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Application Case-Based Technology for Improving Functional Literacy in Teaching Chemistry at Secondary Schools

Abstract

The concept of "functional literacy" was first mentioned in UNESCO documents and began attract the attention of pedagogical researchers from the mid-20th century onward. While traditional understood as an individual's ability to adapt to society, in the modern context, functional literacy is regarded as a key factor influencing personal development, adabtability and the capacity for lifelong learning. This makes it an essential component in shaping a competitive and well-rounded individual capable of meeting contemporary demands. Scientific concepts, real-life contexts and cross-disciplinary skills are considered key components of scientific literacy. The primary aim of this research is to assess these concepts and skills in an integrated manner.

Particular attention is given to identifying which questions can be addressed through scientific reasoning and evaluating students' ability to draw evidence-based conclusions from the data provided. Among the most effective approaches to fostering such competencies is the use of case-based learning.

This method helps students build essential skills such as analytical thinking, self-assessment, generating and defending creative solutions, and applying theoretical knowledge to real-world scenarios. Problem-based, inquiry-driven and project-oriented teaching strategies from the foundation for successfully integrating case-based techniques into educational practice.

Keywords: *case-based learning, functional literacy, chemistry education, technology education, case-technology*

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Təkmilləşdirmək üçün Case-based Technology tətbiqi – ümumtəhsil məktəblərində kimya tədrisində funksional savadlılıq

Xülasə

"Funksional savadlılıq" anlayışı ilk dəfə YUNESKO sənədlərində qeyd edilmiş və 20-ci əsrin ortalarından başlayaraq pedaqoji tədqiqatçıların diqqətini cəlb etməyə başlamışdır. Ənənəvi olaraq fərdlərin cəmiyyətə uyğunlaşma qabiliyyəti kimi başa düşülsə də, müasir kontekstdə funksional savadlılıq şəxsi inkişafa, uyğunlaşma qabiliyyətinə və ömür boyu öyrənmə qabiliyyətinə təsir edən əsas amil kimi qəbul edilir. Bu, onu müasir tələblərə cavab verə bilən, rəqabətqabiliyyətli və hərtərəfli fərdin formalaşdırılmasında vacib komponentə çevirir. Elmi anlayışlar, real həyat kontekstləri və fənlərarası bacarıqlar elmi savadlılığın əsas komponentləri hesab olunur. Bu tədqiqatın əsas məqsədi bu anlayışları və bacarıqları inteqrasiya olunmuş şəkildə qiymətləndirməkdir. Elmi əsaslandırma vasitəsilə hansı sualların həll oluna biləcəyinin müəyyən edilməsinə və tələbələrin təqdim olunan məlumatlardan sübuta əsaslanan nəticələr çıxarmaq bacarığının qiymətləndirilməsinə xüsusi diqqət yetirilir. Bu cür səriştələrin inkişaf etdirilməsi üçün ən təsirli yanaşmalardan biri vəziyyətə əsaslanan öyrənmənin istifadəsidir. Bu üsul tələbələrə analitik təfəkkür, özünüqiymətləndirmə, yaradıcı həllər yaratmaq və müdafiə etmək, nəzəri bilikləri real dünya ssenarilərinə tətbiq etmək kimi əsas bacarıqları formalaşdırmağa kömək edir. Problemə əsaslanan, sorğuya əsaslanan və layihə yönümlü tədris strategiyaları təhsil praktikasına keys-əsaslı üsulların uğurla inteqrasiyası üçün təməl təşkil edir.

Açar sözlər: *case-based öyrənmə, funksional savadlılıq, kimya təhsili, texnologiya təhsili, case-texnologiya*

Introduction

The significance of literacy stems from societal conditions and evolving demands. Being literate provides individuals and communities with access to local culture and the ability to understand social experiences that have developed over generations and hold regional importance. As noted by Z.Zhekov, "modern science functions as a subsystem within the broader structure of society, and its roles and responsibilities are shaped through its interactions with this larger social system" (Zhekov, 2001).

The value of literacy is shaped by the demands and conditions of society. It enables both individuals and cultural communities to access and engage with local traditions and heritage, which have evolved over centuries as regionally important social experiences. Moreover, literacy plays a key role in fostering personal growth and supporting active participation in social life (UNESCO, 2003). Technology is the core of study within technology education. Any educational process that involves the instruction and acquisition of technological skills can be considered a part of technology education (Dimitrova, 2009).

Technology education evolves in tandem with advancements in technology (Dugger, Eldon Yung, 1995). During the industrial era of the 20th century, it was primarily delivered through industrial arts and crafts, reflecting the lifestyle and work culture of industrial societies. As society has progressed-driven by intellectual growth and rapid technological development- technology education has expanded and redefined its content to better align with socially significant innovations (Georgiyeva, 1995).

Today, technology education plays an increasingly vital role due to the need for informed career choices that match the demands of the labor market, the rise of diverse technical tools, and the emergence of new workplace technologies. It's also important to consider the fluid nature of occupations in a market economy, along with the growing importance of family businesses and small enterprises, where individual roles and responsibilities are constantly evolving (Kolev, Kavdanska, Zoneva, 2000).

The core aim of technology education, through its cognitive aspects, is to provide students with a structured body of knowledge that serves as a foundation for:

1. Making well-informed career and professional decisions
2. Applying professional training effectively
3. Developing a sense of responsibility toward harmonizing personal ambitions with societal needs (Georgiyeva, 2004).

