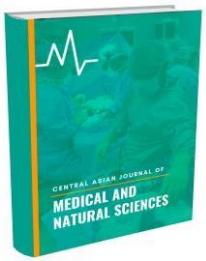

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Article

Interdisciplinary Integration in Chemistry Education: Enhancing Scientific Competence Among Students

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Abstract: This study explores the impact of interdisciplinary integration in chemistry education on the development of scientific competence among secondary school students. Despite the increasing emphasis on STEM education, there remains a knowledge gap in understanding how interdisciplinary approaches specifically enhance chemistry learning. Using a mixed-methods approach, including classroom observation and student assessments, the research investigates the effectiveness of integrating chemistry with subjects such as biology, physics, history, and geography. The findings reveal that students exposed to interdisciplinary teaching methods show improved critical thinking and problem-solving skills, as well as a deeper understanding of chemical concepts. These results suggest that interdisciplinary integration not only fosters a more holistic educational experience but also enhances students' readiness for international scientific evaluations. The implications of this study advocate for broader adoption of integrated curricula in secondary education to better prepare students for the complexities of modern scientific challenges.

Keywords: integration, integrated education, water, sulfur, mineral fertilizers, electronic simulator, divers, advertising lights

1. Introduction

In the world, it is becoming urgent to provide high-quality education to students of general education schools, to introduce modern technologies for the development of subject competence, to improve the didactic system of the mechanisms of creating their software, including the technologies for organizing each subject based on interdisciplinary integration.

On August 12, 2020, the presidential decree «On measures to increase the quality of continuous education and the effectiveness of science in the fields of chemistry and biology « was signed. In this decision, the development of chemical and biological sciences in our country, and the improvement of the quality of education and the effectiveness of science in these areas are set as a priority task.

Also, to fundamentally improve the quality of education in chemistry and biology, to introduce a completely new system of teaching these subjects in secondary schools, to provide educational institutions with modern laboratories, textbooks and other educational equipment, attracting qualified teachers-coaches to these directions, training personnel and establishing close communication and cooperation between the fields of education, science and production in the use of scientific results focused.

In order to ensure the implementation of this decision, the issue of training competitive personnel who can organize chemistry in general education schools to the level of

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modern requirements and effectively use advanced foreign experiences is the most urgent task before us. Therefore, we teachers should mobilize all our knowledge and energy to educate students and increase their interest in science.

2. Materials and Methods

The methodology for this study involved a comprehensive approach to evaluating the effectiveness of interdisciplinary integration in chemistry education within secondary schools. The research was conducted over a semester, focusing on students from the 7th and 8th grades. The study utilized a combination of qualitative and quantitative methods to capture a holistic view of the teaching process and its impact on student competence.

Initially, the research involved designing integrated lesson plans that combined chemistry with related subjects such as biology, physics, history, and geography. These lesson plans were developed based on existing educational frameworks and tailored to meet the specific curriculum requirements of the participating schools. Teachers were trained to implement these interdisciplinary lessons, with a focus on encouraging critical thinking and real-world application of scientific concepts.

Data collection involved classroom observations, where the interactions between teachers and students were recorded and analyzed to understand the dynamics of the interdisciplinary teaching approach. Additionally, pre- and post-tests were administered to assess the students' knowledge and competence in chemistry before and after the implementation of the integrated lessons. The tests were designed to measure not only content knowledge but also the ability to apply interdisciplinary concepts to solve complex problems.

The qualitative data from observations were analyzed using thematic analysis to identify patterns in teaching practices and student engagement. Quantitative data from the tests were statistically analyzed to determine the significance of the changes in student performance. The combined insights from these analyses provided a comprehensive understanding of how interdisciplinary integration influences the development of scientific competence in secondary education.

3. Results and Discussion

Integration in education is not one-sided, but comprehensive development is achieved in the student's knowledge and imagination of the world.

Interdisciplinary (integration) is the basis for the formation of a scientific worldview, teaches the student to correctly and fully understand nature, logical thinking, and the use of information technologies in practical activities for the purpose of scientific and technical development;

Integration is an interdisciplinary connection, which implies two types of integration: External integration-Mathematics, Biology, chemistry, geography, history, literature, Informatics, physical education.

Internal integration-Intersubjective connection, Interconnection and coherence of subjects.

In order to solve the problem of integrated teaching of sciences, it is necessary to understand the history of the emergence of sciences and their development.

For this, it is necessary to know the history of the development of sciences. Then it is possible to think about the current situation of the problem of integrated teaching of the sciences, the history of the emergence and development of the sciences, and what kind of sciences should be in the future.

The concept of "integration" when applied to the educational process has two meanings: Firstly, to achieve acceptance of the world around us as a whole among the students of this school (in this case, integration comes to the fore as an educational goal); Secondly, bringing together general aspects of science knowledge (in which integration is considered as an educational tool).

