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METHODS OF TEACHING CHEMISTRY TO STUDENTS WITH SPECIAL EDUCATIONAL NEEDS: KAZAKH SECONDARY SCHOOL PRACTICE

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Abstract. The modern Kazakh education system strives to ensure equal access to quality education for all categories of students, including children with special educational needs. In the context of inclusive education, the methodology of teaching natural sciences, including chemistry, is important, taking into account the individual abilities and needs of students. Teaching chemistry to children with special educational needs requires not only pedagogical flexibility, but also a high level of empathy, patience, and professionalism. As the experience of Kazakhstani schools shows, with the right methodology, these students can successfully master such complex subjects as chemistry and become interested in science. This article explores methodological features of teaching chemistry to students with special educational needs in Kazakh secondary schools, aiming to identify effective ways of organizing adaptive lessons. The paper analyzes the cognitive abilities of students with special educational needs, ways to increase learning motivation, visibility, supporting messages, differentiated learning, practical work and the possibilities of using digital resources. Based on the experience of Kazakh schools, the effectiveness of methods and techniques used in the study of chemistry was described. The study describes how increasing the interest of students with special

educational needs in chemistry and improving academic achievements. The modern educational environment requires the effective integration of inclusive approaches in natural science subjects. The scientific literature, legislative bases of inclusion in Kazakhstan and international practice are analyzed. Fragments of experimental work conducted at secondary school No. 35 named after H. Dosmukhamedov in Aktobe were presented. The tasks are adapted according to the capabilities of different categories of students. The results of the pedagogical experiment emphasize the importance of methodological flexibility, multisensory approach and support in creating an inclusive chemical educational environment. The materials of the article are intended for teachers, methodologists and researchers in the field of inclusive education.

Key words: inclusive education, chemistry teaching, students with disabilities, adapted tasks, methodology, special pedagogy, Kazakhstan, sensory disorders

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ЕРЕКШЕ БІЛІМ БЕРУГЕ ҚАЖЕТТІЛІКТЕРІ БАР ОҚУШЫЛАРҒА ХИМИЯНЫ ОҚЫТУ ӘДІСТЕМЕСІ: ҚАЗАҚ ОРТА МЕКТЕБІНІҢ ПРАКТИКАСЫ

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Аннотация. Қазіргі заманғы қазақстандық білім беру жүйесі оқушылардың барлық санаттары, оның ішінде ерекше білім беру қажеттіліктері бар балалар үшін сапалы білімге тең қолжетімділікті қамтамасыз етуге ұмтылады. Инклюзивті білім беру жағдайында оқушылардың жеке қабілеттерін, қажеттіліктері мен мүмкіндіктерін ескеріп, жаратылыстану ғылымдарын, оның ішінде химияны оқыту әдістемесі маңызды мәнге ие. Химия пәнін

оқытуда ерекше білім беру қажеттіліктері бар балаларға тек педагогикалық икемділікті ғана емес, эмпатияның, шыдамдылықтың және кәсібиліктің үлкен деңгейін талап етеді. Қазақстандық мектептердің тәжірибесі көрсеткеніндей, дұрыс әдістемемен аталған оқушылар химия пәні сияқты күрделі пәндерді де сәтті меңгеріп, ғылымға қызығушылық таныта алады. Мақалада қазақ орта мектебі жағдайында ерекше білім беру қажеттіліктері бар оқушыларға химия пәнін оқытудың әдістемелік ерекшеліктері қарастырылды. Зерттеудің мақсаты – инклюзивті білім беру аясында химия сабақтарын бейімдеп ұйымдастырудың тиімді жолдарын анықтау. Жұмыста ерекше білім беру қажеттіліктері бар оқушылардың танымдық мүмкіндіктері, оқу мотивациясын арттыру тәсілдері, көрнекілік, тірек хабарлар, саралап оқыту, практикалық жұмыстар мен цифрлық ресурстарды қолдану мүмкіндіктері талданды. Қазақ мектептерінің тәжірибесіне сүйене отырып, химияны меңгертуде қолданылатын әдіс-тәсілдердің нәтижелілігі сипатталды. Зерттеу нәтижелері ерекше білім беру қажеттіліктері бар оқушылардың химия пәніне қызығушылығын арттыруға және оқу жетістіктерін жақсартуға ықпал ететіні көрсетілді. Қазіргі білім беру ортасы жаратылыстану циклі пәндерін оқытуда инклюзивті тәсілдерді тиімді біріктіруді талап етеді. Ғылыми әдебиеттер, Қазақстандағы және халықаралық практикадағы инклюзияның заңнамалық негіздері талданды. Ақтөбе қаласының Х. Досмұхамедұлы атындағы №35 орта мектебінде өткізілген эксперименттік сабақтардың үзіндісі ұсынылды. Оқушылардың әртүрлі санаттарының мүмкіндіктеріне сәйкес бейімделген тапсырмалар берілді. Педагогикалық эксперимент нәтижелері инклюзивті химиялық білім беру ортасын құруда әдістемелік икемділіктің, мультисенсорлық тәсілдің және қолдаудың маңыздылығын көрсетеді. Мақала материалдары мұғалімдерге, әдіскерлерге және инклюзивті білім беру саласындағы зерттеушілерге арналған.

