KİMYANIN TƏDRİSİ METODİKASI
МЕТОДИКА ПРЕПОДАВАНИЯ ХИМИИ
METHODOLOGY OF TEACHING CHEMISTRY

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AN INVESTIGATION OF MIND MAPPING and STEAM-BASED LEARNING IN DEVELOPING RESEARCH SKILLS IN TEACHING CHEMISTRY

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KİMYANIN TƏDRİSİ ZAMANI TƏDQİQATÇILIQ BACARIQLARININ İNKİŞAF ETDİRİLMƏSİNDƏ ZEHN XƏRİTƏLƏRİNİN VƏ STEAM ƏSASLI ÖYRƏNMƏNİN ÜSTÜNLÜKLƏRİ

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ИССЛЕДОВАНИЕ МЕТОДА МЫСЛЕВЫХ КАРТ И ОБУЧЕНИЯ НА ОСНОВЕ STEAM В РАЗВИТИИ ИССЛЕДОВАТЕЛЬСКИХ НАВЫКОВ ПРИ ПРЕПОДАВАНИИ ХИМИИ

Abstract. In the article, in order to increase the quality and efficiency of education during the teaching of chemistry, to ensure the cognitive activity of students, the advantages of the role of mind maps on the way from memory to thinking, some issues related to the main content, specific characteristics and application of mind maps, subject-subject relations during interactive training, the academic level In addition to the development of the social and emotional sphere, there is talk of formation possibilities, STEAM, which is an important model of project-based learning during teaching, and virtual and augmented realities.

Keywords: *research, inductive, deductive, mind maps, virtual reality, augmented reality, project based learning, STEAM*

Xülasə. Məqalədə kimyanın tədrisi zamanı təhsilin keyfiyyət və səmərəliliyinin artırılması, təhsilalanların idrak fəaliyyətinin təmin edilməsi məqsədilə, hafizədən təfəkkürə gedən yolda zehin xəritələrinin rolunun üstünlüklərindən, zehin xəritələrinin əsas məzmunu, spesifik xüsusiyyətləri və tətbiqi ilə bağlı bəzi məsələlərdən, interaktiv təlim zamanı subyekt-subyekt münasibətlərindən, akademik səviyyənin inkişafı ilə yanaşı sosial və emosional sferanın da inkişaf etdirilib, formalaşdırma imkanlarından, tədris zamanı layihə əsaslı öyrənmənin vacib modeli olan STEAM-dan, virtual və artırılmış reallıqlardan söhbət açılır.

Açar sözlər: *tədqiqat, induktiv, deduktiv, zehn xəritələri, virtual reallıq, artırılmış reallıq, layihə əsaslı öyrənmə, STEAM.*

Аннотация. В статье в целях повышения качества и эффективности образования при преподавании химии, обеспечения познавательной деятельности учащихся показаны преимущества роли интеллект карт на пути от памяти к мышлению, рассмотрены некоторые вопросы, связанные с основными содержание, специфика и применение интеллект-карт, субъект-субъектные отношения при интерактивном обучении, академический уровень наряду с развитием социальной и эмоциональной сферы, идет речь о возможностях формирования, STEAM, который является важной моделью проектного обучения, виртуальная и дополненная реальности.

Ключевые слова: *исследования, индуктивное, дедуктивное, интеллект карты, виртуальная реальность, дополненная реальность, проектное обучение, STEAM.*

Introduction

From the beginning of the 19th century to the present, the teaching of chemistry has been the point of view of all chemical scientists. Over the years, the development of chemistry teaching has been followed, and it has been shaped according to the interests and needs of the individual, society and the state. T he latest stage in the history of the development of chemistry is the era of modern chemistry. Modern chemistry stands out over traditional chemistry eras due to its affordability. The main point today is that a new approach to chemistry requires an improvement in the quality of teaching. Given that chemistry is more of an experiential, experimental subject, specificity, accessibility and reality are very important when teaching chemistry. Laboratories, rich material and technical educational base, libraries are fertile conditions for students to conduct research. But there are schools where the environment for research is simple or non-existent. At this time, as a result of the teacher's professionalizm, the students' research skills go from memory-oriented. Mind maps to virtual and augmented realities that pave the way for thinking-oriented research. In this regard, the advantages of project-based and problem-based learning in the direction of developing research skills during the teaching of chemistry are considered a priority.

