained data. However, significant differences between the control results obtained with traditional methods and innovative instruments may indicate either the unreliability of the data obtained or the unsuitability of certain instruments for assessing the required educational outcomes of students.

In the development of control and measurement materials, the aim was to identify elements not only of knowledge but also of the activity components of competencies. During the descriptive phase of the research, it was established that traditional methods and means primarily assess knowledge, often at a reproductive level, as well as the ability to replicate prescribed actions.

Contextual tasks are contained in the control and measurement materials developed for the International PISA Education Quality Study. Most researchers classify contextual tasks as non-standard tasks that can activate the cognitive activity of schoolchildren (Aligberova & Stepin, 2002; Pichugina, 2004). Therefore, contextual tasks allow us to assess the quality of students' knowledge, not the amount of content mastered. When developing contextual tasks, the following rules were followed:

- The personal significance of the assignment for students, since the content is related to everyday life or professional activity;
- The complexity of control achieved by a set of tools used to evaluate a given amount of content;
- Creating conditions for the manifestation of independent thinking. At the same time, the context of the task should not contain hints that contribute to solving the problem or may provide several solutions, of which at least one does not meet the given situation.

Considering the possibilities of contextual tasks, Pankova (2002) notes that they can be applied in the context of competence-based education. This conclusion is justified by the fact that contextual tasks require independent thinking and the presence of formed experience in performing actions. Situational tasks offered to measure chemical competencies are mainly practice-oriented or professionally oriented.

Pedagogical Modeling

The implementation of the above-mentioned steps will contribute to enhancing the effectiveness of the educational process through the application of modern teaching methods and technologies in natural science disciplines. Additionally, creating conditions that ensure the development of socio-humanitarian security aspects in future chemistry teachers and their integration into the educational process of secondary education institutions is essential (Mukatayeva, 2023). Promoting a sense of satisfaction by ensuring socio-humanitarian security as a specific state of protection of the vital interests of individuals is also a key outcome. Questions of socio-humanitarian security within the framework of natural science education have their distinctive features depending on the subject.

Modeling is understood as the study of objects based on their corresponding models, as well as the construction of models of real-world objects and processes in order to explain and predict their properties, characteristics, and patterns of functioning. The following functions of pedagogical modeling can be distinguished:

- Scientific consistency and consistency in the search for optimal and pedagogically appropriate solutions and organized pedagogical processes;
- Implementation of the ideas of humanism, health savings, productivity, creativity, and other necessary values in the system of socio-educational and professional-labor relations;
- Concretization and updating of all components in the theoretical and implemented pedagogical processes;
- Flexible management of personal development opportunities through specially developed resources and products of scientific and pedagogical activity (Vikulina, 2013).

According to the structural mechanism, structural and functional models are most often used in pedagogical modeling, in the construction of which the object is considered as an integral system, including component parts, components, elements, subsystems. The parts of the system are connected by structural relations describing subordination, logical and temporal sequence of solving individual tasks (Kozyrev, 2021). The following stages of creating a pedagogical model are distinguished: structuring the object of pedagogical modeling (selection of elements, selection of a set of properties that ensure the completeness of the description of various aspects of the studied pedagogical phenomenon and building a system of relations between the selected elements; building a formalized scheme of the educational process, establishing a system of pedagogical parameters and components, taking into account those factors that are taken into account during formalization; identification of the model is the definition of interaction and interdependencies within the structure of the model, ensuring the most effective implementation of the pedagogical phenomenon (Zakrevskaya, 2011).

The term "training model" is most often used. In the context of the implementation of the competence approach, this model is considered as an educational process that prepares students to solve professional problems. The training model is a dynamic system with a certain content and structure. The correct choice of methodological and methodological foundations for teaching disciplines, as a factor of high-quality training, contributes to the construction of a model, the implementation of which allows you to achieve the planned result.

The formation of the concept of socio-humanitarian safety takes place in the educational process, which is based on the methodology of the competence approach. It is necessary to form competencies among future chemistry teachers that allow them to form the concept of socio-humanitarian safety among students in institutions of general secondary education. In the curricula, expand the list of competencies formed by students by including competencies related to socio-humanitarian safety. Student must:

- Have a holistic understanding of the components of socio-humanitarian safety;
- Be able to analyze the causes of instability and predict solutions that contribute to achieving socio-humanitarian safety;
- Be ready to implement the components of socio-humanitarian safety in the educational process through effective pedagogical approaches;
- Be able to design the educational process taking into account the interdisciplinary nature of the disciplines taught and the versatility of aspects of socio-humanitarian safety.

Data Analysis

In order to organize the process of measuring competencies, the following axioms were adopted:

- Competencies can be measured indirectly, so it is important to create conditions for their manifestation.

- There are always multiple external manifestations (indicators) describing latent characteristics, which are subject to measurement.

- The achievable accuracy of measurement is determined by the amount of prior information available about the competency as the object of study.

When developing the methodology, we adhered to the law of diversity: the variety of assessment tools should be adequate to the content of the object being measured, through which various educational tasks are solved. In this regard, the following were used in the development of the methodology:

- A comprehensive approach, involving the application of commonly accepted methods and means of control along with innovative measuring instruments, allowing for the most complete identification and measurement of competency formation;

- A systemic approach, involving: the organization of monitoring studies to analyze the dynamics of competency formation and development during the learning process; determining the level of formation of chemical competencies at the final stage of educational program completion. For this purpose, an accumulative system for recording results and calculating the cumulative rating score was applied. Prior to conducting experimental activities to study the validity of the developed methodology, preparatory work was carried out, including identifying the content of chemical competencies, selecting appropriate tools, developing control and measurement materials, and assessing their reliability. The experiment was conducted in the context of changes in the legislation of the Republic of Kazakhstan regarding the implementation of the new format of the Unified National Testing (UNT) (2024) as part of the final state certification of graduates of secondary schools. The results of UNT were considered as an indicator of students' preparedness quality, and the control and measurement materials were regarded as instruments for its measurement. It was important for us to determine whether the competency formation could be assessed using these control and measurement materials, thus the results of UNT in chemistry for students in the experimental groups were compared with the results of comprehensive measurement.

Individual scores underwent statistical processing to determine Mean values, which were considered as generalized indicators of achieving the set goals. Subsequently, they were compared, and the Pearson correlation coefficient (%) was calculated. Competency-oriented tests, case studies, and contextual tasks were applied as innovative tools. The determination of the level of students' chemical competency formation was based on the results of monitoring and certification control and evaluation activities. Monitoring was conducted in 10th and 11th grades as part of the chemistry curriculum implementation. The indicators of students' chemical competency formation included the results of contextual tasks, competency-oriented tests, and knowledge and skills demonstrated during oral interviews and other forms of assessment. Criteria and diagnostic indicators were developed to organize the teacher's control and evaluation activities.

