Cognitive interest in teaching chemistry in secondary school on the basis of the principle of connection with life

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Annotation. The problem of motivating schoolchildren in the study of exact subjects, such as chemistry, is quite acute. The purpose of the work is to determine whether the motivation and perception of students will increase when teaching chemistry based on the principle of connection with life. The scientific and practical significance of the work is to show that the classical teaching of this discipline in high school, based on the study of topics related exclusively to the subject, sometimes makes it abstract and unattractive for students. The working hypothesis is that learning based on the principle of connection with life would rose students' interest to the subject of chemistry. To motivate students, it is necessary to diversify didactic strategies. Therefore, such training should be practiced sporadically, alternating with «classical» education, and not continuously throughout the year. By the method of analyzing theoretical material regarding the described problem, an example of a topic is given that can be used to stimulate the cognitive interest of students. The methods and sequence of teaching are presented, with varied and original tasks for maximum motivation of students. The value of the study is that few teachers implement teaching based on the study of non-chemical topics, and so far, it has not been possible to analyze the proposed sequence. The obtained results allow us to conclude that teaching based on the principle of connection with life, such as «Perfume», motivates students more than the classical one, but requires more hours in terms of planning. The practical significance of the work lies in the possibility of applying the presented sequence to other exact objects.

Keywords: exact science, alternative, science education, planning, didactic sequence.

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Пізнавальний інтерес до навчання хімії в загальноосвітній школі на основі принципу зв'язку з життям

Анотація. Досить гострою є проблема мотивації школярів до вивчення точних предметів, наприклад хімії. Мета роботи – визначити, чи підвищиться мотивація та сприйняття учнів при навчанні хімії за принципом зв'язку з життям. Науково-практичне значення роботи полягає в тому, щоб показати, що класичне викладання даної дисципліни у вищій школі, засноване на вивченні тем, пов'язаних виключно з предметом, іноді робить її абстрактною та непривабливою для учнів. Робоча гіпотеза полягає в тому, що навчання за принципом зв'язку з життям підвищить інтерес учнів до предмету хімії. Для мотивації учнів необхідно урізноманітнити дидактичні стратегії. Тому таке навчання слід практикувати спорадично, чергуючи з «класичним» навчанням, а не безперервно протягом року. Методом аналізу теоретичного матеріалу з описаної проблеми наведено приклад теми, яка може бути використана для активізації пізнавального інтересу учнів. Представлено методику та послідовність навчання, різноманітні та оригінальні завдання для максимальної мотивації студентів. Цінність дослідження полягає в тому, що небагато вчителів реалізують навчання на основі вивчення нехімічних тем, і наразі не вдалося проаналізувати запропоновану послідовність. Отримані результати дозволяють зробити висновок, що навчання за принципом зв'язку з життям, таке як «Парфуми», мотивує студентів більше, ніж класичне, але потребує більшої кількості годин з точки зору планування. Практичне значення роботи полягає в можливості застосування представленої послідовності до інших точних об'єктів.

З наукових праць досвідчених педагогів можна зробити висновок, що навчання, засноване на вивченні тем із повсякденного життя, епізодично, чергуючи з класичним навчанням, дозволило б викликати більший інтерес в учнів середньої школи. Це дуже важливо для предмета хімії. Однак небагато вчителів практикують таке навчання, і це твердження не можна перевірити на практиці. Для цього необхідно, наприклад, викладання повсякденного життя та класичного викладання здійснювати паралельно в двох класах протягом року, а потім перевіряти їх відповідний вплив на мотивацію учнів. На жаль, часу на такий глибокий експеримент не вистачило.

Ключові слова: точна наука, альтернатива, наукова освіта, планування, дидактична послідовність.

Introduction

The goal of all teachers should be to help students achieve a certain level of knowledge in their subject matter. In the process of teaching, students are often faced with the problem of motivating them to learn new knowledge. Often, school knowledge for most students is only disciplinary objects, subjects to learn (Höft, Bernholt 2019) [6]. The classical education system promotes a utilitarian attitude toward knowledge (Utemissova, Gavronskaya, Unerbayeva, Shokybayev 2021) [14]. Teaching for satisfactory grades moves away from a gnoseological attitude toward knowledge, that is, we interest students in knowledge for the sake of knowledge, for the meaning, it gives to reality, to the personal development it brings. Science is fundamental to society. In the education systems of developed countries, all students are encouraged to acquire scientific knowledge during school education (Krapp, Prenzel, 2011) [2011]. The teaching of science is becoming more and more necessary not only for learning about natural phenomena but especially for enriching the culture of students with the contribution of reasoning and scientific inquiry methods.