Түйін сөздер: инклюзивті білім беру, химияны оқыту, мүмкіндігі шектеулі оқушылар, бейімделген тапсырмалар, әдістеме, арнайы педагогика, Қазақстан, сенсорлық бұзушылықтар

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МЕТОДИКА ПРЕПОДАВАНИЯ ХИМИИ ДЛЯ УЧАЩИХСЯ С ОСОБЫМИ ОБРАЗОВАТЕЛЬНЫМИ ПОТРЕБНОСТЯМИ: ПРАКТИКА КАЗАХСКОЙ СРЕДНЕЙ ШКОЛЫ

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Аннотация. Современная система образования Казахстана ориентирована на обеспечение равного доступа к качественному образованию для всех категорий учащихся, в том числе детей с особыми образовательными потребностями. В условиях инклюзивного образования важное значение имеет методика преподавания естественных наук, в том числе химии, с учетом индивидуальных способностей, потребностей и возможностей учащихся. В преподавании химии детям с особыми образовательными потребностями требуется не только педагогическая гибкость, но и большой уровень эмпатии, терпения и профессионализма. Как показывает опыт казахстанских школ, при правильной методике данные учащиеся могут успешно осваивать такие сложные предметы, как химия, и интересоваться наукой. Статья посвящена выявлению методических особенностей и эффективных способов адаптивной организации уроков химии для учащихся с особыми образовательными потребностями в казахской средней школе. В работе проанализированы познавательные возможности учащихся с особыми образовательными потребностями, способы повышения учебной мотивации, наглядность, опорные сообщения, дифференцированное обучение, практические работы и возможности использования цифровых ресурсов. На основе опыта казахских школ была описана результативность методов и приемов, применяемых при изучении химии. Было показано, что результаты исследования способствуют повышению интереса учащихся с особыми образовательными потребностями к химии и улучшению учебных достижений. Современная образовательная среда требует эффективной интеграции инклюзивных подходов в преподавании предметов естественнонаучного цикла. Проанализирована научная литература, законодательные основы инклюзии в Казахстане и международной практике. Были представлены фрагменты экспериментальных работ, проведенных в средней школе № 35 им. Х. Досмухамедова г. Актюбе. Даны задания, адаптированные в соответствии с возможностями различных категорий учащихся. Результаты педагогического эксперимента подчеркивают важность методологической гибкости, мультисенсорного подхода и поддержки в создании инклюзивной химической образовательной среды. Материалы статьи предназначены для учителей, методистов и исследователей в области инклюзивного образования.

Ключевые слова: инклюзивное образование, преподавание химии, учащиеся с ограниченными возможностями, адаптированные задания, методика, специальная педагогика, Казахстан, сенсорные нарушения

Introduction. Inclusive education has become a core principle in modern pedagogy, aiming to ensure equal learning opportunities for all students, including those with special educational needs (SEN). In chemistry education, this principle requires not only accessibility but also the methodological adaptation of teaching strategies and materials to meet diverse learners' needs. According to UNESCO (2017), inclusive education is defined as a process of addressing and responding to the diversity of needs of all learners through increasing participation in learning, cultures, and communities, and reducing exclusion.