The studied scientific, pedagogical and methodical sources indicate that the problem of an integrated approach to the primary education system is a very urgent problem, and a number of works are being carried out in this regard. In addition to theoretical information, a number of lesson plans are published in many methodical sources, addressing various subjects and topics. One of the main problems of implementing integration in education is the lack of lesson plans and methodical instructions aimed at showing the structure of integrative lessons. One of the important pedagogical problems of today is the development of relevant methodological recommendations for the implementation of integration in education and its implementation.

We will give examples of some of the interpretations carried out in our experience. Before starting the chemistry lesson, it is important to determine the mentality of the students. To do this, it is better to start with life-problem situations or instructive stories that reach the reader's mind with exciting events in the lives of great people. You will not always be able to do this. To prepare for this in advance, we suggest that you plan your lesson and enrich it with all the interesting information and life experiences.

In the teaching of the topic "Sulphur" 8th grade. In ancient times, in order to know the quality of sulfur, a piece of it was squeezed by hand and held to the ear. If the sulfur makes a slight crackling sound, it is of good quality, if it does not make a sound, it is considered to be of poor quality and not used. Tell me, why is pure sulfur crunchy?

Answer: the sulfur is heated in the hand, and sections of different temperatures appear. As a result, tension occurs and a weak sound is heard.

In this case, the topic requires revealing the connection with physics, history and biology.

Questions:

1. What were the uses of sulfur in ancient times? Answer based on historical sources?
2. What is the cause of the rustling sound caused by the temperature in the palm of the hand? Answer based on the laws of physics?
3. What is the temperature of the human palm? It can be seen from a person and his health.
4. Apricot drying process? Prepare a presentation on this assignment.

In the 7th grade, when passing the topic of the periodic table of elements: When we think of the name D. I. Mendeleev, the periodic table of chemical elements comes to mind. On January 31, 1865, he defended his doctoral thesis. It is clear that everyone thinks that it must be from inorganic chemistry or the periodic table of elements. However, the dissertation was on a completely different topic. it can.

Answer: Combination of alcohol with water (vodka)

Question 1: Tell us about the harm of alcohol to the human body? Why does a person become unconscious under the influence of alcohol? What organ is this related to Based on what you learned from biology classes?

Question 2: What other discoveries was Mendeleev famous for in history? Look at history and answer?

Question 3: What is vodka made from?

When teaching the topic "Water" in the 7th grade: A person consumes a lot of drinking water during his life. Dirty water is the plague of the century. Dirty water is cleaned

from various mechanical and chemical impurities and disease-causing bacteria, viruses, microbes and pests using various methods. For this, chlorine, sodium hypochlorite, hydrogen peroxide and ozone are used clean? Answer: Ozone.

In this case, it is possible to show the connection between the sciences of biology, ecology and geography and the science of chemistry.

Questions:

1. How much water a person consumes in one day is equivalent to his daily water consumption? Give a reasoned answer based on biological knowledge?
2. What processes does water take part in the human body?
3. How long can you live without water?
4. Prepare a presentation project on the stages of water purification?
5. What is the percentage of drinking water in the world?
6. Why are ocean and river waters unsuitable for drinking? Answer based on your knowledge of geography?

Emphasizes the importance of various internal resources for students' creativity to successfully engage in creative work on the basis of interdisciplinary, as well as the importance of the environment in which creative work is carried out. Within such approaches, it serves as an important scheme for evaluating creative thinking. However, in order to gain a better understanding of students' creative thinking, it is necessary to contextualize these approaches in ways that are relevant to students' everyday school life. It reflects the unique aspects of the observation of creative thinking in the educational process and its constituent aspects. In the subjects of the National Curriculum prepared for general secondary school students for 8th grade students:

In order to prepare general secondary school students for international evaluation studies, they should teach this topic and explain the implementation of project work. For the project work, they should also study the tasks of scientifically justifying the use of mineral fertilizers during the growth of one of the plants (tomatoes, corn or cucumbers).

In forming the competence of scientific interpretation of data and evidence in their students, they will have the skills to perform tasks based on international evaluation studies and to prepare contextual tasks related to them. The results and conclusions obtained during the performance of the tasks given in the project work should be scientifically detailed. For example:

Project work 1: The mineral fertilizers given as feed for the cultivation of corn varieties given to the students as a project work are represented. Scientifically justify when the mineral fertilizers shown in the picture are given to the corn variety and how important it is for their growth. It will take at least 3 to 6 months to complete the project work. During this time, write down which mineral fertilizers are given and how they affect the corn variety in the following lines (Figure 1).