Students must also develop a personal sensitivity to the environmental problems and resource use facing our modern society (Su, Cheng, 2019) [12]. In high school, science tends to

be divided into disciplines whose task is to acquire elementary knowledge. Obviously, science in general is too complex for students to understand at a young age. Thus, the main goal of teachers is to try to simplify science concepts and organize them in such a way that students can understand them.

In their work (Kang, Hense, Scheersoi, Keinonen, 2019) [7]. suggest building and organizing didactic sequences around the use of specific educational situations, such as watching a television program or visiting a museum In their view, these activities allow concepts to be linked and treated in alternative ways, anchoring the sequence on students' interests or prior knowledge. The authors also suggest other alternatives to science education, such as planning a didactic sequence around acquired knowledge, method of mastery, obstacles to overcome, or success. It recommends that the teacher seek to mobilize several of these components, depending on the educational context and the time available.

The teaching of chemistry in higher education has changed significantly over the past twenty years (Kerimbayev, Garvanov, Tkach, Akramova, Balmash, 2021) [8]. Teachers have shifted from theoretical and abstract instruction to a more life-like and playful approach that integrates experimentation as a teaching method and increasingly connects it to everyday life. Teachers are striving in school programs to strike a balance between pedagogical practice, practical work, and the teaching of theoretical knowledge. This study is based on two postulates for which a working hypothesis has been proposed: 1) teaching chemistry in secondary school does not allow students to acquire all the skills described in the school curriculum (to understand information disseminated by the media in areas such as the environment, raw materials, food, for example, to realize that chemistry is closely related to other sciences; 2) classical chemical education makes chemistry unattractive to students, especially when the teaching is predominantly lecture-based. In this situation, the student works little and remains passive; he or she does not construct his or her own knowledge. The working hypothesis is that learning topics based on the principle of connection with everyday life, carried out in episodic, alternating with “classical” learning, would increase students' appreciation for the subject of chemistry. The purpose of this article is to confirm or refute the working hypothesis.

Materials and methods. To confirm or refute the working hypothesis, it was necessary to establish and describe a methodological teaching sequence based on a topic from everyday life. Then evaluate the impact of this type of learning on students by comparison. Two groups of ninth-grade students of 48 students (24 students per group) participated in the comparative experiment. The age category of the participants was 13-15 years old. Group 1 continued to study chemistry in a classical way, group 2 received instruction based on the study of topics based on the principle of connection with everyday life, carried out in an episodic, alternating with “classical” learning.

To eliminate demotivation in chemistry lessons for whatever reason (difficult content, topics devoid of interest, etc.), the sequence of chemistry instruction performed in group 2 was based on topics related to everyday life. To increase students' motivation, a relevant topic was chosen that would arouse great interest on the part of students, and build a didactic sequence based on the topic, including various pedagogical components aimed at achieving learning: immersing students in the thematic situation, providing additional knowledge and, above all, encouraging students' questions that would lead to the acquisition of scientific knowledge on the subject of chemistry. The advantage of this teaching method, which certainly uses roundabouts, is to create an intriguing educational scenario that mobilizes the student's knowledge and preconceptions.

The first phase of this work consisted of selecting a topic from everyday life that most students would be interested in and whose understanding of the accompanying phenomena would not require a deep knowledge of chemistry. It was also important that the chosen topic

allowed the didactic sequence to include specific pedagogical situations that particularly motivated students, such as original demonstrations, watching a film or documentary, reading texts about current events, or even visits to a museum. The theoretical review provided insight into topics related to everyday life that can be viewed from a chemistry perspective. However, many of the topics addressed in the works analyzed only deal with certain aspects specific to the subject of chemistry. On the other hand, not all of the topics touched upon are necessarily known to the general public. In the end, the topic “Perfumery” was chosen. It met all the selection criteria. The second stage of this work was to make as exhaustive a list as possible of everything that could fit the chosen theme. For the sake of clarity, the different items were collected in the form of a heuristic map (mind map). It was then important to select among these items those that could awaken questions in the students that could lead them to acquire knowledge of chemistry. In addition, 10 teachers were interviewed about the problems described.