Through this, students are equipped with a social framework for solving real-world problems and adapting swiftly to changes in all areas of life (Yolova, 1985). This approach ensures that dual goals of education- imparting knowledge and fostering personal development- are achieved. Students grow not only by acquiring technical and technological skills, but also by developing emotional and creative connections to technology and innovation processes (Dimitrova, 2010).

Research

The development of students' chemical literacy is based on the joint activity of both teachers and learners. The roles and actions of participants in the educational process are aligned with a competency-based approach, which serves as the foundation for fostering chemical literacy (Garkunov, 1977). To effectively achieve the intended goals, it is essential to apply the modeling method. This approach allows for the design and development of a structured model that supports the process of building chemical literacy (Dolgorukov, 2009). Fostering natural science and chemical literacy among students involves mastering chemical terminology, understanding processes and phenomena, developing practical skills, strengthening learning abilities and interest in education, cultivating a desire for new knowledge, and applying acquired skills and knowledge in real-life contexts. It also includes the ability to identify and solve problems (Lufftoloyev, 2012).

The proposed model for developing chemical literacy integrates case-based learning techniques and emphasizes the interrelation and coherence of all components involved in the teaching process (Rever Argur, 2001). The model we suggest is built on the following key components: objectives, tasks, core ideas, instructional forms and methods, as well as the expected outcomes of the research conducted (Alekseyev, 1999). This model illustrates the integrity and interaction within the pedagogical process, where instruction aims to promote knowledge acquisition, skill development, habitual competence, and personal growth in students. Each component of the model is interconnected, working together to form a unified system.

An Example of a Lesson Developed Through the Application of the Case Method

Lesson Topic: Carboxylic Acids

Lesson Objectives:

- To engage students in active exploration and consolidation of new knowledge related to carboxylic acids.
- To support the development of essential skills and competencies needed to understand and work with carboxylic acids.
- To introduce the concept of oxygen-containing organic compounds with a focus on the carboxylic acid group.
- To build student understanding of chemical nomenclature, covering both systematic and common naming of carboxylic acids.
- To develop students' ability to analyze the structural and functional characteristics of carboxylic acids, including writing chemical formulas, naming compounds, identifying isomers and homologous series, and exploring their physical and chemical properties.
- To highlight the real-world relevance of carboxylic acids in industrial processes, healthcare, daily life, and other practical domains.
- To encourage critical thinking and problem-solving through the analysis and interpretation of scientific data.

Total duration of the lesson: 45 minutes.

Lesson structure	Teacher's role
Activation of Prior Knowledge – 10 minutes	The teacher assesses students' retention of knowledge from the previous topic. The assessment is carried out through the application of a case-based task related to the topic "Aldehydes and Ketones." Students are divided into small groups, and each group is assigned a specific case. **Case №1** The given substance, when reacted with bromine, can form 2,3,6,7-tetrabromo-3,7-dimethyloctanal-1. Upon oxidation with potassium permanganate in an acidic medium, the compound with the formula $C_7H_{14}O$ converts into a mixture of acids and ketones. This compound, $C_7H_{14}O$, is also found naturally in eucalyptus oil. **Tasks for the Case:** • Identify the class of the organic compound • Draw the molecular structure of the compound • Try to describe its chemical properties **Case №2** The characteristic aroma of cloves is primarily due to the presence of eugenol and a compound with the molecular formula $C_7H_{14}O$. **Tasks for the Case:** Based on the following clues, determine the structural formula of the compound: • The compound does not react with silver oxide (Ag_2O) in an ammonia solution, indicating the absence of an aldehyde group. • Upon hydrogenation, the reaction yields 2-heptanol. **Case №3** In the animal kingdom, communication often occurs via chemical signals that transmit specific information. For example, ants produce a $C_7H_{14}O$ compound as a distress signal. **Tasks for the Case:** Determine the structural of this compound based on the following information: • It reacts with hydroxylamine and hydrocyanic acid, forming a compound with the formula $C_7H_{15}ON$ • After catalytic hydrogenation, the product is 4-methylhexanol-3.
Motivation for Learning Activity- 2 minutes	To engage students by emphasizing the relevance and real-world significance of the topic, and to foster a positive emotional atmosphere for the entire lesson. Students are encouraged to independently formulate the main goal and learning objectives related to the topic.
Presentation of New Material- 15 minutes	Case video presentation Students are shown videos demonstrating: • The synthesis of the acid • Its chemical and physical properties
Consolidation of New Knowledge- 8 minutes	The teacher implements a knowledge reinforcement system using a flipchart.
Reflective and Evaluative Stage- 5 minutes	The teacher conducts reflection, the reflection technique " ZUH" (Bloom's methodology)

Lesson Summary-3 minutes	Summarizes the lesson and provides comments on the grades received during the session.
Information about homework – 2 minutes	Announces the homework; Provides a list of educational and reference literature with the author and page numbers.

Conclusion

In conclusion, the model composed of interrelated and complementary components is aimed at fostering students' chemical literacy through the integration of the case method into the teaching process.

The essence of the case-based approach lies in the collaborative interaction between teacher and student- the educator encourages learners to solve the case through analysis and critical thinking.

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