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Metanet Sarkhan NURIYEVA,
orcid.org/0009-0000-7461-9912
Doctoral Candidate
Azerbaijan State Pedagogical University
(Baku, Azerbaijan) metanet.nuriyeva91@gmail.com

SAMPLE LESSON PLAN ON THE TOPIC 'FACTORS AFFECTING THE RATE OF CHEMICAL REACTIONS' IN THE CHEMISTRY COURSE OF 8TH GRADE IN SECONDARY SCHOOLS, BASED ON THE 5E INSTRUCTIONAL MODEL

The establishment of a conducive learning environment is delineated for the pedagogical delivery of the subject «Factors Influencing the Velocity of Chemical Reactions» within the educational module «Categorization of Chemical Reactions. Equilibrium» in comprehensive educational institutions. Emphasis is placed on explicating principles, statutes, and experimental paradigms germane to the subject by contextualizing them within everyday scenarios, fostering students' autonomous resolution of computational quandaries grounded in their comprehension. The didactic framework, predicated on the 5E instructional model, seeks to enrich students' cognizance through both theoretical and applied dimensions, cultivating logical, evaluative, and inventive cogitation. The execution of the extant instructional blueprint involves the application of theoretical and empirical insights, as well as authentic contextualizations, employing a concatenated pedagogical methodology. The research additionally investigates the deployment of the 5E instructional model in instructing «Factors Influencing the Velocity of Chemical Reactions,» with a particular focus on appraising students' assimilated knowledge during practical and laboratory exercises. The article also underscores the significance of evaluating students' proficiency in procedural knowledge development through regulated practical tasks pertaining to the subject matter. The inclusion of content standards in the chemistry curriculum, presented in the format of knowledge and skills, is predicated on the objective that students comprehend not only fundamental concepts pertaining to the instructed topics but also discern the significance of the theoretical and experimental knowledge they acquire in their actual lives. Moreover, it aims to empower them to apply this knowledge pragmatically in their daily lives.

Key words: *5E instructional model, integration, chemical kinetics, rate of chemical reactions, catalytic reaction, nature of substances, catalyst, solubility, pressure, temperature.*

Метанет Сархан НУРІЄВА,
orcid.org/0009-0000-7461-9912
докторант
Азербайджанського державного педагогічного університету
(Баку, Азербайджан) metanet.nuriyeva91@gmail.com

ЗРАЗОК ПЛАНУ-КОНСПЕКТУ УРОКУ З ТЕМИ «ФАКТОРИ, ЩО ВПЛИВАЮТЬ НА ШВИДКІСТЬ ХІМІЧНИХ РЕАКЦІЙ» З КУРСУ ХІМІЇ 8 КЛАСУ ЗАГАЛЬНООСВІТНІХ НАВЧАЛЬНИХ ЗАКЛАДІВ ЗА НАВЧАЛЬНОЮ МОДЕЛЛЮ 5E

Передбачено створення сприятливого навчального середовища для педагогічного викладання предмету «Фактори, що впливають на швидкість хімічних реакцій» у рамках навчального модуля «Категоризація хімічних реакцій. Рівновага» в загальноосвітніх навчальних закладах. Основна увага приділяється роз'ясненню принципів, положень та експериментальних парадигм, пов'язаних із предметом, шляхом контекстуалізації їх у повсякденних сценаріях, сприяючи самостійному вирішенню студентами обчислювальних труднощів, заснованих на їхньому розумінні. Дидактична структура, заснована на навчальній моделі 5E, прагне збагатити знання студентів за допомогою як теоретичних, так і прикладних аспектів, культивуючи логічне, оціночне та винахідливе мислення. Виконання наявного навчального плану передбачає застосування теоретичних та емпіричних ідей, а також автентичних контекстуалізацій із застосуванням об'єднаної педагогічної методології. Дослідження додатково вивчає розгортання навчальної моделі 5E під час навчання «Фактори, що впливають на швидкість хімічних реакцій», з особливим акцентом на оцінці засвоєних знань студентів під час практичних і лабораторних занять. У статті також підкреслено важливість оцінювання навичок студентів у формуванні процедурних знань через регламентовані практичні завдання, що стосуються навчального матеріалу. Включення змістових стандартів у навчальну програму з хімії, представлених у форматі знань і вмінь, базується на меті, щоб учні зрозуміли не лише фундаментальні поняття, що стосуються тем, що навчаються, але й усвідомили значення теоретичних та експериментальних знань, які вони набувають у їх реальне життя. Крім того, він має на меті надати їм можливість прагматично застосовувати ці знання у повсякденному житті.