Results

No matter how improved the reforms and modernizations are, the main organizational form of learning remains the classic lesson. But modern school is looking for new methods of organizing lessons, to motivate students. This is especially true for the teaching of exact sciences. Any lesson, even related to exact sciences, such as chemistry, offers a solution to the problems of education, value attitude to life, development of meaningful creative position, motivated by the non-traditional organization of the learning process (Algozhaeva, Zhumabekova, 2021) [2]. According to (Akhmetov, Azimbayeva, 2018) [1], the lesson is the main dynamic and variable form of organizing the process of purposeful interaction between the teacher and students, which includes the content, forms, methods, and means of learning and is systematically used to solve the problems of learning, education, and development of the student. In the light of the concept of modern education at the present time, much attention is paid to training, education, and development, as the development of scientific and technological progress in the 20th century has revealed the great need of all mankind in obtaining a quality education. The works devoted to the topic, what should be a modern lesson, how should change its structure is very diverse. Recently, teachers' interest in the problems of modern lesson, including chemistry, has increased dramatically. It is indisputable that the lesson should have a systematic nature, consistency, and simplicity for the assimilation of students' knowledge (Medetbayeva, Akhmetov, 2021) [10]. The effectiveness of lessons largely depends on the right choice of method and properly organized lesson structure. According to (Vogelzang, Admiraal, van Driel, 2019) [15], cognitive interest can be awakened or strengthened by including all students in active learning activities at their disposal, bringing the joy of learning, a sense of satisfaction with success. To do this, it is sometimes advisable to put a problematic issue or question, a heuristic or cognitive problem in front of the class. To improve the memorization of the most important material different techniques are used, in particular, fixation on the board, a special poster, or projection on the screen with the help of technical means of the main semantic moments - concepts, terms, basic data, names, diagrams, etc. - the main thing, memorization of which contributes to the reproduction of the whole material (Dai, Trung, Tiem, Hao, Anh, 2021) [5].

(Chiu, 2021) [4] raises the issues of identifying the features of the main organizational form of chemistry teaching, the features of the modern lesson, as well as the development of a chemistry lesson outline. The author considers the lesson as an integral system; analyzes the goals and objectives of chemistry lessons; defines the typology and structure of lessons; reveals the main stages of the lesson, namely, preparation for the lesson, summarizes, and organizational aspects; evaluates the modern chemistry lesson.

Much scientific work has been devoted to the study of methodological and scientific literature and to lesson modeling and typology of lessons. To this day this question remains a controversial one in modern chemistry teaching. There are several approaches to classifying lessons, each of which has a defining characteristic and potential for combination with the principle of everyday life (Trang, Huong, Lien, Ngoc, 2021) [13]. Lessons are classified according to didactic purpose, the purpose of lesson organization, content and methods of the lesson, the main stages of the learning process, didactic tasks solved in the lesson, teaching methods, ways of organizing student learning. activities. (Srisawasdi, Panjaburee, 2019) [11] gives a modern classification of the lesson based on the principle of everyday life to correct knowledge, skills, and abilities.

Kazakh didacticians (Kerimbayev, Garvanov, Tkach, Akramova, Balmash, 2021) [8] note that in the endless flow of many lessons, you can notice a well-known repetition and stopping of those lesson structures that occur more often than others. The structure of a lesson is understood as the arrangement and mutual logical connection of its elements that ensure the integrity of the lesson. Allocation of stages of the lesson is based on the logic of the process of knowledge acquisition: perception - understanding - memorization - application - generalization - reflection. The teacher's lesson plan is a more general form of the lesson plan and is left to the teacher's discretion. Regardless of the chosen form of registration in the plan should be reflected: the topic of the lesson; the goals of the lesson and a list of teaching aids; questions to students; texts of tasks or numbers of tasks, exercises to test or consolidate knowledge and skills; thesis content of new material on points (questions); data, constants, terms, definitions, formulae, equations of reactions, names of scientists - everything that the teacher is not expected to remember; list of chemical experiments or other visualization indicating their place in the class; homework. According to the authors, the simplest form of planning should cover only the content of the course and limits the planning process to distributing instructional material to individual subjects and lessons roughly in accordance with the number of hours provided in the curriculum. The most complex form of planning resembles a teacher's lesson plans, as it includes the formulation of learning, growth, and development goals for each lesson; a summary of content; methods for conducting the lesson; equipment for lessons; material for repetition; assignments; and often other details of lessons.