1. Object and methods of research

The research object is the process of teaching chemistry in the 8th grade of general education schools with new methods, determining the ways of developing research skills in mind maps and STEAM-based learning, especially in the teaching of the subject of chemical communication, investigating the ways of organizing the advantage of research skills for effective learning opportunities for students. Students' ability to sequence their ideas and logical connections, select keywords and make illustrations becomes a very important point in the research skills of students for making mind maps. the brain remembers information better with illustrative explanations. STEAM-based learning is considered the most superior method of project-based learning. At this time, the natural sciences instill integrative skills for a holistic understanding of the system. Collaborative learning technology, building objects as engineering skills, grouping abilities, artistic spirit, and mathematical literacy become the main part of the learning method together. In order to develop research skills and increase the efficiency of learning, students can use virtual methods as well as real opportunities. At the same time, virtual laboratories, virtual and augmented reality shape the digital direction of their activities even more strongly. The impact of new technologies on learning, such as research methods GROW and REAL, make the learning environment even more interesting.

Advantages of mind maps and STEAM-based learning

The main features of interactive training are the subject-subject character of the teacher-student relationship, the activity of the participants throughout the lesson,conducting the lesson in the form of dialogue, actively using the emotional and personal qualities of the students,creating ample opportunities for their freedom and initiative, being based on logic and vreative thinking and most importantly,teaching flexibility of forms and methods,diversity of knowladge sources. Despite the variety of forms and methods applied in the education system, the most important factor for pupils and students is that they remember well what they have studied. Memory is the most important product of brain activity. Our brain,which consists of two parts-the left and right hemisperes of the brain, ensures the existence of emotional memory, short-term memory and long-term memory, characteristics of humans. Knowladge is forgotten unless it is transferred from short-term memory to long-term memory. One of the importnat reasons for failure during exams is forgetting some of the topics studied,that is forgetfulness. Preparation of mind maps and their use develop imagination,creative thinking, strengthen memory, sharpen memory, ensure the joint activity and harmony of the left and right brain hemispheres, and as a means of learning and teaching, they are successfully used in almost all areas of life can be applied. Mind maps are sometimes called the friend of the brain,the key to memory.

The role of learning with mind maps in the formation of research skills

As our memory is strengthened and sharpened, we have the chance to achieve the following successes in life: It becomes easier for us to memorize new knowledge, our ability to concentrate increases, our communication skills improve, our self-confidence increases, we become more mentally stable, our vocabulary increases, and our ability to learn a new foreign language increases faster, storing data by grouping it can be facilitated, the learning opportunities of the students in their suitable audiences can increase from 20% to 80%,the knowledge that becomes permanent in the brain is easily remembered in practical life, and our risk of getting Alzhaimer's disease (complete forgetfulness) when we got old is reduced. Through the use of mind maps, the requirements of two principles of training-integration (inductive method-from facts to general conclusions) and differentiation (deductive method-from general to details) are easily understood.

Mind maps on chemical communication

Keywords on types of chemical bonds: types of covalent bonds: non-polar, polar, -σ (sigma) və - π (pi) bond; hybridization and types; iyon, metal, hydragen bonding.

An incomplete mind map of the topic can be prepared by using keywords on the topic of types of chemical bonds. An incomplete mind map will give students an opportunity to deer mine in which direction to research, which knowledge is important during the execution of the process. The student first conducts purposeful research from the textbook or textbooks, writers or pastes the knowledge he has mastered on the incomplete map with colored pencils, colored stickers, thereby creating an optimal learning environment for the student to complete the mind map. In order to further recall this knowledge, symbols, drawings or conventional signs corresponding to the words can also be recorded.

Consistency of ideas and connections, selection of keywords, and visualizationare important in mind mapping because our brain remembers symbols, drawings, or conventional symbols better. Mind maps made with the power of private imagination are completely individual, because the selected information and symbols are the product of each student's brain, which is theirs. Incomplete maps, consisting only of keywords, serve the purpose of both learning the topic and determining the extent to which the material has been mastered. It is efficient and fun to repeat one sheet of A4 instead of pages of material when repeating. Mind maps are a perfect tool for repetition. The method of learning with mind maps strengthens the memory, sharpeners the memory, increases creative thinking, because the lesson is also learned with feelings and emotions, bright and vivid colors (Fig.1.)