Results

For conducting a proper comparison, the results of quantitative assessment using contextual tasks are juxtaposed with grades on a five-point scale. In this regard, the grade "5" corresponds to a score ranging from 100% to 80% of the maximum possible; "4" - 80% - 60%; "3" - 60% - 30%; "2" - less than 30% in Table 2.

Table 2

The correspondence of measurement results to qualitative grades (based on the performance of contextual tasks)

Qualitative assessment	5	4	3	2
Score count	72-58	57-43	42-22	21-0

The results of assessing the mastery of the general chemistry curriculum by students in the 10th grade experimental groups are presented in Tables 1-3. The traditional control results were considered in terms of the Mean grade of the student, calculated based on the aggregate of marks for written and oral responses. A comparative analysis of the results of traditional assessment and the completion of contextual tasks was conducted based on correlation analysis. The statistical characteristics of the obtained results are presented in Table 3.

Table 3

Results of the assessment of the chemistry curriculum mastery by the 10th-grade students

№	Results of assessment using traditional means	Results of assessment using contextual tasks	
		Quantitative score	Qualitative grade
1.	5	34	3
2.	4	21	2
3.	5	32	3
4.	5	49	4
5.	4	15	2
6.	4	27	2
7.	4	16	3
8.	4	21	2
9.	3	15	2
10.	4	15	2
11.	5	41	3
12.	3	9	2
13.	3	28	3
14.	4	23	3
15.	3	12	2
16.	4	27	3
17.	5	16	2
18.	5	42	3

The traditional assessment results were considered in terms of the Mean score of each student, calculated based on the combination of marks for written and oral responses. A comparative analysis between the results of traditional assessment and the performance in contextual tasks was conducted using correlation analysis. Statistical characteristics of the obtained results are presented in Table 4.

Table 4

Statistical criteria for the measurement and evaluation of chemical competencies of students in the 10th grade

Results of "traditional" assessment		Results of completing contextual tasks	
Indicators	Values	Indicators	Values
Mean value	4,2	Mean value	2,97
Standard error	0,11	Standard error	0,08
Median	4	Median	3
Mode	4	Mode	3
Standard deviation	0,72	Standard deviation	0,53
Sample variance	0,52	Sample variance	0,28
Kurtosis	-0,98	Kurtosis	0,88
Skewness	-0,32	Skewness	-0,03
Number of intervals	2	Number of intervals	2
Minimum score	3	Minimum score	2
Maximum score	5	Maximum score	4
Total	168	Total	119
Account	40	Account	40
The reliability level (95.0%)	0,23	The reliability level (95.0%)	0,16

Note. *The Pearson correlation coefficient = 0.47

As seen from the tables, the calculation of the Pearson correlation coefficient yields a value falling within the interval corresponding to weak correlation between the correlated features (up to 0.3 - practically no correlation; 0.3-0.5 - weak correlation; 0.5-0.7 - moderate correlation; 0.7-1 - strong correlation). This allows us to conclude that both traditional methods and means of control and contextual tasks are used to identify and measure elements of different components of chemical competencies. The analysis shows that in the first case, mainly the mastery of theoretical knowledge is controlled, with insufficient attention paid to independent thinking, functionality, and flexibility of knowledge. From conversations with teachers, it can be concluded that educators lack sufficient instructional time to develop these qualities in students, and this issue could be addressed by increasing the amount of instructional time. To test this hypothesis, we assessed the level of formation of chemical competencies in students of Gymnasium №178 in Almaty, where chemistry is studied for 4 hours per week. Measurement of chemical competencies in this group of students was conducted using the same tools as in other experimental groups. Calculation of the initial level of their training showed that initially students of Lyceum №12 in Almaty are better prepared in the subject. Therefore, it can be assumed that they should cope more successfully with contextual tasks. However, the analysis of the performance of contextual tasks in this group of students did not confirm this assumption. It turned out that students of Lyceum №12 faced the same difficulties as other students. In particular, they do not know how to identify the knowledge necessary to solve problems, have difficulty in independently determining the method of problem-solving. The knowledge of students in this group has also not reached the required level of application and analysis, indicating a low level of formation of their activity component of competencies. The matrix of performance of contextual tasks by 10th-grade students of Lyceum №12 in Almaty is presented in Appendix 31. The obtained results were analyzed using methods of mathematical statistics, as reflected in Table 5.

Table 5

Statistical characteristics of the measurement results of chemical competencies for 10th grade "g" students, school lyceum №12, Almaty

Results of "traditional" assessment		Results of completing contextual tasks	
Indicators	Values	Indicators	Values
Mean value	3,91	Mean value	3,91
Standard error	0,18	Standard error	0,18
Median	4	Median	4
Mode	3	Mode	3
Standard deviation	0,90	Standard deviation	0,90
Sample variance	0,81	Sample variance	0,81
Kurtosis	-1,80	Kurtosis	-1,80
Skewness	0,18	Skewness	0,18
Number of intervals	2	Number of intervals	2
Minimum score	3	Minimum score	3
Maximum score	5	Maximum score	5
Total	90	Total	90
Account	23	Account	23
The reliability level (95.0%)	0,38	The reliability level (95.0%)	0,38

Note. *The Pearson correlation coefficient = 0.69

Calculation of the Pearson correlation coefficient indicates a moderate level of correlation between the correlated features. These data somewhat differ from those previously presented in Tables 4-5, which is quite understandable. The chemistry teacher in the 10th "G" grade of Lyceum

№12 in Almaty considers the development of students' chemical thinking, the enhancement of the strength and functionality of their knowledge as a priority task. However, in the conditions of the subject-knowledge model of the graduate, this task is not fully resolved, as confirmed during the research. Therefore, the volume of instructional time is not the determining factor, although undoubtedly, it is essential for improving the quality of chemical education. The research results indicate that addressing the identified task is possible based on the recognition of the competency model of the graduate and its implementation in the educational process. The methodology of a comprehensive approach to competency measurement allows considering the results not only of internal but also external control. Currently, the quality control of graduates' preparation in secondary schools is carried out during the final state certification, conducted in the form of UNT. Students from the experimental groups, including those from the 10th "G" grade of Lyceum №12, participated in UNT for chemistry (87% of the total number of students in the class). The quantitative results of the participants in UNT were compared with qualitative grades on a five-point scale. The intervals of qualitative grades were established based on the minimum number of points in chemistry determined by the Kazakhstani education system, as outlined in Table 6.

Table 6

Correspondence of unified national testing score to qualitative grade on a 5-point scale

Qualitative assessment	5	4	3	2
Score count	76-100	50-75	34-49	0-33

The analysis of the content of UNT in chemistry led to the conclusion that the majority of test tasks assessed knowledge at the level of reproduction or application by example. The test items did not include tasks with a practical orientation or requiring independent thinking. Therefore, the tests are aimed at identifying the content of the knowledge component of subject competencies and are not oriented towards the activity component. Consequently, assessing the level of formation of subject competencies using them is not feasible, and it is advisable to use other measures. One of these measures is contextual tasks, which were offered to students in the 11th grade at the end of the educational program in chemistry. The test included tasks compiled by the author and taken from the educational-methodical manual "Fascinating tasks and impressive experiments in chemistry".