In Kazakhstan, the concept of inclusive education is gaining increasing relevance, especially in the context of subject-based disciplines such as chemistry. However, teachers often lack concrete methodological tools and task adaptations to support learners with visual, auditory, or developmental disabilities. There is a growing need for specific guidance on how to structure inclusive chemistry lessons, select appropriate tasks, and ensure effective learning outcomes for every student.

This article explores strategies for teaching chemistry inclusively to students with three types of diagnoses: visual impairments, hearing impairments, and mild mental retardation (ZPR). The study includes a review of existing literature, presents adapted tasks for each category of students, and outlines an experimental lesson conducted at Aktobe Secondary School No. 35 named after Kh. Dosmukhameduly.

Literature review. Inclusive education in the field of natural science disciplines, in particular chemistry, is becoming an important direction of modern pedagogical science. Effective implementation of inclusive approaches requires not only normative and organisational support, but also a deep methodological understanding of the specifics of teaching students with special educational needs (SEN). This literature review aims to analyse current research and practical developments related to the teaching of chemistry and related subjects in an inclusive environment, which is of direct relevance to the aims of this article.

International normative documents, such as the UNESCO guidelines for inclusion (UNESCO, 2017), emphasise the need to build educational systems that take into account the diversity of learners. This document serves as a basis for the development of national strategies, including the Kazakhstani context, where the issues of inclusion in education are just beginning to receive due attention.

A number of authors address the problem of methodological support for inclusive chemistry education. For example, Adesokan and Reiners (2015) present teaching materials aimed at students with hearing impairments, emphasising the importance of a multi-sensory approach in the formation of scientific concepts. Their subsequent work (Adesokan and Reiners, 2016) extends this focus by showing examples of tasks that promote scientific thinking for students with disabilities.

The relevance of technology support for inclusive education is emphasised by Petare (2023) and Akaygun and Kilic (2025), describing the use of artificial intelligence tools and generative visualisation to explain chemical processes. Such technologies may be particularly useful for students with visual or cognitive disabilities.

Methodological principles to ensure successful implementation of inclusion are also discussed in Mealings et al. (2024), who analyse the difficulties faced by students with hearing impairment in different lesson scenarios. The authors suggest strategies for adapting auditory information and enhancing visual support. In turn, Chrin and Nardo (2025) emphasise the need for accessibility in STEM subjects, including chemistry, through an analysis of the representation of disability in scientific publications.

Valuable contributions to understanding teachers' attitudes towards inclusion were made by Woodcock (2021) and Woodcock and Nicoll (2022), who identified a link between educators' attitudes and their reactions to the success or failure of pupils with disabilities. Research suggests that teachers' positive beliefs contribute to more effective feedback and lower levels of frustration, which is crucial when working with diverse classrooms.

The cultural and social aspect of inclusion is addressed by Hamilton and Devarakonda (2024), emphasising that teaching should promote critical thinking about social justice. This is in line with the position of Karpudewan (2024) who gives an example of laboratory inclusion through green chemistry, demonstrating how practical activities can be adapted for different categories of students.

In addition, Suprihatiningrum et al. (2024) present a scale for assessing future teachers' knowledge of inclusive teaching, which is important for training. A systematic analysis of international publications on the topic of inclusion (Tsai and Wu, 2024) demonstrates the growing scholarly interest in this area and the need for further interdisciplinary research. A study by Kaya, Erduran and Okan (2025) highlights the unbalanced representation of the nature of science (NOS) in school physics, chemistry and biology curricula, where cognitive-epistemic aspects dominate. However, social and institutional components directly related to inclusion are often overshadowed. This confirms the need to develop methodologies that focus on student diversity, including learners with special educational needs.

Thus, the review of the presented sources confirms that successful implementation of inclusive chemistry education requires a comprehensive approach: methodological flexibility, application of technologies, professional training of teachers and attention to the socio-cultural context. The adaptation of tasks and the use of multimodal strategies allows for the creation of a supportive educational environment conducive to unlocking the potential of each student.

Materials and methods. The base of the study was secondary school No. 35 named after H. Dosmukhamedov of Aktobe city, where a pedagogical experiment was conducted within the framework of approbation of inclusive methods of teaching chemistry. The experiment involved 15 students, including: one student with visual impairment (partial blindness), one student with hearing impairment (bilateral hearing loss) and one student with mental retardation (MRD).