Ключові слова: *навчальна модель 5E, інтеграція, хімічна кінетика, швидкість хімічних реакцій, каталітична реакція, природа речовин, каталізатор, розчинність, тиск, температура.*

Introduction. According to our investigation, a constructivist learning theory based on a teaching model grounded in real-life scenarios not only mitigates challenges encountered in imparting theoretical and practical understanding but also ameliorates adverse learning conditions hindering the assimilation of these concepts.

In our illustrative planning instance for the topic «Factors Affecting the Rate of Chemical Reactions», we implemented the 5E instructional model. The 5E instructional model encompasses the subsequent stages:

- **Engagement Stage:** At this stage, the educator directs students' focus toward initial understandings of chemical kinetics, ensuring active participation in the instructional process. Motivational knowledge at this stage is not only fundamental but critically emphasizes students' enthusiasm for the topic, primarily by relating it to their daily lives.
- **Exploration Stage:** The second stage involves research or focusing, being the phase where students are most active. Here, the educator utilizes various teaching forms, such as class discussions and experiments, to shape students' knowledge and skills related to the topic.
- **Explanation Stage:** The third stage is termed the explanation or information discussion phase. In this stage, the educator and students elucidate the topic in a discussion environment, clarifying important insights and definitions collaboratively. This stage aims not only to highlight significant understandings and definitions but also to prevent the formation of misconceptions among students regarding the topic.
- **Elaboration Stage:** The fourth stage is known as the deepening or creative application phase, where students apply newly acquired knowledge in various situations. This stage primarily determines principles such as solving theoretical problems, experimental inquiry, and research projects.
- **Evaluation Stage:** The final stage of the model involves the assessment and evaluation of students' demonstrated knowledge and skills within the framework of teacher-student collaboration.

Additionally, in teaching the subject, the educator should use controlled practical tasks related to the topic to assess students' procedural knowledge development. In this manner, the instructional plan includes specific laboratory experiments and experimental assignments that students can independently perform under the teacher's supervision.

Degree of Elaboration of the Problem – Numerous methodological instruments and scholarly articles have been disseminated concerning the implementation of the 5E instructional model in the pedagogical delivery of subjects associated with chemical kinetics (M. Abbasov, 2014; Bybee, R., ets., 2006; Alipaşa Ayas, 2017). Exploring the integration of the topic «Factors Affecting the Rate of Chemical Reactions» with real-life scenarios (S. Çepni, 2014; M.Abbasov, 2018; H. Kutu, 2011), diverse outcomes of scientific research endeavors have been scrutinized. The primary focus of our research is to ensure the cultivation of students' logical and creative thinking regarding the advancement of both theoretical and experimental knowledge in the instruction of the topic «Factors Affecting the Rate of Chemical Reactions» within the 8th-grade chemistry curriculum in comprehensive educational institutions, employing the 5E instructional model.

Objectives and Goals. The principal aim of this research is to guarantee the active cognitive engagement of students in the instructional process of the topic «Factors Affecting the Rate of Chemical Reactions» in 8th-grade classrooms of general education schools, applying the 5E instructional model grounded in real-life contexts. Specific objectives encompass the meticulous assimilation of theoretical foundations, the evolution of experimental knowledge, and the profound comprehension of acquired knowledge, facilitating its correct application to the resolution of experimental challenges. Another pivotal goal involves assessing the efficacy and efficiency of the recently applied instructional model in prompting students to execute independent tasks through the utilization of active/interactive pedagogical methods in the discourse of the topic «Factors Affecting the Rate of Chemical Reactions».

Methods. Depending on the delineated objectives, efficacious methodologies, investigative approaches, problem-solving techniques, logical methodologies, and independent study modalities, crafted with contemporary pedagogical technologies, have been employed in elucidating subjects associated with chemical kinetics predicated on the 5E instructional model.