Often the form of the thematic plan is set by the school. Thus, forms of thematic planning cannot be fixed once and for all. The annual thematic plan must meet the requirements of the program. The annual plan is usually approved by the deputy director of education and approved by the principal. Along with the development of scientific and technological progress, modern society has identified the need for high-quality education. After all, in-depth, accurate knowledge in any field of activity shows the professional level and requires appropriate skills, the ability to quickly navigate depending on the situation. This knowledge must be acquired at school, using examples from everyday life. School is the beginning of laying down basic fundamental knowledge and ideas. Once the initial knowledge is established, the student can choose a profession. School teaches independence and also teaches how to acquire knowledge independently and to navigate in a complex and saturated information space. Accordingly, a school teacher faces complex, responsible, and multifaceted tasks. The modern teacher must link together three components: 1) professionalism, the ability to engage them students, interest, show “relating” to their discipline; 2) vision of the psychology of students, both for the individual student and in the classroom, with the general psychology of the collective, its customs, traditions, ideals, and values. Teachers will have to adapt to the innovations of pedagogy, learn to guide ideals and values in the classroom, and take into account the psychology of each student; master innovative techniques, methods, and methods. Methods of improving and transforming the classical lesson to motivate and improve learning outcomes are suggested by (Avargil, Piorko, 2022) [3]. The positive side of

the classic lesson design is that everyone is prepared for such a lesson through the previous experience of students and teacher, there is a plan to shape the lesson more effectively, with a new individual approach to students. The modern lesson is an activation of the student's work in the lesson, the teacher's role becomes relegated to the background, but at the same time, on the part of the teacher, additional effort is required, both to create a “new lesson” and to monitor and homework. At the same time, checking functions are also assigned to them. The most challenging task in conducting a “new lesson” is the task of choosing the roles that are most psychologically comfortable for students. Gradually the process of liberation develops, the ability to work with the public. Here the teacher is required to take into account the individual-psychological features of children. In such a lesson, certain learning tasks should be solved mechanically.

Using the principles of connection to the everyday life of learning and an active approach to learning, the new pedagogy offers a variety of lesson forms, such as: workshop; game-based learning; modular learning; collaborative learning; group learning; project method; portfolio.

Modern pedagogy has freed itself from a number of stereotypes and allows for variability and curriculum change (Su, Cheng, 2019) [12]. But such an issue as interdisciplinary integration of the subject of chemistry always remains relevant. We adhere to the opinion that a particular set of broad and diverse knowledge and ideas about the scientific and artistic picture of the world speaks about the culture of the individual. At the lessons, it is necessary to show the role of society and the individual in conjunction with the cultural outlook of the world. To reveal the system of universal spiritual and moral values and priorities. The introduction of aesthetic views from a young age is equated with the ability to logical and emotional and imaginative mastering of real and historical reality. Realization of the disclosure of the mentioned qualities with the help of education and the disclosure of universal paradigms of education is provided, first of all, by the content of education. Pupils should learn to understand the essence of nature and man's place in nature, thus they will form a natural-science picture of the world.

The ability to find information is essential. The ability to find information quickly is necessary for success in later careers. The teaching profession involves daily work on oneself. When preparing for a lesson or an extracurricular activity, a teacher must work with a large amount of information, study, and rethink special and methodological literature. Thus, only by complying with these requirements will the lesson acquire the status of the most effective form of learning and fulfill its mission.

Discussion. The learning sequence was divided into different parts. For each of the parts, the content related to perfumery, which implies the study of the chosen subject to solve, correlated with some of the chemistry content in the current curriculum. Knowing the content of each part, both in the topic of perfumery and in chemistry, finally made it possible to plan the flow of the lessons. This allowed students to structure their learning around the chemistry content.

The research conducted on the topic of Perfume made it possible to make a heuristic map, (Fig. 1).

The figure shows all the subthemes that fit the theme “Perfumery”.

Teachers were also interviewed to confirm the hypothesis of the work. Only one out of ten teachers interviewed had experimented and regularly experiments with this kind of teaching. Different teachers were asked if they found the proposed teaching sequence applicable to other subjects and if it might cause some difficulty in application.