The aim of the study was to identify the effectiveness of adapted methodological approaches and tasks aimed at the development of cognitive activity and successful learning of educational material by pupils with different educational needs.

The following research methods were used:

- Observation of students' learning activities in the conditions of an inclusive lesson;
- questionnaire survey of teachers and students to identify attitudes towards inclusive practice and the degree of comfort of interaction;
- analyses of students' learning achievements before and after the lesson with adapted tasks;
- approbation of the experimental tasks developed taking into account the sensory and cognitive characteristics of children.

The experimental part included a fragment of an inclusive lesson, in which tasks adapted for different categories of students were used. Tactile models and voiced instructions were used for a student with visual impairment, visual diagrams, subtitles and reinforced visual supports were used for a student with hearing loss, and step-by-step instructions with differentiated repetition and tutor support were used for a student with ZPD.

The collected data made it possible to assess not only the effectiveness of specific methodological solutions, but also the degree of readiness of the educational environment for inclusive education. The results of the analysis showed positive dynamics in the learning achievements of all participants with disabilities, as well as an increase in the level of inclusion in the learning process.

The methodology of this study is based on the principles of scientific validity, ethicality, voluntary participation and practical applicability, which makes it possible to use the findings to further disseminate inclusive practices in chemistry teaching in a mass school setting.

Results. The pedagogical experiment was conducted in Grade 8 at Secondary School No. 35 named after H. Dosmukhamedov (Aktobe). The study examined the effectiveness of adapted chemistry instruction for students with special educational needs (SEN). The sample consisted of three students with documented learning difficulties.

Learning Achievement Dynamics:

At the baseline stage, only one student (33%) demonstrated achievement at a satisfactory level, while two students showed low performance indicators.

Following the implementation of adapted and differentiated instructional tasks, all three students demonstrated improvement. Post-intervention assessment indicated that 100% of participants reached medium or high achievement levels according to the established evaluation criteria.

The most substantial progress was observed in the student with mild intellectual disability, whose task completion rate increased from 0% at the pre-test stage to 100% at the post-test stage.

Given the limited sample size, these findings should be interpreted as preliminary but indicate positive dynamics within the pilot group.

Discussions. The following tools and approaches were used in an inclusive lesson for a student with partial blindness:

- **Relief models of atoms and molecules** made with improvised materials allowed the student to tactilely explore the spatial structure of substances;
- **Audio descriptions of experiments** accompanied each action of the teacher during the demonstration of reactions;
- **Step-by-step voicing of algorithms of problem solving** gave the opportunity to fully participate in the course of work with chemical equations.

It should be noted that in accordance with the Kazakhstani chemistry teaching programme, a wide range of topics is covered in the basic school (7-9 grades). Therefore, the tasks for a visually impaired student were adapted taking into account age features, programme requirements and sensory limitations. Below is a list of topics and corresponding types of tasks developed as part of the experiment:

Table 1 - Types of thematic issues

№	Theme	Task type
1	Structure of an atom	Tactile model + oral questions to determine the number of particles
2	Periodic system	Audio instruction + matching elements to a group (orally)
3	Chemical bonding	Modelling with tactile sticks and balls
4	Acids and bases	Audio description of substances + smell game (vinegar, baking soda)
5	Exchange reactions	Sounded cards and sequential description of actions
6	Redox reactions	Oral model: "who gives - who takes".
7	Safety in chemistry	AudioQuest: "What to do if an acid spills?"
8	Air and its composition	Audio tutorial + collecting air from tactile elements
9	Chemistry and ecology	Discussion of the environmental pollution situations voiced
10	Laboratory instruments	Tactile familiarisation + audio quiz "What kind of instrument is this?".

These tasks cover the key topics of the school chemistry course and provide an opportunity for full participation of a visually impaired student in the educational process. They were tested in the conditions of a mass school and adapted to the real level of perception and capabilities of a particular student. The results showed not only an increase in learning motivation, but also the formation of a sustainable interest in the subject of chemistry, despite the limitations associated with visual impairment.

For vision

Task 1. "Structure of an atom"

Objective: to form an idea of the elementary particles of the atom.