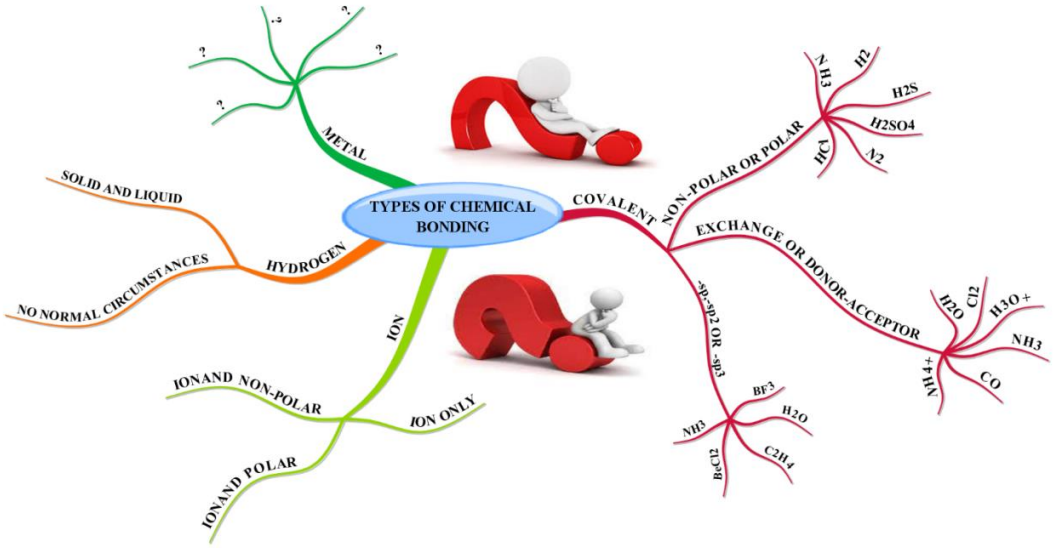


Figure 1. An example of a mind map created to summarize the topic of chemical communication

2.Project-based learning STEAM

STEAM is a learning model that incorporates the best of project-based learning (PBL).At this time, the creation of a new product as a result of the problem, its benefits, and the prediction of its prospects act as an important factor. STEAM based learning has proven itself better by integrating technology into people's lives. So, digital technology, which is an integral part of integration Z, is naturally included in education specifically. STEAM has been applied in various countries since 1950. In Azerbaijan, STEM based learning under the name STEAM has been introduced since the 2019-2020 academic year started. The STEAM learning model is known as an acronym that combines 5 main disciplines. Science, Technology, Engineering, Art, MATH is based on the idea of teaching in an integrative way. The main goal of the STEAM project is to develop 21st century skills in students, especially 4K-creativity, critical thinking, cooperation and communication skills. As a result of practicality, STEAM is to show students the application of the theoretical foundations of science in everyday life, to teach them engineering skills, and to improve their skills in using digital opportunities by applying various programming languages.

Chemistry is the most research-based of the natural sciences.it is very important to teach this subject in the laboratory, which is carried out on the basis of experiments and experiences. But how should research be carried out in schools with no or weak laboratory facilities? The answer to this question lies in the virtual and augmented reality available in STEAM.

3. The main directions of the development of student research in the teaching of chemical communication.

Chemical communication is a subject with poor experimental capabilities. Research on this topic is more theoretical. Students are involved in psychomotor activity along with cognition in this topic. Thus, they can understand the essence of chemical communication by constructing special molecular models using spindles. For example, by preparing ammonia, water, and methane molecules, students can determine the number of electons involved in the formation of chemical bonds, the number of double and single electron hybrid and non-hybrid orbitals, polar and non-polar bonds and the existence of sigma and pi bonds. Thanks to the possibilities of digital technology, they travel inside the molecules of matter with virtual realities and observe them virtually. Students who understand the mutual movement of atoms and molecules as a result of travelling to the planets with VR glasses, withness how the atoms of a molecule are connected to each other through the "Mergecube" Object viewer application in AR(Figure 2-4)