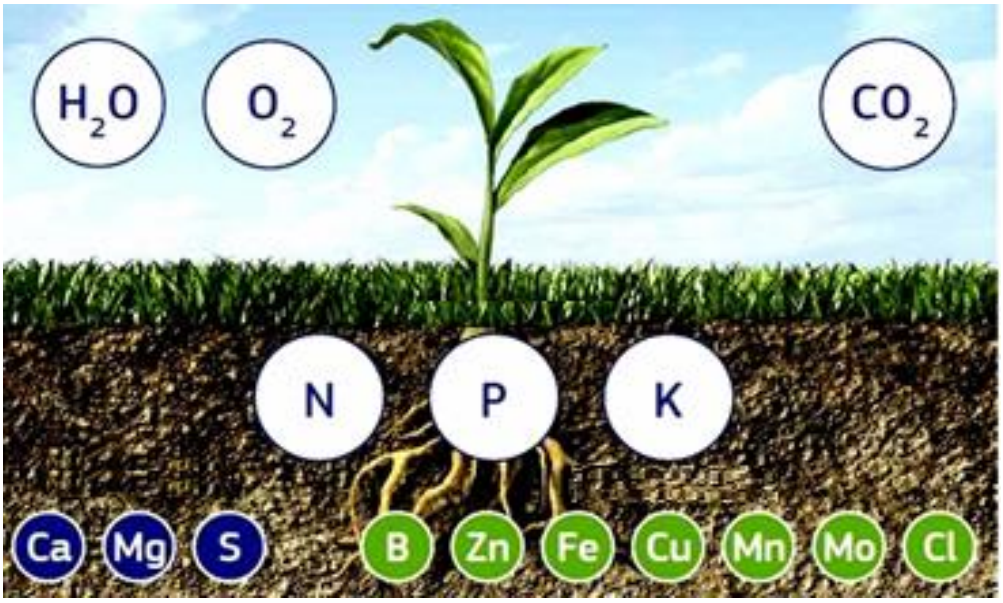
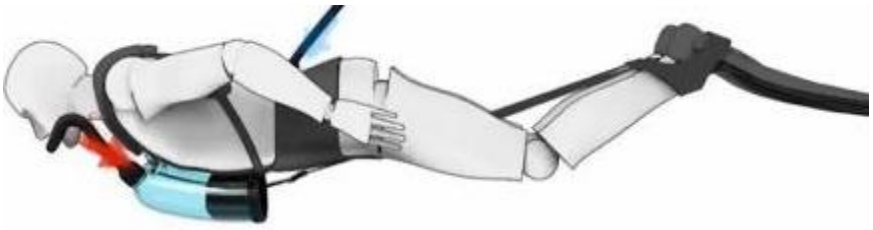


Figure 1. Composition of mineral fertilizers for plant development

Project Work 2: The pictures below show a scuba diver's air balloon and a diver's electronic device. Read the text above and find the connection between the hot air balloon and the diver. A dummy electronic diver was used before exploring underwater landscapes. Electronic dummies were lowered into the water before the divers lowered them into the water. The study of water composition, pressure, working conditions of the organism was usually carried out through an electronic simulator.

Figure 2. A scuba diver's air balloon and a diver's electronic device

Identify the relationship between the scuba diver and inert gases and explain how they affect the body. Write your answer on the lines below.



Project work 3: The following pictures represent the processes of inert gas ad preparation. In the production of advertising, slides are made of thin plastic polymers with light-transmitting properties (colorless pictures are prepared and inert gas solution or liquefaction is applied to these pictures instead of colors), then when they are illuminated, the colorless pictures drawn on the slides appear in color.

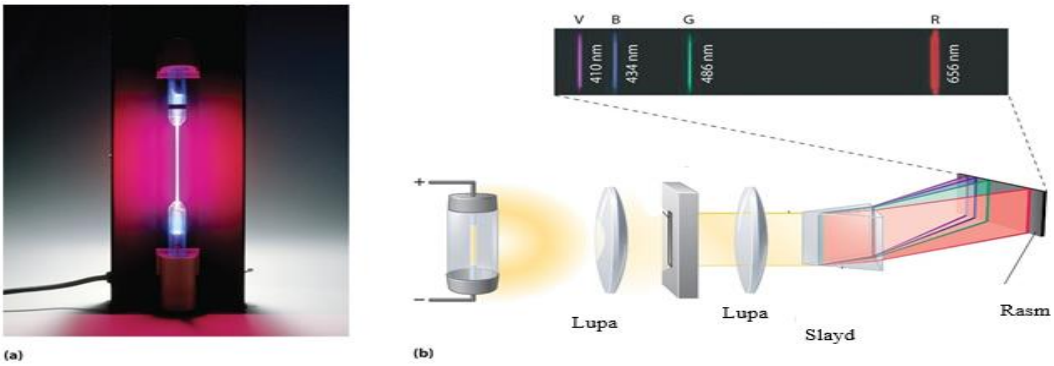


Figure 3. Use of inert gases in advertising banners

4. Conclusion

The findings of this study highlight the significant positive impact of interdisciplinary integration in chemistry education on students' scientific competence, particularly in enhancing critical thinking and problem-solving skills. The research demonstrates that integrating chemistry with subjects such as biology, physics, history, and geography fosters a more comprehensive understanding of scientific concepts among secondary school students, preparing them for the complexities of modern scientific challenges. These results underscore the importance of adopting integrated curricula in secondary education to improve students' readiness for international scientific evaluations. However, further research is recommended to explore the long-term effects of interdisciplinary integration on student performance across different educational contexts and to develop standardized methodologies for implementing such approaches effectively.

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