1. Unloading Fertilizers: "Several tons of frozen mineral fertilizer are lying on open railway platforms. How to unload such a composition?"

2. Home Chemistry: "In A.I. Makievsky's book 'Home Chemistry,' an interesting observation is provided: '...The fairer sex often consumes vinegar in enormous quantities, either in its pure form or with other dishes to maintain a slender waistline. The goal is achieved perfectly, but along with the graceful waist, an unattractive complexion is acquired.' Consequently, excessive use of vinegar can lead not only to the appearance of a sallow complexion but also to serious poisoning. How to provide first aid to a beauty who has overindulged in vinegar, using means that do not harm health?

3. Grain Storage Treatment: "Dichloroethane is used in agriculture for disinfecting grain storage facilities. Calculate the amount of substance required to treat a room with an area of 500 m^2, if 300 g of this substance is used per square meter."

4. Toothpaste: "Calculate the mass (g) of sodium monofluorophosphate sodium triphosphate (Na2PO3) contained in a tube of toothpaste (tube mass 100 g) labeled 'Active fluoride content 0.15%". Evaluation of contextual tasks is carried out using the developed criteria outlined in Table 7.

Table 7

Approximate evaluation scheme for contextual tasks

Criteria	Evaluation criteria	Score
Correspondence of the indicated problem to the conditions of the task	- the identified problem fully corresponds to the conditions outlined in the task	2
	- the problem identified in the task is detected but does not correspond to the conditions presented in the problem statement	1
	- the problem is identified incorrectly	0
Completeness and sufficiency of the data required to solve the problem	- the student used the data provided in the problem statement, and in case of their insufficiency, conducted independent research to gather additional information	2
	- the student uses the data provided in the problem statement, but in case of their insufficiency, did not conduct a search for the necessary information	1
	- the conditions of the problem were not utilized	0
The sequence and correctness of the solution steps	- the steps of solving the problem are sequential and correct	2
	- the steps of solving the problem are sequential, but errors were made in the solution	1
	- the sequence of steps and the method of solving the problem are incorrect	0
The rationale for the solution approach	- several solution approaches are proposed, but the most rational one is chosen, which is justified by the student	2
	- one solution approach is proposed, but the choice is not justified	1
	- no solution approach is proposed	0
The completeness and correctness of the provided answer	- the answer is complete and correct	2
	- the answer is correct, but not complete	1
	- the answer is incorrect	0
The completeness and correctness of the solution presentation	- the initial data and the solution steps are presented correctly, using figures, graphs, which confirm the solution	2
	- the data and solution steps are presented correctly, but there are no diagrams, figures, or illustrations illustrating the solution	1
	- the data and solution method are not formatted correctly	0

To conduct a correct comparison between the results of contextual task performance and grades obtained through traditional assessment, the quantitative measurement results were correlated with qualitative grades in Table 8.

Table 8

Correspondence between the results of contextual task performance and qualitative grades

Qualitative grade	«5»	«4»	«3»	«2»
Quantitative result	84-68	67-51	50-26	25-0

Results of contextual task performance by students of the 11th grades in the experimental groups are presented in appendices 36-38. In addition to contextual tasks, students in the 11th grades of the experimental groups were offered competency-oriented tests at the final stage of their education. The content of the competency-oriented test is presented in section 3.3.

Multiple-choice task: (with a choice of one correct answer) The storage period of car tires at t= 20°C is 5 years, while at t= -10°C it is 13 years. What will be the storage period of these tires at 5°C?

1) 18 years, 2) 20 years, 3) 21 years, 4) 22 years, 5) 23 years

Open-ended completion task: (involves writing a short answer) For scanning the brain, 48 g of iron is required. The time required to conduct electrolysis of the iron sulfate (FeSO4) solution at a current strength of X amperes to obtain the necessary mass of pure metal is…

Task with free-form response: Discuss the environmental impact of plastic pollution on marine ecosystems and propose potential solutions to mitigate this issue

The compound with the molecular formula C3H8O underwent oxidative dehydrogenation, resulting in the formation of a product with the composition C3H6O. This substance reacts with the "silver mirror," forming a compound C3H8O2. When calcium hydroxide acts on the latter, a substance used as a food additive under the code E282 is obtained. It inhibits mold growth in bakery and confectionery products and is found in Swiss cheese. Provide the formula for E282, write down the equations of the mentioned reactions, and name all organic substances.

After determining the primary data, we conducted their scaling to obtain qualitative marks. The necessity of this procedure is explained by the fact that only in this case we can compare the quantitative scores obtained through the competency-oriented test with the results of assessment using traditional methods and means in Table 9.

Table 9

Correspondence of competency-oriented test results to qualitative marks

Qualitative grade	«5»	«4»	«3»	«2»
Quantitative result	48-38	37-29	28-14	13-0

We assumed that the competency-oriented test, as well as contextual tasks, allows for the identification of the same elements of competency content, and there should be no significant differences between the measurement results. To confirm this assumption, we used correlation analysis and calculated statistical criteria. The results of the statistical analysis are presented in Table 10.

Table 10

Statistical criteria for analyzing the measurement results of students' chemical competencies in experimental groups

Results of "traditional" assessment		Results of completing contextual tasks	
Indicators	Values	Indicators	Values
Mean value	25,431	Mean value	35,43
Standard error	1,65	Standard error	2,01
Median	27	Median	34
Mode	33	Mode	24
Standard deviation	7,94	Standard deviation	9,66
Sample variance	63,07	Sample variance	93,34
Kurtosis	-1,07	Kurtosis	-1.27
Skewness	-0,46	Skewness	0,17
Number of intervals	25	Number of intervals	31
Minimum score	12	Minimum score	24
Maximum score	37	Maximum score	55
Total	585	Total	815
Account	23	Account	23
The reliability level (95.0%)	3,43	The reliability level (95.0%)	4,17

The existence of a significant similarity in quantitative indicators is supported by a correlation coefficient value of 0.84. Therefore, our assumption has been confirmed, and these instruments are valid for measuring the content of both the knowledge and activity components of students' chemical competencies. Comparison of the results of internal assessment (contextual tasks, tests, "traditional means") and external control (national standardized testing) was conducted using methods of one-way analysis of variance and correlation analysis. The results of assessing the mastery of the educational program in chemistry by students of the 11th grade in the experimental groups are presented in Table 11.