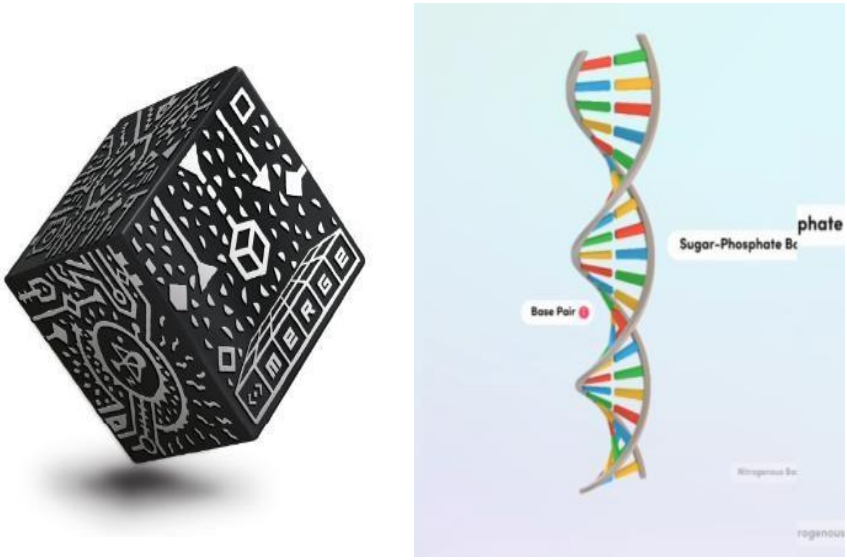


Figure 2, 3, 4. QR code reflected in Merge edu cube,3D view of DNA in Merge edu cube, QR code.

The creation of life as a result of 4 main factors-fire, water earth, air (Aristotle, 4th century BC), and the situations that arise as are result of communication between them-drought, cold, humidity, heat-can be realized in the virtual "Little Alchemy" application. (Fig.5,6)

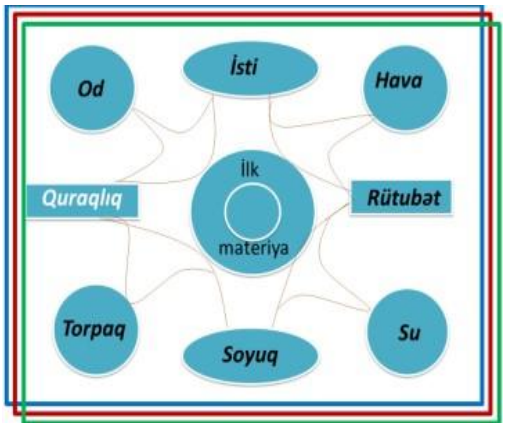
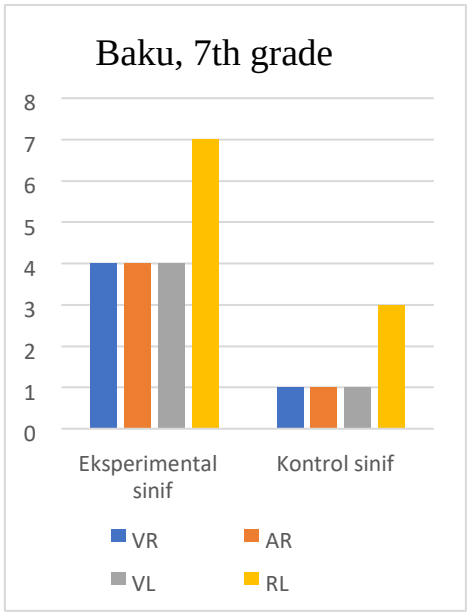
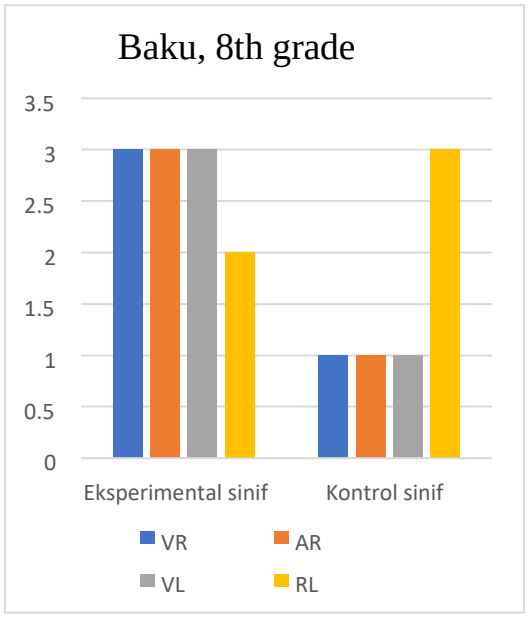


Figure 5,6. Using Aristotle's first table of elements, "Little Alchemy", which describes the importance of the 4 elements for the formation of matter.

The connection of chemical communication with the human body and "Virtualy-Tee" takes science to a new dimension in the most beautiful way. Thus, the connection of the organ system allows us to obtain information about the human body in general. With augmented reality and amazing 3D learning experiences, it is possible to explore the circulatory, respiratory and digestive systems with fully immersive 360 video. Here, the connection between technology and the human body is realized in reality.