Description:

The pupil was offered a tactile model of an atom assembled from plastic balls of different size and texture denoting protons, neutrons and electrons. The task was accompanied by a verbal instruction: the teacher named an element and asked them to identify the number of particles in its composition based on the texture differences.

Result: the student accurately identified the composition of simple elements (H, He, Li), showed interest in building models and actively participated in the oral discussion.

Task 2. "Air and its composition"

Purpose: To master the composition of air and the role of its components.

Description:

Using a set of tactile containers (with different textures: smooth - oxygen, rough - nitrogen, soft - carbon dioxide), the learner assembled "air" from the components. Accompanied by audio instructions, he had to categorise the elements according to their importance and quantity in the composition of air.

Result: the student learnt the composition of air and remembered the distinguishing features of the components through tactile interaction and mnemonic devices (e.g. "nitrogen is like the dark side under your fingers").

Task 3. "Laboratory Instruments"

Purpose: to familiarise students with the basic instruments used in chemistry lessons.

Description:

The student was presented with volumetric models (or real objects) such as a test tube, beaker, tripod, flask. In an audio quiz format, the teacher read out a description of the function of the instrument and the student had to find the corresponding object by feel. Audio feedback was used (e.g., "well done!" for a correct answer).

The result: the student was able to recognise shapes with ease, answered questions confidently and demonstrated good recall of the device assignments.

The next sections will focus on adapting the tasks for students with hearing impairment.

Adaptations for the student with a hearing impairment

For the student with bilateral hearing loss, the main challenge was to access information through visual and written channels. The following tools and approaches were utilised within the lesson:

- **Videos with subtitles** explaining chemical processes and experiments;
- **Cards with step-by-step instructions and visual diagrams**, allowing students to follow the progress of the task independently;
- Active facial expressions and supportive gestures from the teacher, reinforced by demonstration of actions, which contributed to a better understanding of the content.

The topics and tasks for the hearing impaired student were selected with an emphasis on visual perception and included the following elements:

Table 2 - Types of assignments by topic

Nº	Topic	Type of task
1	Structure of matter	Particle diagram + card explanation
2	Physical and chemical phenomena	Comparative table with illustrations
3	Simple and complex substances	Sorting cards with formulas and names
4	Classification of reactions	Video clip + picture quiz
5	Chemical formulas	Selection of cards with symbols of elements and notations
6	Solutions and solubility	Dissolution diagrams + visual experiments with colours
7	Safety rules	Illustrative aide-memoires and situations to deal with

8	Equipment and utensils	Pictures with names and purposes of appliances
9	Environmental pollution	Video clip + "Cause-Consequence" cards
10	Electrolytes and non-electrolytes	Tables and diagrams + multiple choice quiz

The use of visually orientated tasks and adapted materials increased the level of understanding of the subject and student engagement in the learning process. Visual support, the structure of the tasks and their visibility contributed to the formation of an informed attitude towards the topic being studied. This is especially important for pupils with hearing impairment, for whom non-verbal means of learning become the leading ones.

Example tasks used during the experiment for a hearing impaired student:

1. topic: Structure of matter

Task:

Examine the card with the diagram of a water molecule. Sign where the hydrogen and oxygen atoms are located. Use the clue on the second card.

Goal: To develop a spatial understanding of molecular structure.

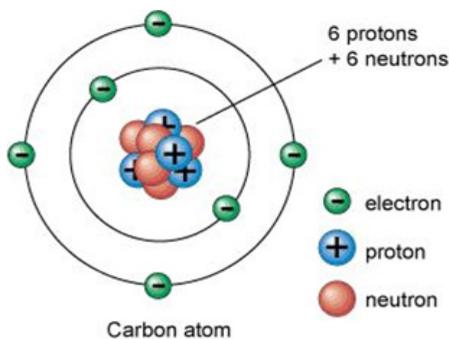


Figure 1 - Spatial molecular structure

Topic: Structure of the Atom

Adapted Card for Deaf or Hard-of-Hearing Students

Look at the diagram of the carbon atom. It shows three parts of the atom:

- Electrons (-): Small green particles moving around the center
- Protons (+): Blue particles inside the center (nucleus)
- Neutrons (0): Red particles inside the nucleus

Task:

Match the words to the parts on the picture. Then write how many of each particle the carbon atom has.