Table 11

Measurement and assessment data of the developed content of chemical competencies of 11th grade students (Academic year 2022-2023)

№	Results of assessment using traditional means	Results of UNT (UNT) in Chemistry		Results of solving contextual tasks		Results of competency-based test	
		Quantitative result	Qualitative mark	Quantitative result	Qualitative mark	Quantitative result	Qualitative mark
1.	4	44	3	35	3	28	3
2.	3	31	3	30	3	19	3
3.	4	44	3	42	3	31	4
4.	5	53	4	39	3	34	4
5.	5	77	5	50	3	33	4
6.	3	-	-	57	4	33	4
7.	5	57	4	30	3	23	3
8.	4	59	4	27	3	21	3
9.	5	53	4	53	4	30	4
10.	3	-	-	53	4	33	4

Statistical analysis of the measurement results of the chemical competencies of the experimental group students and the calculation of the Pearson coefficient between different forms of control indicate significant differences between them, as given in Tables 12-16

Table 12

Statistical criteria for the measurement and assessment of the chemical competencies of 11th-grade students (based on the results of the analysis of variance)

Groups	Score	Sum	Mean	Variance
"Traditional" assessment	40	172	4,3	0,47
Contextual tasks	40	107	2,675	0,37
Test	40	127	3,175	0,35

Table 12 shows the statistical criteria for three different assessment methods: traditional assessment, contextual tasks, and tests. The mean values indicate that the traditional assessment had the highest Mean score (4.30), followed by tests (3.18), and contextual tasks (2.68). The variance values suggest that the scores from traditional assessments and tests were relatively consistent, while the scores from contextual tasks showed more variability.

Table 13

Statistical criteria for the measurement and assessment of the chemical competencies of 11th-grade students (based on the results of the analysis of variance)

Source of Variation	SS	df	MS	F	*p*-value	F-critical
Between Groups	55.42	2	27.71	69.05	1.57E-20	3.07
Within Groups	46.95	117	0.40			
Total	102.37	119				

Table 13 presents the analysis of variance (ANOVA) for the three groups. The F-value (69.05) and the p-value (1.57E-20) indicate that there are significant differences between the groups. The F-critical value (3.07) is lower than the F-value, confirming the significance of the results. This implies that the traditional assessment, contextual tasks, and tests measure different aspects of chemical competencies.

Table 14

Pairwise pearson correlation coefficients between assessment methods

Assessment Method	Traditional Assessment	Contextual Tasks	Test
Traditional Assessment	1	0.48	0.43
Contextual Tasks		1	0.65
Test			1

Table 14 shows the Pearson correlation coefficients between the different assessment methods. The correlation between traditional assessment and contextual tasks is 0.48, indicating a weak relationship. The correlation between traditional assessment and tests is 0.43, also indicating a weak relationship. The correlation between contextual tasks and tests is 0.65, indicating a moderate relationship. These results suggest that the different assessment methods evaluate distinct components of chemical competencies.

Table 15

Statistical criteria for measuring and assessing the chemical competencies of 11th-grade students (based on the results of the analysis of variance)

Group	N	Sum	Mean	Variance
Traditional Assessment	21	80	3.81	0.56
Contextual Tasks	21	54	2.57	0.26
Test	21	60	2.86	0.13

Table 15 presents the mean values show that traditional assessment scores are the highest (3.81), followed by test scores (2.86) and contextual tasks (2.57). The variance indicates that contextual tasks have the least variability in scores (0.26), suggesting consistency in student performance on these tasks.

Table 16

Statistical criteria for measuring and assessing the chemical competencies of 11th-grade students at Gymnasium №178 (based on the results of the analysis of variance)

Source of Variation	SS	df	MS	F	*p*-value	F-critical
Between Groups	17.65	2	8.83	27.94	2.66E-09	3.15
Within Groups	18.95	60	0.32			
Total	36.60	62				

Table 16 provides the ANOVA results for Gymnasium №178. The F-value (27.94) and the very low p-value (2.66E-09) indicate significant differences between the groups. The F-critical value (3.15) being lower than the F-value supports this significance, showing that the traditional assessment, contextual tasks, and tests measure different dimensions of chemical competencies.

Table 17

Pairwise pearson correlation coefficients between assessment methods at gymnasium 178

	Traditional assessment	Contextual tasks	Test
"Traditional" assessment	1		
Contextual tasks	0,82	1	
Test	0,45	0 0,47	1

Table 17 displays the Pearson correlation coefficients between the assessment methods at Gymnasium №178. The correlation between traditional assessment and contextual tasks is 0.83, indicating a strong relationship. The correlation between traditional assessment and tests is 0.45, indicating a weak relationship. The correlation between contextual tasks and tests is 0.47, indicating a weak relationship. These results highlight the significant overlap between traditional assessment and contextual tasks but suggest that tests measure different aspects of competencies.

In the experimental group at Lyceum No. 12 in Almaty, we pairwise compared the results of control using conventional methods and means with the results of UNT. The statistical criteria for analyzing the obtained data are presented in Tables 18 and 19.

Table 18

Statistical criteria for evaluating the chemical competencies of 11th-grade students at Lyceum №12

Groups	*Score*	*Sum*	*Mean*	*Variance*
Traditional assessment	19	77	4,05	0,83
Unified National Testing exams	19	67	3,52	0,59
Contextual tasks	19	58	3,05	0,49

Table 18 shows the statistical criteria for three different assessment methods: traditional assessment, Unified National Testing (UNT), and contextual tasks. The mean values indicate that the traditional assessment had the highest average score (4.05), followed by UNT (3.53), and contextual tasks (3.05). The variance values suggest that traditional assessment scores had the highest variability, followed by UNT and contextual tasks.

Table 19

Analysis of Variance for Evaluating the Chemical Competencies of 11th-Grade Students at Lyceum №12

Analysis of variance						
Source of Variation	SS	df	MS	F	p-value	F-critical
Between Groups	9.51	2	4.75	7.41	0.0014	3.17
Within Groups	34.63	54	0.64			
Total	44.14	56				

Note. The discrepancies in the results are significant at the 0.14% level.

Table 19 presents the analysis of variance (ANOVA) for the three groups. The F-value (7.41) and the p-value (0.0014) indicate significant differences between the groups. The F-critical value (3.17) being lower than the F-value supports this significance, showing that the traditional assessment, UNT, and contextual tasks measure different dimensions of chemical competencies. The discrepancies in the results are significant at the 0.14% level.

Table 20

Pairwise pearson correlation coefficients between assessment methods at lyceum №12

	Traditional methods and means	Unified National Testing (UNT)	Contextual tasks
Traditional methods and means	1		
Unified National Testing (UNT)	0,82	1	
Contextual tasks	0,68	0,66	1

Table 20 displays the Pearson correlation coefficients between the assessment methods at Lyceum №12. The correlation between traditional assessment and UNT is 0.83, indicating a strong relationship. The correlation between traditional assessment and contextual tasks is 0.69, indicating a moderate relationship. The correlation between UNT and contextual tasks is 0.66, also indicating a moderate relationship. These results highlight the significant overlap between traditional assessment and UNT but suggest that contextual tasks measure slightly different aspects of competencies.