An experiment was conducted and the results were obtained regarding the extent to which the quality of teaching in ensured in this way. It would be appropriate to present the results of this experiment shown in the diagram, which was carried out in full secondary school No.7 in Baku city (Diagram 1A and 1B) and in the 7th and 8th control and experimental classes of school-lyceum No.3 in Oguz city (Diagram 2A and 2B)



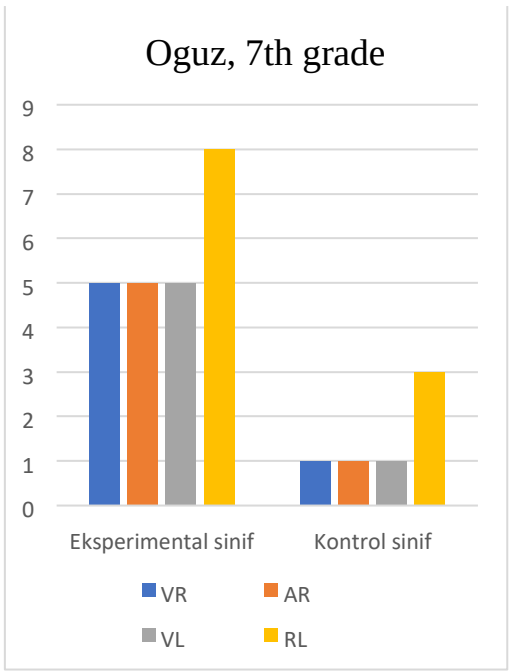


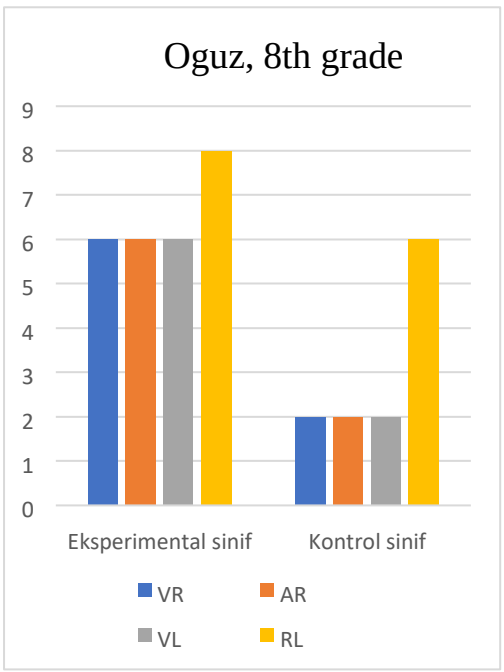
1A **1B**

Diagram 1. (A and B) The result of research-digital skills obtained in the control and experimental classes in the 7-8th grades of secondary school No.7

4 people in the 7th experimental class of full secondary school number 7 of Baku city are more interested in learning with virtual and augmented reality. They model experiments in virtual laboratories.7 people were interested in conducting research in a real laboratory.in the control class,1 person was interested in learning with VR and AR and in a virtual laboratory, while 3 people preferred to work in real laboratories. In the experimental 8th grade, 3 students were interested in VR, AR, and VL and 2 students were interested in RL.

In the control class, this number was 1 person for VR, AR and VL, and 3 people for RL(Diagram 3,4)





2A 2B

Diagram 2. (A and B) control and result of research-digital skills acquired in experimental classrooms.

In Oguz city-lyceum No.3,5 people were interested in AR, VR and VR in the experimental 7th grades. In RL, 8 people preferred to study. In the control class, only 1 person was interested in AR,VR and VR, and 3 people were interested in RL. In the experimental 8th grades, the situation was different, as 6 people were interested in learning with VR,AR,VL and 8 people were interested in RL. In the control class,2 people were exposed to VR, AR, VL, and 6 people were exposed to RL.

