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Experimental Analysis of The Formation of 4k Skills in Chemistry in Students Through Media Education

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Abstract: This article identifies students with knowledge in Chemistry based on 4K skills (creativity, critical thinking, communicativity, and collaborativity) and empirically defines the impact of assignments compiled with reference to mediation on academic performance. In the course of the research, through modern media-based assignments, the level of students ' mastery of chemical concepts, the ability to solve problem situations and teamwork competencies were diagnosed. And the results obtained were compared with indicators determined using traditional training assignments.

Keywords: 4K skills, creativity, critical thinking, communicativeness, collaborativeness, mediata education, mediavocytes, chemistry education, modern assignments, traditional assignments, experimental research, Digital Pedagogy, competence development, diagnostics, pedagogical efficiency.

INTRODUCTION

In the educational process, the ability of students to think actively, be creative and work cooperatively in a team is considered one of the main indicators of competencies of the 21st century. [Kizi, S. U. B. 2025; Alimova F.A. *et al*., 2025; Abdukamalovna, A. F. *et al*., 2025] At this point, the development of 4K skills - creativity, critical thinking, communication and collaboration-through the teaching of chemistry on the basis of mediatechnologies has been made an object of research as a priority of modern education. Within the framework of the study with the aim of moving the methodological system for the formation of 4K skills in chemistry on the basis of medical technologies to a stable and open educational environment “Mediachemistry.uz " an electronic platform concept was developed. This platform is considered as a base of modern mediatechnological resources for teachers of chemistry in general secondary education schools, as well as a set of ready-made lesson materials aimed at the formation of skills of the 21st century in students (creativity, critical thinking, communication and collaborationism). According to the concept of the platform, ready-made lesson developments aimed at the formation of skills of the 21st century are planned for teachers on almost all the main topics envisaged in the state curriculum of chemistry. In the structure of the methodically carefully structured lesson work for each topic, the goals of the lesson are clearly defined in the cross section of 4K skills components, the types of educational activities are enriched with mediotechnological tools, and the criteria for assessing reflection and student activity are expressed through clear and measurable indicators.

At the same time,“- Mediachemistry.uz " platform for each subject, distributive materials are presented as a separate block, which serve to enrich the educational process in a practical and visual way. These include worksheets for laboratory work, graphic organizers, tables and schemes, problem tasks, keys, and group work assignments. This dissemination of materials allows the chemistry teacher to organize an educational environment that stimulates the independent search, thinking and creative activity of students, and not limit the lesson to the transmission of information only.

LITERATURE REVIEW

Jumamuradov R. (2020) 's dissertation,” methodology for improving the effectiveness of teaching chemistry using educational tools", focuses on studying the effectiveness of the use of multimedia educational tools in chemistry classes. The author's work examined methods for enriching the course of the lesson using audio and video materials, virtual laboratories, computer models and interactive simulations. The results of the study showed that e-textbooks and research-based learning activities are an effective tool to increase students ' interest in science, improve the quality of knowledge and develop practical skills. At the same time, the study also developed methodological recommendations for the Non-

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complex use of educational tools.[Zhumamorodov, R. 2020]

Okero E. K. (2021)' s study," Influence of Science Process Skills Teaching Approach on Students '21st century Skills in Chemistry", explores the impact of scientific research exercises and practical" science process" skills-based teaching in chemistry classes on student formation of 21st century skills. The results of the study showed that this approach significantly develops students ' critical thinking, problem solving, creativity, collaboration, and communication skills. Okero's work first documented the experience of developing skills in the 21st century using integrated STEM education methods in the Kenyan context, and scientifically substantiated the possibility of improving the effectiveness of teaching chemistry through the introduction of meaningful laboratory work, tasks requiring critical thought, and small group projects into the educational process.[Eliud, K. O. 2021]

This research, in contrast to the above works, aims to combine multimedia and applied laboratory experiences through which not only to increase students ' knowledge and interest, but also to further develop their 4K (critical thinking, creative approach, collaboration and communication) skills. In addition, the study developed practical methodological recommendations for teachers, a lesson plan and interactive exercise packages, which ensure the effective application of the work in the school setting. [Ganiyeva, M. A. 2025] These aspects make this study clear of its scientific novelty and difference from other studies.

RESEARCH METHODOLOGY

In today's era of globalization and rapid technological progress, the main goal of the educational system is not just to give knowledge, but to form the skills of the 21st century in students, to educate them as individuals who think independently, can find solutions to problems, can work creatively and cooperatively.[Ikromova, Sh. Z. 2025] It is especially important to develop these skills through the Natural Sciences, in particular chemistry. In this regard, project-Based learning (PBL) as a modern approach is being widely applied to the educational process.[Okero, E. K. *et al*., 2021] Project-based education is an activity-oriented learning strategy that focuses students on solving real-life problems, based on deep learning. [Eickelmann, B., & Vennemann, M. 2017] It serves as an important tool in shaping the following 21st century skills in students:

- Critical and systematic thinking
- Collaborative work
- Digital literacy
- Creativity and innovative approach
- Independent learning skills

The uniqueness of Chemistry - its orientation towards practice along with theoretical knowledge, richness in experiments explaining natural phenomena - provides great opportunities for a project approach. [Petko, D. *Et al*., 2018]In order to effectively implement the project approach in chemistry classes, it is necessary to pay attention to the following stages:

I. Problem setting: students are presented with a problem or question that is relevant, of interest to them. For example: how to determine the composition of Drinking Water-?, Bioplastics:can traditional plastic replace-? topics such as.[Price, J. D. *et al*., 1999]

II. Planning: students divide into groups and form a research plan. Each member is clearly aware of his / her mission.[Rosicka C. 2016]

III. Practical activity: students conduct experiments, collect data, conduct observations. This process forms their R D skills.