Drawing a conclusion about the readiness of a school graduate for life and activity using UNT or through "traditional" control methods is quite challenging. The statistical analysis of the measurement results of the chemical competencies across all experimental groups has identified significant disparities between assessments conducted using conventional control methods and innovative tools, thereby validating the utility of employing comprehensive evaluation for thoroughness and objectivity in assessment. Throughout the study, it was revealed that chemical competencies are cultivated and progressed in correlation and interdependence with key competencies. Consequently, it is imperative to monitor the formation and advancement of not only subject-specific competencies but also the key competencies of students.

Discussion

The results indicate a weak correlation (r = 0.48) between traditional assessment scores and contextual task performance. Traditional assessment methods, such as standardized tests and written exams, primarily measure students' ability to recall and reproduce knowledge (Biggs, 2003; Black & Wiliam, 1998). This finding aligns with the literature, which highlights the limitations of traditional assessments in capturing higher-order thinking skills, such as application, analysis, and problem-solving (Gulikers, Bastiaens, & Kirschner, 2004). Contextual tasks, on the other hand, require students to apply their knowledge in practical, real-world scenarios, reflecting their ability to engage in independent thinking and problem-solving (Shepard, 2000). The weak correlation underscores the need for integrating diverse assessment methods to provide a comprehensive evaluation of students' competencies. Incorporating contextual tasks into the assessment framework can offer a more authentic measure of students' readiness for real-life challenges and better reflect their practical capabilities (Dochy, Segers, & Sluijsmans, 1999).

The relationship between traditional assessment and competency-oriented testing also showed a weak correlation (r = 0.43), suggesting that these two methods evaluate different aspects of student learning. Competency-oriented tests are designed to measure not only the knowledge component but also the skills and attitudes necessary for effective performance in specific contexts (Mulder, Weigel, & Collins, 2007). This approach aligns with the competency-based education framework, which emphasizes the development of holistic competencies rather than isolated knowledge components (Gonczi, 1994). Studies by Shavelson et al. (2008) support the notion that competency-oriented assessments provide a more comprehensive evaluation of student capabilities. The weak correlation found in this study highlights the limitations of traditional assessments in capturing the full range of student competencies. Incorporating competency-oriented testing can help bridge this gap, offering a more nuanced understanding of student learning and performance, and ensuring that students are better prepared for professional and real-life situations.

The moderate correlation (r = 0.65) between contextual tasks and competency-oriented testing suggests that these methods share some commonalities in what they assess. Both approaches aim to evaluate students' ability to apply their knowledge and skills in practical, real-world scenarios (Gulikers et al., 2004). This finding is consistent with the literature, which indicates that contextual and competency-based assessments are more aligned with constructivist learning theories that emphasize active, context-based learning (Jonassen, 1991; Wiggins, 1998). For instance, Gulikers, Bastiaens, and Kirschner (2006) argue that authentic assessments, such as contextual tasks and competency-based tests, provide a more accurate reflection of students' capabilities by situating the assessment in real-life contexts. The moderate correlation observed in this study reinforces the value of these assessment methods in providing a holistic evaluation of student competencies, suggesting that they can effectively complement traditional assessments by capturing a broader range of student skills and knowledge.

A strong correlation (r = 0.83) was observed between traditional assessment results and UNT scores, indicating that both methods largely measure similar aspects of student knowledge. This finding aligns with previous research, which shows that standardized tests, like the UNT, are effective in assessing students' knowledge and understanding of subject content (Popham, 2001). However, these assessments often fall short in evaluating higher-order thinking skills and practical application of knowledge (Resnick & Resnick, 1992). The strong correlation suggests that traditional assessments and UNT are reliable in measuring students' theoretical understanding but may not fully capture their practical competencies. This highlights the need for supplementary assessment methods, such as contextual tasks, to provide a more comprehensive evaluation of student learning and readiness for real-world challenges. The findings suggest that while UNT and traditional assessments are valuable for evaluating knowledge retention, they should be supplemented with methods that assess practical skills and problem-solving abilities.

The statistical analysis revealed significant discrepancies between the results of traditional assessments, contextual tasks, and competency-oriented tests (Tables 4-8). This finding is consistent with the literature, which indicates that different assessment methods measure distinct dimensions of student learning (Biggs, 2003; Shepard, 2000). Traditional assessments are often criticized for their focus on rote learning and recall, whereas contextual tasks and competency-based tests emphasize practical application and critical thinking (Brown, Collins, & Duguid, 1989; Wiggins, 1998). These discrepancies underscore the importance of using a variety of assessment methods to capture a comprehensive picture of student competencies. As noted by Darling-Hammond (2006), a balanced assessment system that includes both traditional and innovative methods can provide a more accurate and complete evaluation of student learning, ultimately leading to better educational outcomes. The significant differences in assessment results highlight the need for educational practices to evolve, incorporating a mix of assessment types to fully understand and support student development.

The findings of this study have important implications for pedagogical practices. The weak correlations between traditional assessments and other methods highlight the limitations of relying solely on conventional assessment techniques. Educators should consider integrating more contextual and competency-based assessments into their teaching practices to better evaluate and support student learning (Gulikers et al., 2004). This approach aligns with the shift towards competency-based education, which emphasizes the development of a broad range of skills and knowledge necessary for success in the 21st century (Voogt & Roblin, 2012). By adopting a more comprehensive assessment strategy, educators can provide students with a more meaningful and relevant learning experience, better preparing them for future challenges. This study reinforces the importance of pedagogical adaptability and the integration of diverse assessment methods to foster a more holistic and practical learning environment.

Conclusion

As a result of the research work, it was found that teachers of natural sciences (biology, geography, chemistry) have the skills to establish patterns and identify cause-and-effect relationships between the components of nature, society and the economy. Therefore, as specialists with broad professional competencies in the field of worldview sciences, they are the most prepared to form the foundations of socio-humanitarian safety among students.

In order to determine the place and role of components of socio-humanitarian safety in natural science education, the features of their implementation in the curricula of institutions of general secondary education are considered. The implementation of components of socio-humanitarian safety within the framework of academic subjects of the natural science cycle has its own distinctive features depending on the subject and the specifics of its teaching methodology.

When developing the conceptual foundations for the training of teachers of natural sciences to implement a competence-based approach in the aspect of socio-humanitarian safety of man and society, methodological approaches are highlighted: competence-based, practice-oriented, system-structural, personal-activity, cultural, integrative. In order to implement these approaches, the application of didactic principles for the selection and design of educational content focused on the formation of socio-humanitarian literacy is justified.

The theoretical model of training future teachers of natural sciences to implement issues of socio-humanitarian safety, represents a system of interrelated structural and functional components: targeted, content-methodological, procedural-activity and performance-evaluation. When developing the model, the moderator identified a competence-based approach that allows students to form all groups of professionally significant competencies.

The main educational programs in chemical disciplines do not emphasize the task of implementing components of socio-humanitarian safety in the training of future teachers of natural sciences. When updating the content of the subjects taught, one of the basic principles at the pedagogical university is the continuity and consistency of university and school programs.