Involvement of students in the lesson as a result of the use of new technologies in teaching during learning opportunities are increasing. A study of GROW and REAL methods in the project-based STEAM learning model let's pay attention to the priority issues. Let's first explain the GROW approach:

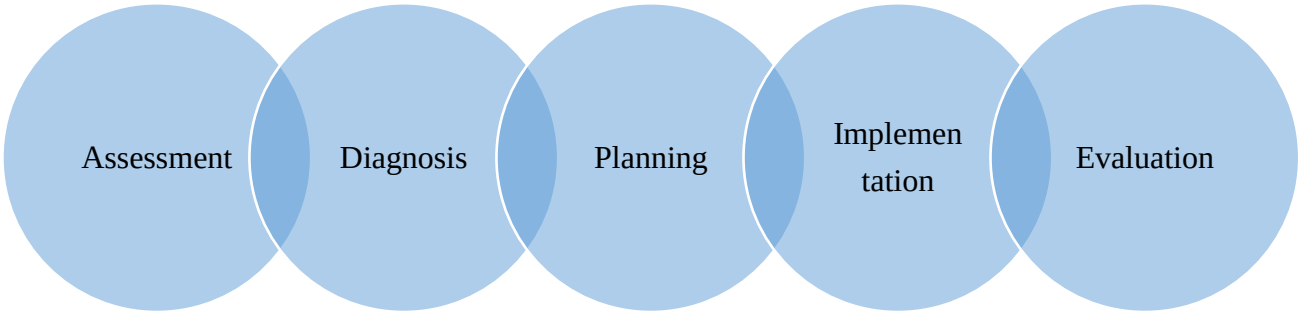
Goal-is the first target as a goal. At this time, the student has a question. *What do yo want?*

Reality-factuality. Considering the real opportunities, another question before the student: *What are you now?*

Options-elections or versions. *What could yo do?* With this question, which options are optimal for the student.

Will- *What will you do in the future?* It provides prognostication.

Through the new model, the application possibilities of the STEAM model are clarified. The student is faced with new possibilities. Students' research opportunities lead to activities such as collaboration, skill-based communication, real-world problem solving and innovation, self-regulation, and digital learning. At this time, "How do we prepare ourselves for real world problems?" the question arises. Because the main goal of imparting research skills is that students are open to ways of learning for life (Scheme1)



Scheme 1. Strategy for developing research skills in STEAM based learning.

Real – reality. *What can I do and how?* In a problem-solving approach, the initial reaction in mastering an event or object is reality. At this time, along with academic knowledge and skills for adaptation, emotional stability and social capabilities come into play.

Experiment-to test. *I can test it!* At this stage, the student can take risks as a researcher, manage feelings constructively, and take initiative skills such as being able to be and trying are needed.

Mind-thinking, mentality. When a student faces a problem, he says, "*I can act by understanding!"* says and decides. He tries to be responsible in his decision.

Loyal-reliability. The student sees the confidence in him, knows and says "*I can do it!"* solves the problem with his thinking.

Result:

1. The formation of research skills during the teaching of chemistry is observed more effectively in research-oriented lessons. During this interactive training, it depends on subject-subject relations, along with the development of the academic level, the social and emotional spere is also developed and depends on the possibilities of formation.

2. It is clear from the research that the traditional low-tech as well as the high-tech model, especially opens to digital activity, is not yet fully encouraging in the teaching of chemistry. Therefore, there is a greater need for teachers to increase their professionalism in this direction.

3. Increases the research orientation of the STEAM model during project-based learning.

According to the demand of the day as well as VR, AR, VL, it is observed that the interest in RL is increasing.

4. The demand for research increases as a result of the impact of mind maps on the development of thinking in learning.

5. The possibilities of applying new technologies: GROW and REAL models for the development of research skills during learning play an important role in the development of the emotional and social sphere, in addition to raising the academic level of students.

The actuality of the subject The investigation of mind mapping and STEAM- based learning in developing research skills in teaching chemistry is very relevant in today's educational landscape. Both approaches offer valuable tools for enhancing students' understanding and application of chemistry concepts. They align with contemporary educational trends that emphasize active learning, interdisciplinary approaches, and the development of practical research skills. By integrating these methods, educators can better prepare students for future scientific challenges and foster a deeper appreciation for chemistry.

Novelty of the problem The novelty of this investigation lies in its exploration of how mind mapping and STEAM-based learning can be uniquely integrated to enhance research skills in chemistry education. By focusing on the intersection of these innovative tools and methodologies, the research aims to provide fresh insights and practical applications that could reshape how research skills are taught and developed in the field of chemistry. This approach not only addresses gaps in existing literature but also aligns with current trends in educational technology and interdisciplinary learning.

The practical importance of the problem The practical importance of exploring mind mapping and STEAM-based learning in chemistry education extends to enhancing student understanding, developing critical research skills, preparing students for future careers, and innovating teaching practices. By integrating these methods, educators can improve learning outcomes, support student engagement, and contribute to the ongoing evolution of educational strategies in science. This research not only benefits students and teachers but also has broader implications for educational research and practice.

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