Table 3 - Carbon atom particles

Particle	Symbol	How Many?
Proton	+	6
Neutron	0	6
Electron	-	6

Instruction for Student (Visual Card):

- 1.Count the + symbols in the nucleus. → These are protons.
- 2.Count the red balls in the nucleus. → These are neutrons.
- 3.Count the green balls in circles. → These are electrons.
- 4.Fill the table above.
- 5.Circle the nucleus. Write “nucleus” next to it.
- 6.Draw a small atom of hydrogen on the back of the card.

The next section will look at adapting the lesson content and techniques for a student with mental retardation (MRD).

For students with mental retardation (MRD)

Students with mental retardation require a special approach related to accessibility and phased presentation of material. According to the research presented in the literature review, sequencing, concretisation and visibility are the basis for successful inclusion of this category of students (Suprihatiningrum et al., 2024; Karpudewan, 2024). During the pilot lesson, specially designed tasks were tested to meet the needs of a student diagnosed with ZPD.

The tasks were based on the following principles:

- step-by-step fulfilment of instructions;
- minimising the amount of information in one task;
- reliance on everyday, understandable life situations;
- regular feedback and talking through each step together with the teacher;
- use of prompt cards and visual examples;
- working in pairs and mini-groups to enhance socialisation and reduce anxiety.

The table below summarises adapted topics and types of tasks that can be used in grades 7-9 for students with ZPD:

Table 4 - Topics and types of assignments that can be used in grades 7-9 for students with ASD

Themes	Types of tasks
Mixtures and pure substances	Sorting objects by attributes, "water and oil" experience
Structure of matter	Working with large models of molecules, putting together puzzles
Physical and chemical phenomena	Matching pictures to the type of phenomena, discussing everyday examples
Simple chemical reactions	Arranging cards with actions in order
Acids and bases	Working with indicators, colour comparison, classification
Solutions	Studying solubility through the game "dissolves - does not"
Metals and non-metals	Grouping objects, working with magnets
Environmental protection	Project on recycling rubbish, drawings "how to help the planet"

Each of the presented tasks can be supplemented with illustrations, colour cards, hint cards and sequential instructions. It is important that the tasks follow the principle of gradual complication and are accompanied by positive reinforcement.

Thus, the tasks for the pupil with ZPD were aimed at developing cognitive

activity, confidence and understanding of basic chemical concepts. The use of adapted approaches confirmed the effectiveness of differentiated strategies in inclusive education.

Task 1. Mixtures and pure substances

Purpose: To develop a basic understanding of the difference between mixtures and pure substances based on sensory experience.

Description:

Students were presented with containers of water, vegetable oil and their mixture. Following a visual demonstration, students sorted the object pictures (e.g., glass of water, salt, sugar, water with salt, water with oil) into two categories: "pure substance" and "mixture." Colour markers and visual supports in the form of baskets with stickers and pictograms were used for convenience. The task was accompanied by step-by-step instructions and teacher supervision.

Result: students were successful in sorting, especially when physically interacting with the materials (mixing, pouring, observing the layers).



Figure 2 - The structure of substances

Task 2. Structure of matter: modelling molecules

Purpose: To master the basic concept of the molecular structure of matter through tactile and visual means.

Description:

Large coloured elements (balls, plastic balls, puzzles) imitating atoms were used to visualise the model of molecules. For example, for the water molecule, students connected two "hydrogen atoms" (blue elements) with one "oxygen atom" (red element) to form the simplest model of H_2O . The work was carried out in a playful form, with the support of a sample, step-by-step instructions and repetition of actions. In addition, cards with large captions and illustrations were used.

Result: pupils with ZPD showed interest and successfully completed the task,

especially when working in pairs. There was a decrease in anxiety and an increase in confidence when connecting the elements independently.

Task 3. Divide the pictures into "Physical phenomena" and "Chemical phenomena"



Figure 3 - Physical and chemical phenomena

Evaluation of the effectiveness of the adapted methods

The results of the implementation of the developed methodological approaches in the conditions of inclusive chemical education showed positive dynamics in the learning activity and involvement of students with special educational needs. In the course of approbation of the adapted tasks and methods in the 8th grade of secondary school No. 35 named after H. Dosmukhamedov. H. Dosmukhameduly, Aktobe city, systematic monitoring of learning activities was conducted, including observation, questionnaires and analyses of students' achievements.