From the point of view of achieving optimal results in preparing future teachers of natural sciences to implement aspects of socio-humanitarian safety, it is necessary to use such methods and forms of work that will contribute not only to more effective assimilation of knowledge, but also allow future teachers to acquire practical skills to apply the acquired knowledge in their future professional activities. The choice of the organizational form of training depends on the conformity of the forms of training sessions with the goals, content and applied teaching methods. When preparing future teachers of biology, geography and chemistry to implement aspects of socio-humanitarian safety in the educational process, it is advisable to introduce interactive learning methods that are aimed at increasing the level of professional competence of the teacher.

To prepare future teachers of the specialty chemistry for the implementation of aspects of socio-humanitarian safety, optional classes "Aspects of socio-humanitarian safety in the study of chemistry in institutions of general secondary education" can become an effective form of work. The content of the offered elective classes is based on the curricula of institutions of higher education in the academic disciplines of the natural science cycle, on methods of teaching chemistry, as well as on curricula in the academic subjects "Chemistry" for institutions of general secondary education.

In conclusion, this study highlights the necessity for integrating diverse assessment methods to capture the full range of student competencies. Traditional assessments, while reliable for measuring theoretical knowledge, fall short in evaluating practical application and higher-order thinking skills. Contextual tasks and competency-oriented tests provide a more holistic assessment, better reflecting students' real-world capabilities. The significant discrepancies between these methods underscore the importance of a balanced assessment approach. Integrating various assessment techniques can provide a more comprehensive evaluation of student learning, ultimately leading to improved educational practices and outcomes. The study's findings suggest that educational systems should move towards incorporating a mix of assessment methods to ensure that all aspects of student competencies are accurately measured and developed.

The implications of this research extend to educational policy and curriculum design, advocating for a more nuanced and multifaceted approach to student assessment. Future research should explore the implementation of these diverse assessment methods across different educational contexts and subject areas to validate and refine the findings of this study. Additionally, professional development for educators should include training on the design and use of contextual and competency-based assessments to ensure effective integration into teaching practices. By adopting a more comprehensive and integrated assessment strategy, educators can better prepare students for the complexities and demands of the modern world.

Author Contributions

Conceptualization, NG; methodology, VAh and ZhM; data curation, NG and NZh; writing – original draft preparation, NG, VAh and MO; writing – review and editing, MO; visualization, ZhM and NZh; supervision, VAh. All authors have read and agreed to the published version of the manuscript.

Conflicts of Interest

The authors declare no conflict of interest.

References

Adu-Gyamfi, K. (2020). Pre-service teachers' conception of an effective science teacher: The case of initial teacher training. *Journal of Turkish Science Education, 17*(1), 40–61. https://doi.org/10.36681/tused.2020.12

Aharodnik, V. E., Podberezko, S. A., & Yastrebova, N. V. (2020). Socio-humanitarian security as one of the areas of practice-oriented training of future teachers of natural sciences. *Current Problems of Science, Production and Chemical Education: Materials of the XI International Scientific and Practical Conference* (pp. 87–88). Astrakhan: Astrakhan State University, Publishing House "Astrakhan University".

Aharodnik, V. E., Podberezko, S. A., & Yastrebova, N. V. (2021). Implementation of socio-humanitarian safety components during natural sciences students' pre-graduation practice. *Priorities in Modern Science Education: Problems and Prospects* (pp. 512–521). Yakutsk.

Aharodnik, V. E., Mukataeva, Zh. S., & Danilchik, D. S. (2024). Formation of ideas about socio-humanitarian security among future teachers through an optional discipline. *Scientific Schools as the Basis for the Development of Science: Collection of Articles of the International Scientific and Practical Conference* (pp. 26–35). Novosibirsk.

Alikberova, L., & Stepin, B. (2002). Entertaining tasks and effective experiments in chemistry. Bustard.

Al-Musaidi, A., Al-Hajri, F., & Al-Mahrooqi, M. (2021). Gender differences in Omani students' perception of the pedagogical content knowledge of their science teachers as appeared in reality and students' preferences. *Journal of Turkish Science Education, 18*(4), 781–797. http://doi.org/10.36681/tused.2021.103

Ambusaidi, A., Al-Hajri, F., & Al-Mahrooqi, R. (2021). Pedagogical content knowledge of natural science teachers. *International Journal of Science Education, 43*(2), 246-266. https://doi.org/10.1080/09500693.2020.1844179

Baluev, D. G. (2004). *Social security and its elements in modern society*. Russian Academy of Sciences.

Banks, J. A., McGee Banks, C. A., Cortes, C. E., Hahn, C. L., Merryfield, M. M., & Moodley, K. A. (2001). *Multicultural education: Issues and perspectives* (4th ed.). John Wiley & Sons.

Beers, S. Z. (2011). *21st Century skills: Preparing students for their future.* John Wiley & Sons.
Bell, S. (2010). Project-based learning for the 21st century: Skills for the future. *The Clearing House: A Journal of Educational Strategies, Issues and Ideas, 83*(2), 39-43. https://doi.org/10.1080/00098650903505415
Biggs, J. (2003). *Teaching for quality learning at university: What the student does* (2nd ed.). Open University Press.
Black, P., & Wiliam, D. (1998). Assessment and classroom learning. *Assessment in Education: Principles, Policy & Practice, 5*(1), 7-74. https://doi.org/10.1080/0969595980050102
Boesdorfer, S. B. (2012). *PCK to practice: Two experienced high school chemistry teachers' pedagogical content knowledge in their teaching practice* [Unpublished doctoral dissertation]. Illinois State University.
Brown, J. S., Collins, A., & Duguid, P. (1989). Situated cognition and the culture of learning. *Educational Researcher, 18*(1), 32-42. https://doi.org/10.3102/0013189X018001032
Bybee, R. W. (2008). Scientific literacy, environmental issues, and PISA 2006: The 2008 Paul F-Brandwein lecture. *Journal of Science Education and Technology, 17*(6), 566–585.
Cannon, A. S., Anderson, K. R., Enright, M. C., Kleinsasser, D. G., Klotz, A. R., O'Neil, N. J., & Tucker, L. J. (2023). Green chemistry teacher professional development in New York State high schools: A model for advancing green chemistry. *Journal of Chemical Education, 100*(6), 2224–2232.
Capraro, R. M., Capraro, M. M., & Morgan, J. R. (Eds.). (2013). *STEM project-based learning: An integrated science, technology, engineering, and mathematics (STEM) approach.* Sense Publishers.
Carmichael, R. S. (2013). Safety in the school science laboratory: Providing students with a safe learning environment. *Journal of Chemical Education, 90*(7), 825-829. https://doi.org/10.1021/ed3008059
Carvalho, C., Fíuza, E., Conboy, J., Fonseca, J., Santos, J., Gama, A. P., & Salema, M. H. (2015). Critical thinking, real life problems and feedback in the sciences classroom. *Journal of Turkish Science Education, 12*(2), 21–31.
Chai, C. S., Koh, J. H. L., & Tsai, C. C. (2013). *A review of technological pedagogical content knowledge. Educational Technology & Society, 16*(2), 31-51.
Chan, K. K., & Hume, A. (2019). Towards a consensus model: Literature review of how science teachers' pedagogical content knowledge is investigated in empirical studies. In A. Hume, R. Cooper, & A. Borowski (Eds.), *Repositioning Pedagogical Content Knowledge in Teachers' Knowledge for Teaching Science* (pp. 3–76).
Creswell, J. W., & Plano Clark, V. L. (2018). *Designing and conducting mixed methods research* (3rd ed.). Sage Publications.
Darling-Hammond, L. (2006). *Powerful teacher education: Lessons from exemplary programs*. Jossey-Bass.
Darling-Hammond, L., Hyler, M. E., & Gardner, M. (2017). Effective teacher professional development. *Learning Policy Institute*. https://learningpolicyinstitute.org/product/effective-teacher-professional-development-report
Desimone, L. M. (2009). Improving impact studies of teachers' professional development: Toward better conceptualizations and measures. *Educational Researcher, 38*(3), 181-199. https://doi.org/10.3102/0013189X08331140
Dochy, F., Segers, M., & Sluijsmans, D. (1999). The use of self-, peer and co-assessment in higher education: A review. *Studies in Higher Education, 24*(3), 331-350. https://doi.org/10.1080/03075079912331379935
Domenici, V. (2022). STEAM project-based learning activities at the science museum as an effective training for future chemistry teachers. *Education Sciences, 12*(1), 30. https://doi.org/10.3390/educsci12010030
Elmas, R., & Geban, Ö. (2016). The effect of context based chemistry instruction on 9th grade students' understanding of cleaning agents topic and their attitude toward environment. *Education and Science, 41*(185). https://doi.org/10.15390/EB.2016.5502