IV. Presentation: each group presents the results of their project to classmates and teachers. Through this, students develop the skills of Public Speaking, clear expression of thought, defense of one's own opinion.

V. Reflection: the process is analyzed, errors and achievements are discussed. At this stage, students learn self-assessment. (Kizi, S. U. B. 2025)

The main goal of the study is to develop a scientific and practical methodology for the development of 4K skills in chemistry using mediatechnologies in general secondary educational institutions and to test it in practice. To achieve this goal, the following tasks were set:

✓ Analysis of theoretical and methodological foundations of 4K skills;

✓ learning the possibilities of forming 4K skills in traditional chemistry education;[Po'latov, Sh. N. 2020]

✓ development of a model and program for the development of 4K competencies based on mediatechnologies;

✓ formation of research areas, i.e. experience and control groups;

✓ determination of the initial state of 4K skills by conducting initial diagnostics at the

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beginning of the experiment; [Romeo, G. *et al*., 2012]

✓ introduction of teaching methods based on mediatechnologies in the experimental period;

✓ evaluation of results by mathematical-statistical analysis and drawing scientific conclusions.

The following mesh of pedagogical experimental and test work carried out within the framework of the study.

Table 1. The main stages of pilot work

№	Stage name	Content
1	Preparatory stage	A program, plan and mediacontents were developed to test the 4K skill development methodology based on mediatechnologies. Evaluation criteria were prepared, questionnaires and tests were drawn up. Experience and control groups were formed in Tashkent, Namangan, Khorezm, Samarkand and Bukhara regions.
2	Initial diagnostic stage	The initial level of 4K skills of students in experimental and control groups was studied through questionnaires, tests and observations. Diagnostic data was collected and summarized for analysis.
3	Basic experience period	The methodology developed on the basis of mediatechnologies was introduced in experimental groups. Classes were organized on the basis of mediatopsychics, virtual laboratories and group discussions. During the experiment, regular pedagogical monitoring was carried out.
4	Final diagnostic and evaluation stage	After the completion of the educational process, the 4K skills of students were evaluated again. The initial and final results were given a comparative analysis, the effectiveness of the mediatechnological methodology based on the T-criterion of the styling was scientifically proven.

This four-stage structure provided the scientific basis for the systematic organization of the research process, impartial analysis and the development of 4K skills based on mediatechnologies.

Pedagogical experimental and test work constitutes the decisive practical stage of the research of this dissertation. Its main purpose is to determine the effectiveness of the methodology for the development of students ' 4K skills (critical thinking, creativity, communication and collaboration)in chemistry on the basis of mediatechnologies and scientifically substantiate its practical value. At this stage, it was analyzed to what extent the experimentally developed methodological model will work in educational practice, its impact on the formation of student activity, independent thinking, collaborative activities and creative approach.

ANALYSIS AND RESULTS

In the formation of experience and control groups, special attention was paid to the fact that the total number of students, class composition and territorial characters are in balance. The number of participants in each region (Tashkent City, Namangan, Khorezm, Samarkand and Bukhara regions) equal to or close to the total number of respondents was divided into two groups: an experimental group - Students trained in the 4K skill development methodology developed on the basis of mediatechnologies; a control group - consisted of students who took classes in the traditional method. This approach made it possible to conduct an impartial and comparative analysis, taking into account the educational environment in different regions, the level of training of teachers and the number of students in classes. For example, Grades 8-A and 9-A of No. 1 School in Yangiqorgan District of Namangan province were selected as an experimental group, and grades 8-B and 9-b as a control group. The same distribution was done in Khazorasp District School No. 40 of Khorezm region, Ishtikhan District No. 82 of Samarkand region, Peshku District No. 19 of Bukhara region and Yunusabad District No. 239 of Tashkent City.

The pedagogical experiment-testing process was carried out in stages over three academic years (2022-2025). At the initial stage (2022-2023), special modules related to the use of mediatechnologies were developed, through which practical training was carried out in students, developing 4K skills. In the later stages (2023-2024 and 2024-2025), the data obtained on the result of these exercises were analyzed, interactive methods and mediacontents were applied repeatedly. Evaluation criteria based on 21st century skills have been used to evaluate the results. In it, the activities of each student were evaluated by classes "excellent (5)", "Good (4)",

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"satisfactory (3)" and "unsatisfactory (2)". In this assessment system, indicators of knowledge and understanding, creativity, critical thinking, communication and cooperation were defined as the main criteria.