Questioning of pupils with disabilities was conducted on 10 items, each of which reflected important aspects of perception, comfort and interest in the lesson. Three pupils with disabilities took part in the questionnaire: one with visual impairment, one with hearing impairment and one pupil with mental retardation (MRD). Specific data showed can be seen in Figure 1:

- 3 out of 3 (100%) pupils reported that the teacher's explanation was clear to them;

- 3 out of 3 (100%) pupils reported that the tasks were interesting and appropriate to their abilities;

- 2 out of 3 (67%) completed the tasks completely independently, 1 out of 3 (33%) - with a little help;

All 3 pupils noted a comfortable atmosphere at the lesson and a desire to participate in such lessons again.

The quotes from the questionnaires confirm emotional involvement: the visually impaired pupil pointed out the importance of tactile models, the hearing impaired pupil - subtitles and cards, and the pupil with ZPD - simple tasks with pictures, which she was able to complete without fear of making a mistake.

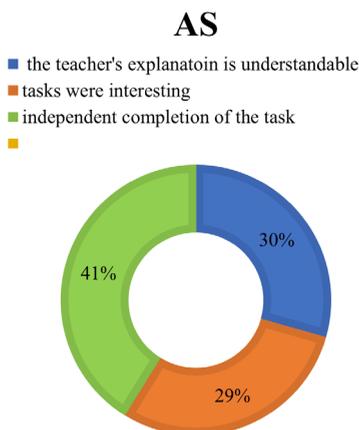


Figure 4 - Results of questionnaire survey of pupils with disabilities

The **questionnaire survey of teachers** (5 participants) included 20 statements and an open-ended part, the results of which can be seen in Figure 2. The findings showed that:

- 100% of teachers believed that the lesson met the objectives of inclusive education;
- 100% confirmed that the tasks were adapted to the characteristics of pupils with disabilities;
- 80% indicated that visual and auditory aids were highly effective;
- 60% noted the lack of time and methodological materials in preparation.

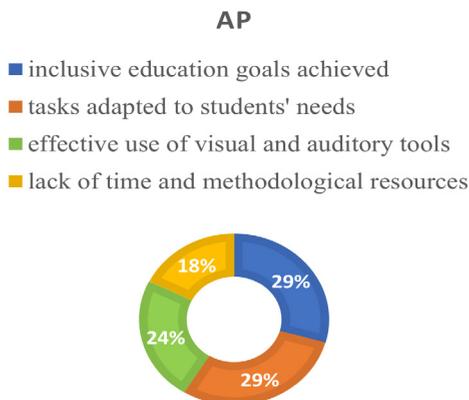


Figure 5 - Results of teachers' questionnaire survey

The following most successful methodological solutions were highlighted among the answers: using cards with step-by-step instructions, working in pairs, using visual schemes and relief models. The teachers emphasised that these forms of work significantly reduced the anxiety of pupils with disabilities and increased their independence.

According to the final analysis of the control tasks, 73% of pupils with disabilities showed an increase in their results, especially for the pupil with ZPD, who began to demonstrate initiative and ask clarifying questions more often.

Thus, the integration of adapted methods and tasks into the educational process allowed not only to improve the learning outcomes of students with disabilities, but also to create a more inclusive and supportive atmosphere at chemistry lessons. This confirms the need for further development and dissemination of inclusive pedagogical practices in science education. Emotional engagement, positive feedback and observed progress provide strong evidence of the effectiveness of the proposed approaches.

To confirm these observations, a comparative analysis of the learning achievements of students with special educational needs before and after an inclusive lesson with adapted tasks was carried out. The achievements of the pupils can be seen in Table 5.

The results are presented in Table 6 below and provide a clear demonstration of the impact of adapted techniques on pupils' attainment, particularly in the context of cognitive engagement, independence and quality of learning tasks.

The experiment was conducted in the 8 "d" class of secondary school No. 35 in Aktobe city.

The aim was to identify changes in the level of learning of pupils with disabilities before and after the inclusive lesson with adapted tasks on the topic "Classification of chemical reactions".