European Commission (EC). (2011). Consumer understanding of labels and the safe use of chemicals. *Special Eurobarometer 360.* Brussels: European Commission.

Galymova, N. G., Mukataeva, Zh. S., Zhussupbekova, N. S., & Orazbayeva, M. A. (2023). Ways to implement socio-humanitarian security in the preparation of future chemistry teachers. *Bulletin of the Abay Kazakh National Pedagogical University of the National Academy of Sciences of the Republic of Kazakhstan, 3*(403), 34–44. ISSN 2518-1467 (Online), ISSN 1991-3494 (Print).

Gay, G. (2010). *Culturally responsive teaching: Theory, research, and practice* (2nd ed.). Teachers College Press.

Gonczi, A. (1994). Competency-based education and training. In M. Mulder (Ed.), *Competence-based vocational and professional education* (pp. 23-44). Springer.

Gulikers, J. T. M., Bastiaens, T. J., & Kirschner, P. A. (2004). A five-dimensional framework for authentic assessment. *Educational Technology Research and Development, 52*(3), 67-86. https://doi.org/10.1007/BF02504676

Gulikers, J. T. M., Bastiaens, T. J., & Kirschner, P. A. (2006). Authentic assessment, student and teacher perceptions: The practical value of the five-dimensional framework. *Journal of Vocational Education and Training, 58*(3), 337-357. https://doi.org/10.1080/13636820600955443

Guskey, T. R. (2002). Professional development and teacher change. *Teachers and Teaching: Theory and Practice, 8*(3), 381-391. https://doi.org/10.1080/135406002100000512

Harris, J., Mishra, P., & Koehler, M. (2009). Teachers' technological pedagogical content knowledge and learning activity types: Curriculum-based technology integration reframed. *Journal of Research on Technology in Education, 41*(4), 393-416. https://doi.org/10.1080/15391523.2009.10782536

Herrington, J., & Oliver, R. (2000). An instructional design framework for authentic learning environments. *Educational Technology Research and Development, 48*(3), 23-48. https://doi.org/10.1007/BF02319856

Hill, R. H., & Finster, D. C. (2016). Laboratory safety for chemistry students (2nd ed.). *Journal of Chemical Education, 93*(10), 1730-1731. https://doi.org/10.1021/acs.jchemed.6b00589

Hmelo-Silver, C. E., Duncan, R. G., & Chinn, C. A. (2007). Scaffolding and achievement in problem-based and inquiry learning: A response to Kirschner, Sweller, and Clark (2006). *Educational Psychologist, 42*(2), 99-107. https://doi.org/10.1080/00461520701263368

Hsu, P. S. (2016). Examining the impact of educational technology courses on teacher candidates' perceptions. *Educational Technology & Society, 19*(3), 150-160.

Hui, C., Cao, M., He, J., & Yu, J. (2017). Methodology for developing research activities in training future teachers using information resources. *Journal of Education and Practice, 8*(5), 123-131.

Hui, C., Amanbayeva, M. B., Assiya, M. D., Unerbayeva, Z. O., Shalabayev, K. I., Sumatokhin, S. V., Imankulova, S. K., & Childibayev, J. B. (2017). Methodology of research activity development in preparing future teachers with the use of information resources. *EURASIA Journal of Mathematics, Science and Technology Education, 13*(11), 7400–7410. https://doi.org/10.12973/ejmste/79329

Hussein, B., & Shifera, G. (2022). Knowledge, attitude, and practice of teachers and laboratory technicians toward chemistry laboratory safety in secondary schools. *Journal of Chemical Education, 99*(9), 3096-3103. https://doi.org/10.1021/acs.jchemed.2c00043

Jonassen, D. H. (1991). Objectivism versus constructivism: Do we need a new philosophical paradigm? *Educational Technology Research and Development, 39*(3), 5-14. https://doi.org/10.1007/BF02296434

Johnson, E. B. (2002). *Contextual teaching and learning: What it is and why it is here to stay.* Corwin Press.

Kazakov, M. A. (2013). Human security as a basis of internal policy of modern Russia. Bulletin of Nizhny Novgorod University named after Lobachevsky. *Ser. Social Sciences, 1*(29), 22–27.

King, D., & Henderson, S. (2018). Context-based learning in the middle years: Achieving resonance between the real-world field and environmental science concepts. *International Journal of Science Education, 40*(10), 1221–1238. https://doi.org/10.1080/09500693.2018.1470352

Koehler, M. J., & Mishra, P. (2009). What is technological pedagogical content knowledge (TPACK)? *Contemporary Issues in Technology and Teacher Education, 9*(1), 60-70.

Kozyreva, O. A. (2021). Pedagogical modeling as a construct of theorization and scientific search. *Bulletin of NVSU, 1,* 88–94.