Main section

Integration of Theory and Practice in Chemistry Lessons with Real-Life Relevance

The teaching of the topic «Factors Affecting the Rate of Chemical Reactions» aims to motivate students in the direction of understanding scientific concepts related to chemical kinetics by integrating theory and practice with real-life relevance, providing them with conditions to perceive the importance of what they learn (Çepni, 2014: 121-171). During this process, we can not only engage students who aspire to specialize in chemistry but also generate interest in

the topic among other students. Enhancing students' interest in the field of chemistry is crucial in laying the foundation for their potential future activities in any chemistry-related field. The cultivation of logical, critical, and creative thinking, as well as the development of skills in acquiring, organizing, analyzing, and modeling information independently, is stimulated through the utilization of the 5E instructional model based on real-life scenarios in teaching topics related to chemical kinetics in general education schools.

Therefore, the application of the 5E instructional model in teaching topics related to chemical kinetics, specifically the «Factors Affecting the Rate of Chemical Reactions», in the 8th-grade chemistry course, not only serves to motivate students towards scientific understanding but also facilitates the development of independent skills such as acquiring, organizing, analyzing, and modeling information, which are essential for their future endeavors. We present an illustrative instructional plan that we have prepared and implemented based on the 5E instructional model for the topic «Factors Affecting the Rate of Chemical Reactions» in the 8th-grade chemistry course.

Topic: Factors affecting the rate of a chemical reaction

Sub-standards:

2.2.1. Organizes reaction kinetics for important inorganic compounds.

2.2.2. Conducts calculations based on reaction kinetics for important inorganic compounds.

3.1.1. Conducts observation and experiments for important inorganic compounds, and expresses opinions on the results.

Training outcomes:

1. Organizes reaction kinetics to determine factors affecting the rate of chemical reactions and expresses opinions on the results.

2. Expresses opinions on various methods of solving calculation problems related to determining factors affecting the rate of chemical reactions.

3. Conducts observations and experiments to determine factors affecting the rate of chemical reactions and expresses opinions on the results.

Training format: Group work

Training method: Debate, cluster

Resources: Mortar and pestle set, 5 test tubes, crushed iodine crystal, zinc powder, pipette, distilled water, sodium metal, copper sulfate solution.

Stages of the Lesson

Stage I: Engagement Stage

In this stage, we organize a small demonstration experiment to capture the students' attention (Abbasov, 2018: 14). The main objective of conducting this demonstration experiment is to create subject-specific integration by providing students with a tangible observation of the impact of a catalyst on the rate of a chemical reaction. The aim is to connect students' prior knowledge of the topic with new insights.

Materials: Mortar and pestle set, crushed iodine crystal, zinc powder, pipette, distilled water.

Procedure: We mix zinc powder with crushed iodine crystals in a china dish. When no changes occur, students observe the separation of violet clusters on top of this mixture when 2-3 drops of distilled water are added from the pipette into the container where the experiment is conducted.

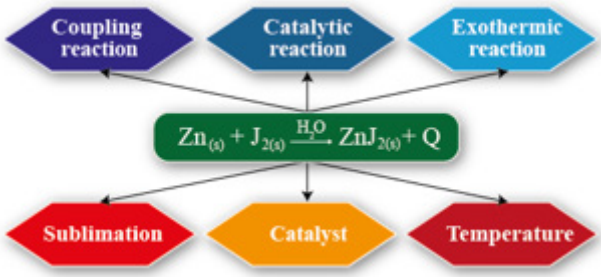
Research Question: What factors influence the rate of chemical reactions?

Stage II: Exploration Stage

In this stage, we note the reaction kinetics of the demonstration experiment conducted at the center of the board. We divide the students into four groups and instruct each group to write, in the form of small headings, the factors they will investigate related to this event.

Firstly, the idea generator creates conditions for students in each group to note terminologies associated with the reaction kinetics. Essential terms are then recorded (Alipaşa Ayas, 2017: 233).

Scheme 1.



Stage III: Explanation Stage – During this stage, the teacher provides brief explanations to create connections between students' previous knowledge and the newly introduced concepts. In this way, the combined knowledge is reinforced for the students. The theoretical foundations of the topic are explained in response to the questions posed (Abbasov, 2022: 26-29).

Thus, we record the explanation of the theoretical foundations of the topic by providing answers to the posed questions (Abbasov, 2022: 26-29):

$$Zn_{(b)} + J_{2(b)} \xrightarrow{H_2O} ZnJ_{2(b)} + Q$$

➢ What type of reaction is indicated by the chemical reaction demonstrated in the experiment in terms of the number and composition of reactants and substances obtained? (Combination reaction).