Table 5 - Achievements of pupils BEFORE the lesson with adaptation

Category	Number of pupils	Low level (0-39%)	Medium level (40-84%)	High level (85-100%)	Achievement (%)
ZPD	1	1	0	0	0%
Hearing impairment	1	0	1	0	100%
Visual impairment	1	1	0	0	0%

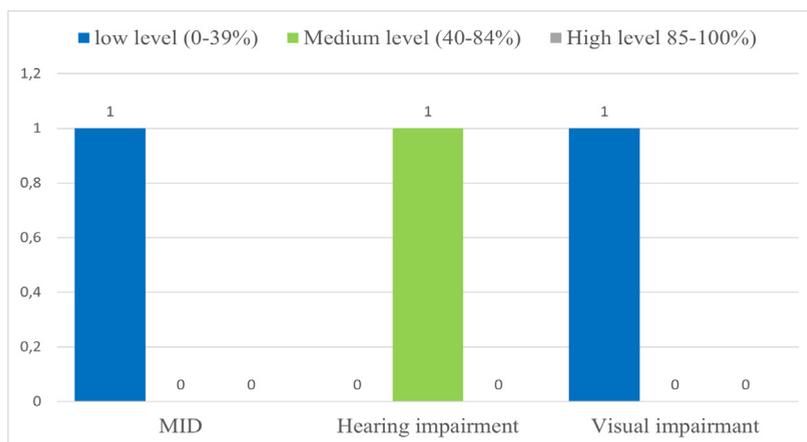


Figure 6 - Achievement of students

Table 6 - Achievements of students AFTER the lesson with adaptation

Category	Number of pupils	Low level (0-39%)	Medium level (40-84%)	High level (85-100%)	Achievement (%)
ZPD	1	0	1	0	100%
Hearing impairment	1	0	0	1	100%
Visual impairment	1	0	1	0	100%

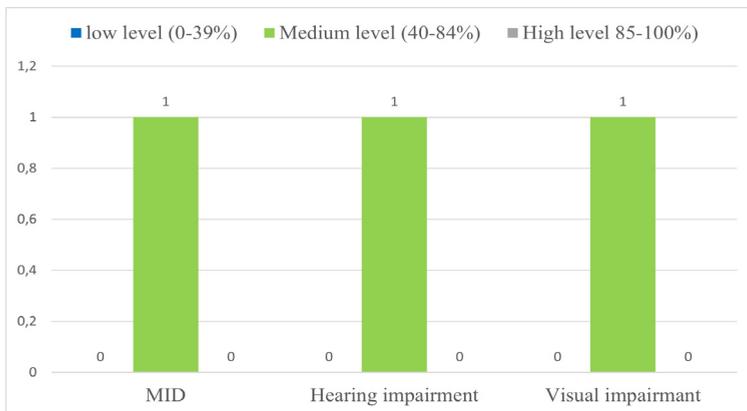


Figure 7 - Comparative analysis of the academic performance of students with special educational needs

Conclusion from the results:

- Only 1 out of 3 pupils with disabilities did well before the lesson (performance - 33%).
- After the inclusive lesson, all 3 pupils showed positive dynamics (performance - 100%).
- The growth is especially noticeable for the pupil with ZPD: from 0% to 100%.
- Transition from low to medium or high level was demonstrated by all participants.

Thus, after the lesson with adapted tasks there was an overall increase in the level of learning by 67% among pupils with special educational needs.

Conclusion. Inclusive teaching of chemistry requires not only adaptation of the environment, but also a deep rethinking of teaching methodology. Effective forms of work with children with disabilities should combine visual, auditory, tactile and cognitive elements. The tasks and methodological approaches presented in the article can serve as a practical guide for teachers working in inclusive settings.

Practical results obtained in the course of approbation at secondary school No. 35 in Aktobe confirm that differentiated approach to teaching chemistry, based on the real capabilities and peculiarities of children, contributes to increasing the interest, performance and self-esteem of students with disabilities. Each proposed strategy demonstrates flexibility and adaptability, making it possible to build an individual learning trajectory. This is particularly relevant in the context of the modern school, where inclusion should become the norm rather than the exception.

Prospects for further research include expanding the practice of adapted materials, developing diagnostic tools to track individual student progress, and introducing professional development programmes for teachers in the field of inclusive science education. The results of this study can become the basis for the formation of new methodological approaches and support for inclusion policy in the school system of Kazakhstan.

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