Kuntz, J. R., & Hess, K. A. (2020). Teacher professional development for inclusive education. *International Journal of Inclusive Education, 24*(12), 1305-1318. https://doi.org/10.1080/13603116.2018.1468495

Kutu, H. (2011). Teaching "Chemistry in Our Lives" unit in the 9th grade chemistry course through context-based ARCS instructional model. *Ondokuz Mayıs Üniversitesi Eğitim Fakültesi Dergisi, 30*(1), 29–62. https://doi.org/10.7822/egt46

Lopez, A. F., & Gonzalez, E. M. (2020). Culturally relevant pedagogy and educational equity. *Review of Educational Research, 90*(4), 573-610. https://doi.org/10.3102/0034654320938126

Magnusson, S., Krajcik, J., & Borko, H. (1999). Nature, sources and development of pedagogical content knowledge for science teaching. In J. Gess-Newsome & N. G. Lederman (Eds.), *Examining Pedagogical Content Knowledge: The Construct and Its Implications for Science Education* (pp. 95–132).

Marifa, H., Abukari, M., Samari, J., Dorsah, P., & Abudu, F. (2023). Chemistry teachers' pedagogical content knowledge in teaching hybridization. *Pedagogical Research, 8*(3), em0162. https://doi.org/10.29333/pr/13168

Mukatayva, Zh. S. (2023). *Educational program: Chemistry-biology.* Department of Chemistry, Almaty.

Mulder, M., Weigel, T., & Collins, K. (2007). The concept of competence in the development of vocational education and training in selected EU member states: A critical analysis. *Journal of Vocational Education and Training, 59*(1), 67-88. https://doi.org/10.1080/13636820601145630

Palermo, M., Kelly, A., & Krakehl, R. (2021). Chemistry teacher retention, migration, and attrition. *Journal of Chemical Education, 98*(12), 3704–3713. https://doi.org/10.1021/acs.jchemed.1c00888

Pankova, S. (2009). From the experience of developing chemical competence. *Chemistry at School, 4,* 29–32.

Pichugina, S. (2004). Non-standard tasks in the activation of cognitive activity of schoolchildren. *Educational Practices, 3*(2), 22-34.

Pilot, A., & Bulte, A. M. (2006). The use of contexts as a challenge for the chemistry curriculum: Its successes and the need for further development and understanding. *International Journal of Science Education, 28*(9), 1087–1112. https://doi.org/10.1080/09500690600730737

Popham, W. J. (2001). *The truth about testing: An educator's call to action*. ASCD.

Prokhorov, B. V. (2010). *Human ecology.* M.: Academy.

Resnick, L. B., & Resnick, D. P. (1992). Assessing the thinking curriculum: New tools for educational reform. Changing Assessments: Alternative Views of Aptitude, *Achievement and Instruction, 2*(1), 37-75.

Schwartz-Bloom, R., Halpin, M., & Reiter, J. (2011). Teaching high school chemistry in the context of pharmacology helps both teachers and students learn. *Journal of Chemical Education, 88*(6), 744–750. https://doi.org/10.1021/ed100097y

Schön, D. A. (1987). *Educating the reflective practitioner: Toward a new design for teaching and learning in the professions*. Jossey-Bass.

Schwartz-Bloom, R., Halpin, M., & Reiter, J. (2011). Teaching high school chemistry in the context of pharmacology helps both teachers and students learn. *Journal of Chemical Education, 88*(6), 744–750. https://doi.org/10.1021/ed100097y

Shalashova, M. M. (2009). Using contextual tasks for assessing student competencies. *Chemistry at School, 4,* 24–28.

Shavelson, R. J., Webb, N. M., & Burstein, L. (1986). Measurement of teaching. *Handbook of Research on Teaching, 3*(2), 50-91.

Shepard, L. A. (2000). The role of assessment in a learning culture. *Educational Researcher, 29*(7), 4-14. https://doi.org/10.3102/0013189X029007004

Shulman, L. S. (1986). Those who understand: Knowledge growth in teaching. *Educational Researcher, 15*(2), 4-14. https://doi.org/10.3102/0013189X015002004

State program for regional development for 2020 - 2025 of the Republic of Kazakhstan. (2019). December 27, №990.

Stuckey, M., Hofstein, A., Mamlok-Naaman, R., & Eilks, I. (2013). The meaning of relevance in science education and its implications for the science curriculum. *Studies in Science Education, 49*(1), 1-34. https://doi.org/10.1080/03057267.2013.802463

Suryawati, E., & Osman, K. (2018). Contextual learning: Innovative approach towards the development of students' scientific attitude and natural science performance. Eurasia *Journal of Mathematics, Science and Technology Education, 14*(1), 61-76. https://doi.org/10.12973/ejmste/79329

Taber, K. S., & García Franco, A. (2010). Learning processes in chemistry: Drawing upon cognitive resources to learn about the particulate structure of matter. *Journal of the Learning Sciences, 19*(1), 99–142. https://doi.org/10.1080/10508400903530049

Tolsdorf, Y., Kousa, P., Markic, S., & Aksela, M. (2018). Learning to teach at heterogeneous and diverse chemistry classes: Methods for university chemistry teacher training courses. *EURASIA Journal of Mathematics, Science and Technology Education, 14*(10). https://doi.org/10.29333/ejmste/93377

TIMSS Turkey. (2017, November 25). *What is TIMSS?* http://timss.meb.gov.tr/?page_id=24

The Unified National Test (2024). *SNT in Kazakhstan: Preparation and order of conduction.* https://egov.kz/cms/en/articles/secondary_school/about_ent

United Nations Development Programme. (1994). *Human development report 1994: New dimensions of human security.* Oxford University Press.
https://hdr.undp.org/content/human-development-report-1994

Vikulina, A. A. (2013). Theoretical and methodological foundations of pedagogical modeling. *Journal of Pedagogical Research, 5*(2), 33-45.

Vikulina, M. A., & Polovinkina, V. V. (2013). Pedagogical modeling as a productive method of organizing and researching the process of distance education at a university. *Successes of Modern Natural Science, 3*, 109–112.

Voogt, J., & Roblin, N. P. (2012). A comparative analysis of international frameworks for 21st century competences: Implications for national curriculum policies. *Journal of Curriculum Studies, 44*(3), 299-321. https://doi.org/10.1080/00220272.2012.668938

Wiggins, G. (1998). *Educative assessment: Designing assessments to inform and improve student performance*. Jossey-Bass.

Zakrevskaya, O. V. (2011). Designing a model of professional orientation of an institution of general (complete) secondary education. *Pedagogical Education in Russia, 5*, 237–243.

Zimmermann, F., Melle, I., & Huwer, J. (2021). Developing prospective chemistry teachers' TPACK: A comparison between students of two different universities and expertise levels regarding their TPACK self-efficacy, attitude, and lesson planning competence. *Journal of Chemical Education, 98*(6), 1863–1874. https://doi.org/10.1021/acs.jchemed.0c01296

Zubarevich, N. V. (2020). *Social inequality and social policy in Russia*. Higher School of Economics.