Combination reactions refer to reactions resulting from the combination of two or more simple or complex substances, leading to the formation of a new complex substance.

➢ Which reactions involve the separation of heat? (With some exceptions, all combination reactions are exothermic, i.e., heat is released upon separation of substances).

➢ Does the chemical reaction conducted in the experiment involve the absorption of heat or its release? (Since it is a combination reaction, it involves the release of heat during the separation of substances).

➢ What are reactions called that occur with the participation of a catalyst? (Catalytic reactions).

➢ How was the temperature created that caused the sublimation of iodine crystals during the course of the experiment? (During the exothermic reaction, the sublimation of crystalline iodine occurred, transforming it into violet-colored iodine vapors as a result of the heat released).

➢ How is the rate of a homogeneous reaction calculated? $\vartheta_{homogen} = \frac{\Delta\nu}{V \cdot \Delta\tau}$

➢ What is a catalyst? (Substances that alter the speed of reactions but remain unchanged themselves).

While answering the question of what a catalyst is, the teacher must also explain the relationship with activation energy.

1. Activation Energy – The minimum amount of energy required for molecules to enter a chemical reaction.

2. Catalyst – Substances that alter the speed of a chemical reaction but remain unchanged themselves. At this point, the teacher should create a small interdisciplinary integration related to the 7th-grade topic of oxygen in the laboratory. Pouring 3% hydrogen peroxide into the test tube and adding MnO_2, the teacher should then ask why the waste approaches the tube when a match is brought close to its mouth. Simultaneously, there should be a discussion between the teacher and the students and among the students themselves about the role of MnO_2 in the reaction. Later on, the teacher notes in the explanation of the experiment's reaction kinetics that water is a catalyst for this reaction. However, it should be emphasized that a catalyst does not create conditions for a reaction that would not occur otherwise. Essentially, in reactions with very low speeds, catalysts increase the reaction speed by reducing the activation energies of the reactants and increasing their collision frequencies. Catalysts that decrease speed are called inhibitors.

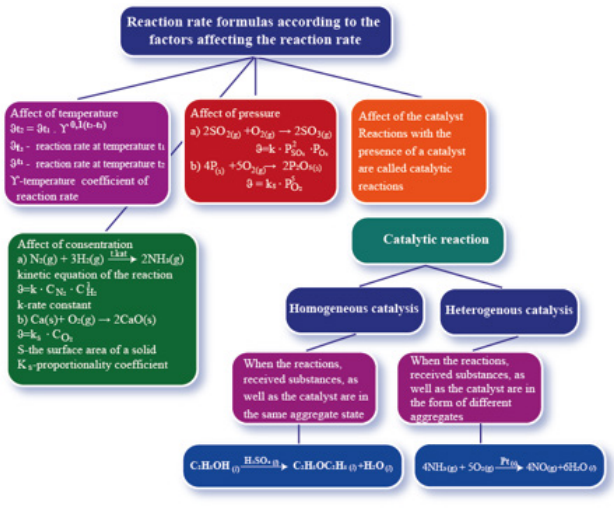
Thus, knowledge about the main factors influencing the speed of chemical reactions is generalized: (*nature of substances, surface area of substances, effect of concentration, temperature effect, pressure effect, catalyst effect*).

- **Nature (Activity) of Substances Involved in the Reaction** – The heightened reactivity of the substances engaged in the reaction correlates positively with the reaction's pace. To illustrate this principle, the instructor should procure three assay tubes and uniformly introduce water into each. Subsequently, the first tube should receive sodium (Na) metal, the second zinc (Zn) metal, and the third copper (Cu) metal. Through this observation, students will discern that the highly reactive sodium metal manifests a more vigorous response to water, the moderately reactive zinc metal displays a comparatively subdued reaction, and the inert copper (Cu) metal, as anticipated, remains unresponsive to water.

- **Variation in the Surface Area of Substances** – In heterogeneous reactions, the surface area or granularity of solid substances directly influences the reaction speed. To illustrate this, by acquiring two assay tubes, and adding an equal measure of 0.5 mol/l chloride solution to each, the instructor can proceed. Subsequently, introduce m grams of zinc (Zn) metal into the first tube and m grams of finely powdered zinc dispersed in the second tube. Observing the disparate reaction rates between the two tubes, students will discern that the reaction in the second tube occurs more expeditiously.