Thus, classes organized on the basis of mediatechnologies in an experimental group provided active creative thinking of students, independent decision-making in solving problems and effective cooperation in group activities. In the control group, however, these rates were at a lower level and remained largely within traditional educational methods.

Table 2. The number of respondents who took part in pilot work in Tashkent, Namangan, Khorezm, Samarkand and Bukhara regions.

Classes	**Years**	**Tashkent City (Yunusabad)**		**NAMANGAN region (Yangikurgan)**		**KHWARAZM region (Khazorasp**		**SAMARKAND region (Ishtikhan**		**Bukhara region (Peshku)**		**Total**	
		Taj.	**Naz.**	**Taj.**	**Naz.**	**Taj.**	**Naz.**	**Taj.**	**Naz.**	**Taj.**	**Naz.**	**Taj.**	**Naz.**
Class 8-A (experience)	2022 – 2023	24		28		26		28		26		**132**	
	2023 – 2024	25		26		25		26		25		**127**	
	2024 – 2025	26		25		24		25		26		**126**	
Class 9-A (experience)	2022 – 2023	25		27		24		26		25		**127**	
	2023 – 2024	24		25		25		25		24		**123**	
	2024 – 2025	26		26		25		26		26		**129**	
Class 8-b (control)	2022 – 2023		26		27		25		27		24		**129**
	2023 – 2024		25		26		25		26		25		**127**
	2024 – 2025		24		24		24		24		24		**120**
Class 9-b (control)	2022 – 2023		25		26		25		26		25		**127**
	2023 – 2024		26		26		25		26		26		**129**
	2024 – 2025		24		25		25		25		24		**123**
Total (in provincial		150	150	157	154	149	149	156	154	152	148	**764**	**755**

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cross section												

While 4K skill-forming training, which is based on mediatechnologies, was introduced into the experimental groups, classes in control groups were organized in the traditional way.

As a result of our research, at the end of the experimental work, which was selected as all the experimental test sites, the effectiveness of the levels of educational quality in the experimental group received a high indicator of 1,136 (13.6%).

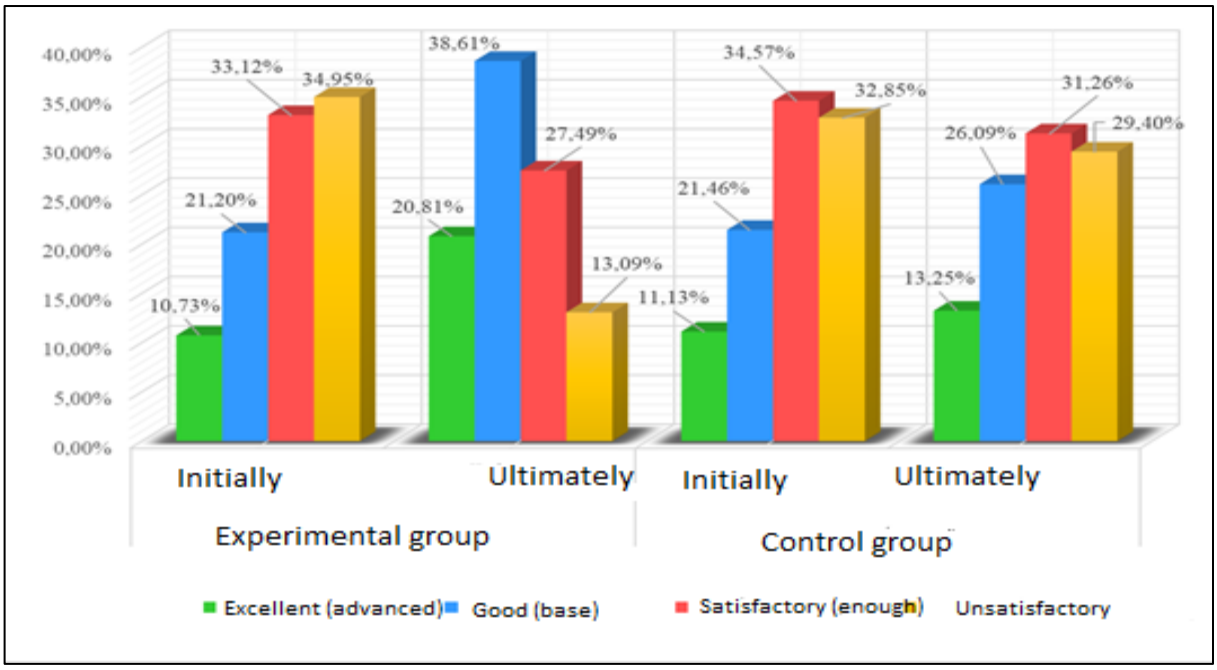

Figure 1

CONCLUSION

In conclusion, a sharp decrease in the share of growth dynamics and low indicators in the experimental group scientifically confirmed the effectiveness of the training methodology developed on the basis of mediatechnologies. This method, as an advanced pedagogical approach that meets the requirements of the 21st century in the teaching of chemistry, highly develops the quality of knowledge, the potential of creativity and the culture of communication of students.

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