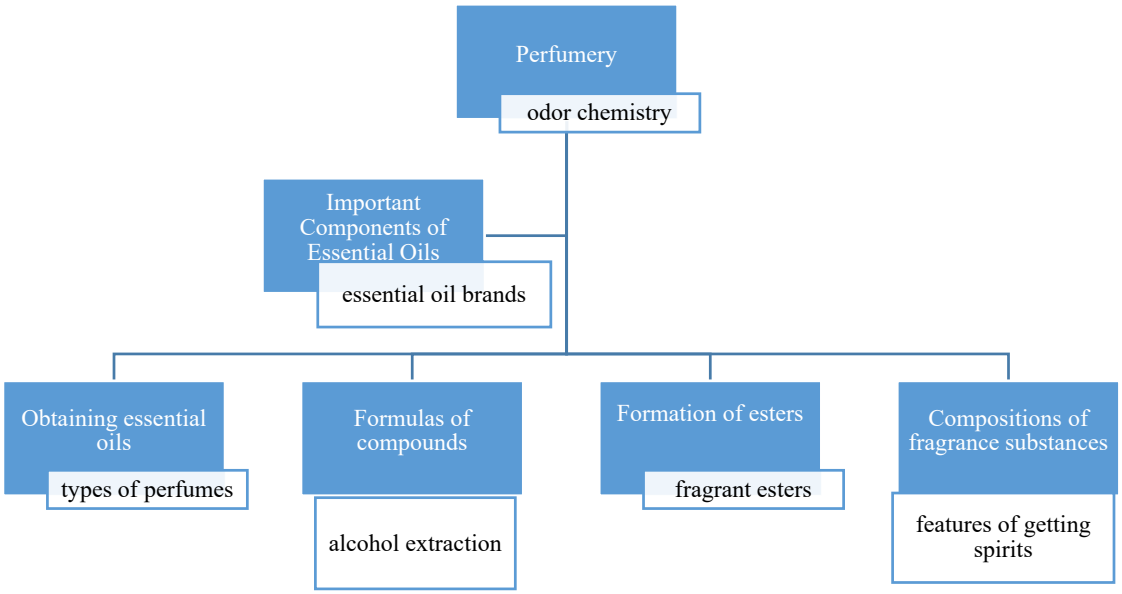

Fig. 1 Heuristic map of the topic "Perfumery".

Teachers gave the following characterization of the sequence:

- students may have lacked some knowledge of chemistry to understand the concepts covered (an observation made by three of the ten teachers),
- that students had trouble making the connection between perfumery and chemistry (two out of ten teachers),
- too ambitious: the proposed sequence includes too many different concepts,
- too superficial: the proposed sequence does not contain enough chemistry,

All of the teachers interviewed found that the topic of perfume, qualified as a catchy topic, was a relevant topic to address the content described in the research plan.

Several advantages were stated. Among them, we note that it is a topic that allows us to approach many of the chemistry content. Implementing a mind map on the topic of perfume allowed the main topics related to perfume to be highlighted. At least briefly, the teachers touched on each of these topics during the sequence.

Basic knowledge of chemistry to better understand specific knowledge of the topic of perfume was common to the syllabi. The sequence was arranged so that students could best integrate the various knowledge of perfumery. Obviously, content specific to perfumery, for which chemical knowledge is required, was thoroughly explored. For example, the beginning of the sequence focused on definitions specific to perfumes. By not going into all the topics outlined above, it was possible to limit the length of the proposed sequence and thus avoid fatigue on the part of the students. The sequence was planned with a division into lessons, including various means of teaching, since we believe that the thematic approach would lose its appeal if the teaching were only ex-cathedra. We planned educational situations in order to motivate students as much as possible in their learning, such as watching a documentary, demonstrations, and group activities.

The results obtained generally confirm the working hypothesis, namely, that learning through the study of topics from everyday life, carried out episodically, alternating with "classical" education, aroused great interest among students, and on the thematic control work, group 2 showed the best results.

Of course, the disadvantages of this type of work should also be pointed out. The content of chemistry is offered in depth during the allotted time. Therefore, the sequence is either too superficial or too ambitious. Without practice, we cannot refute this observation. Therefore, accepting it, it is necessary to either increase the number of hours devoted to this sequence or to teach chemistry in a shorter form. Therefore, an increase in lesson time has been considered. When much knowledge was covered, the length of time provided to teach that knowledge was extended. The proposed final sequence stretched fifteen hours without regard to practical work and assessment.

Conclusion

It is difficult to motivate students in exact science subjects such as chemistry. "Classical" teaching of this discipline in high school is based on the study of topics that are purely chemical in nature, which makes it unlovely for many students. From the scholarly work of experienced educators, we can conclude that teaching based on the study of topics from everyday life, done sporadically, alternating with a classical education, would allow more interest to be aroused in middle school students. This is crucial to the subject of chemistry. Few teachers, however, practice such teaching, and this claim cannot really be tested in practice. This would require, for example, the teaching of everyday life and classical teaching to be implemented in parallel in two classes over the course of a year, then testing their respective effects on student motivation. Unfortunately, there was not enough time for such an in-depth experiment.

This approach seems promising and possible to implement by applying the sequence proposed in this paper. The chosen topic for teaching chemistry in high school is productive, which also allows for an interdisciplinary biology and chemistry approach. But this type of work requires the allocation of more hours to the topic.

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