In order to facilitate the students' application of the acquired knowledge to problem-solving, we present the impact of other factors influencing the rate of chemical reactions in the following schematic representation (Abbasov, 2013: 129-134):

Scheme 2.



Stage IV. – Reaction rate formulas according to the factors affecting the reaction rate. Catalytic reaction is divided into homogeneous analysis (when the reactants, received substances, as well as the catalyst are in the same aggregate) and heterogeneous analysis (when the reactants, received substances, as well as the catalyst are in different aggregates).

Elaboration Stage – In order to develop students' essential skills and foster creative thinking related to the topic, the teacher directs targeted questions:

Based on the knowledge gained from discussions, answer the following questions:

1. Explain the importance of catalysts for living organisms based on examples from your daily life (Kutu, 2011: 29-60).

2. While engaging in sports or consuming food, millions of chemical reactions occur in our bodies. What factors contribute to the occurrence of such chemical reactions? (Abbasov, 2018: 55-56).

In the direction of developing vital skills related to the topic, these questions, posed both interdisciplinarily with the biology subject and integrated into our daily lives, shed light on the integration of these questions into the overarching sciences.

Stage V: Evaluation Stage. In this stage, students are given a classroom assignment aimed at reinforcing their knowledge and skills related to the topic:

Students are given colorful cards with tasks, and are required to independently work on the assigned tasks related to the topic:

1. Substances that change the speed and activation energy of chemical reactions but remain unchanged in the end are called $_{1}$----------.

2. If a reaction with a temperature coefficient of 2 reaches completion in 20 minutes at 20℃, how many minutes will it take for the same reaction to complete at 50℃? $_{2}$---------

3. Catalysts in the same phase as the reacting substances or reactants are called $_{3}$----------, while catalysts in different phases are referred to as $_{4}$----------

4. Catalyst's energy of the activated complex $_{5}$----------

5. The principle of dependence of the reaction rate on temperature is $_{6}$----------

6. When the temperature coefficient of the reaction rate is 2, as the temperature decreases from 60℃ to 40℃, how does the reaction rate change? $_{7}$----------

7. $N2 + 3H2 \rightarrow 2NH3$ reaction rate with respect to ammonia is $0,6 \frac{mol}{l \cdot san}$, and the reaction rate with respect to hydrogen is $(\frac{mol}{l \cdot san})$ $_{8}$--------

8. In this reaction that occurs at a constant temperature, $3X(q) + Y(q) \rightarrow X3Y$:

9. Reaction rate in case of doubling substance X concentration on $_{9}$--------

10. Reaction rate in case of halving substance Y concentration $_{10}$--------

11. The minimum energy required for a chemical reaction to occur is referred to as $_{11}$----------.

12. If the volume of the reaction vessel is halved, the rate of the reaction is $_{12}$---------

13. Catalysts that increase the speed of chemical reactions are called $_{13}$----------, and those that decrease it are called $_{14}$----------.

14. When the volume of the container in which the reaction $2SO_2 + O_2 \rightarrow 2SO_3$ occurs is reduced by half, the speed of the reaction is $_{15}$---------

Thus, the evaluation of the results of experimental assignments based on interdisciplinary and cross-disciplinary integration during the lesson is carried out using a predetermined criterion table.

Conclusion

1. The pedagogical methodology of instructing the subject "Influential Factors on Chemical Reaction Rates" in the eighth-grade chemistry curriculum within general education institutions has been formulated by investigating and applying, thereby establishing a constructive and developmental instructional environment in alignment with contemporary educational system requirements through the application of novel pedagogical technologies.

2. In the instruction of the subject "Influential Factors on Chemical Reaction Rates," an illustrative lesson plan, amalgamating both theoretical and empirical knowledge pertaining to the subject with the everyday experiences of students, has been devised. The implementation of the 5E instructional model, emphasizing the creation of an interconnected comprehension of theoretical-empirical knowledge and the application of skills in daily life, has been employed to cultivate both theoretical and practical competencies in students, particularly in resolving empirical assignments and laboratory experiments.

3. To facilitate the instruction of topics related to chemical kinetics, apt laboratory experiments and empirical assignments have been curated to evaluate and cultivate students' proficiency in applying their accrued knowledge in novel situations. This endeavor aims to augment students' capabilities in applying their acquired knowledge in the direction of subject instruction and for evaluative purposes.

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