

## PROBLEMS AND PERSPECTIVES ON THE DEVELOPMENT OF XXI CENTURY'S SKILLS WHILE EDUCATING CHEMISTRY

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**Abstract.** *One of the most important tasks of educational institutions, publications, teachers and parents is the correct academic and social preparation of the younger generation for the future, the coming world. One of the main problems facing those who want to fulfill their above duty will be that the future will always remain unknown. But despite this, we know that in the coming life the younger generation will definitely need information technology (IT), and will also need 5 qualities of the 21st century. To introduce these skills and qualities, as well as check and test their necessity, the social and pedagogical experiment "Real Chemistry" was conducted. It consisted of two stages, in which 50 students participated. This article outlines the program process, as well as the process analyses, and their outcomes.*

**Keywords:** *pedagogy, research, technology, chemistry, learning, 5 qualities of the 21st century, social and pedagogical experiment, communication skills, critical thinking, creativity, collaboration.*

**Introduction.** The 21st century is certainly the century of development of information technology in all sectors of our lives. As researchers from the Higher School of Economics point out, students should be aware that with the help of IT they can speed up the process of studying certain disciplines, as well as generally facilitate some stages of the educational process [1]. One of the most important functions of education is to prepare the younger generation for future life. This is the task of every teacher, parent, educational book, movie, parable, etc. One of the main difficulties in accomplishing this task is the fact that the future was, is and will always be unpredictable. It has become even more unpredictable thanks to new innovations in technology and the changes they are slowly introducing into people's lives. Despite this unknown, scientists and researchers [2] were able to identify 5 qualities, among all others, that must be developed in a person for his successful prosperity in the 21st century. These qualities are:

1. Communication skills. Communication skills are more important than ever as social media inevitably plays an active role in student development. By using a secure system that openly encourages interaction between peers in front of the teacher and ensures simple and regular communication between teacher and student, the teacher gains a deeper understanding of how each student communicates. By using this tool to bring communication to the forefront in all aspects of learning, students can be taught the basics of verbalizing their knowledge through open discussions and discussions. Sharing opinions and discussing in a non-judgmental and open environment promotes the development of communication skills, planting the seeds that lead us back to creativity and critical thinking [3].

2. Creativity. The ability to develop fresh and inventive ideas is called creativity. To solve problems and overcome difficulties in today's rapidly changing environment, it is very important to be able to adapt and think creatively. Creativity is an important 21st century skill for students and includes not only the ability to generate ideas, but also the ability to apply them effectively [2].

3. Critical thinking. Critical thinking and problem solving are often mentioned by our parents as some of the most important skills we teach. The resilience that comes from solving difficult problems and a growth mindset allow students to approach learning positively. Self-confidence, which is gained by solving problems and collaborating with classmates, plays an important role in children's development [4].

4. Collaboration. Collaboration or cooperation is the ability to work effectively with other people to achieve a common goal, which is another of the five qualities. Teamwork is critical in today's increasingly connected and globalized environment. Collaboration skills involve not only working together, but also negotiating and reaching compromise when necessary [2].

#### 5. The right to choose

The active use of student choice in the educational process makes it possible to resolve the seemingly insoluble problem of individualization in a modern mass school [4].

Wide diagnostic possibilities of choice were noted, for example, by L.S. Vygotsky, who pointed out that thanks to this technique, “we get the opportunity to experimentally create a motive, since the rows we use are mobile and can be increased, decreased, replaced from one moment to another, and finally moved from row to row; in other words, we get the opportunity to experimentally change the basic conditions of choice and trace how the process changes depending on this” [5].

**Research methodology.** It seems obvious that these qualities are important in the development of the younger generation. But real scientists and researchers must test everything in practice, and for this reason we decided to conduct a social and pedagogical experiment by creating an educational competition in chemistry called “Real Chemistry”.

As we know, to this day, most lessons are taught using traditional learning methods and do not take into account the capabilities and interests of each student in the lesson. In order to interest and involve students in (chemistry) lessons, they should try to find information themselves, as this leads to the fact that learning will be more accelerated than usual and more exciting, and also allow them to work in a team, develops their communication skills and allows them to collaborate between themselves. Let's think bigger and pay attention to what's happening in the world. Large corporations, like Google, Space X, Microsoft, HP and others, prefer to hire not individual employees, but teams at once, because thanks to their work, breakthrough products are born [6].

In our pedagogical research, we decided to make sure and show students that they can master more material by working in a team and using different sources of information. The study was conducted among students of academic lyceums with in-depth study of chemistry. In the minds of many freshmen, chemistry appears to be a difficult subject to master. That is why we decided to choose this particular discipline as an experimental one. But during the discussion, the fact was revealed that the ability to present new information and oneself to an audience is an equally important skill of the 21st century. And so we divided the whole process into 2 stages: Stage I – presentation of the topic while working in a team of 5 people.

The task of the students of each team was to choose one of the 10 topics given to them, then study everything related to this topic, divide responsibilities among themselves and prepare a speech-presentation of the topic for the audience. They had 10 days to prepare. Since the students in the groups were randomly selected, it was a new experience and new acquaintances. At the same time, we should not forget that the children need a guide - a mentor, so each group had such a person (2nd year students of the same lyceum were chosen to develop leadership qualities and improve a sense of responsibility). The presentation was organized in a new place for them - New Uzbekistan University, the students' performance was evaluated by students of this university. There were 10 performances with presentations, based on the results of which the top 3 groups with the best performance were identified (evaluation criteria were visual presentation itself, teamwork of students, knowledge of their topic, ability to speak in public).



Stage II – aimed at a specific discipline – chemistry. At this stage, the opportunity to use the chemical laboratory was presented by the administration of the academic lyceum with the support of students by a laboratory assistant. The purpose of this stage was to determine how cohesively students could work in new teams. 5 groups were formed, each with 3 participants and a mentor.

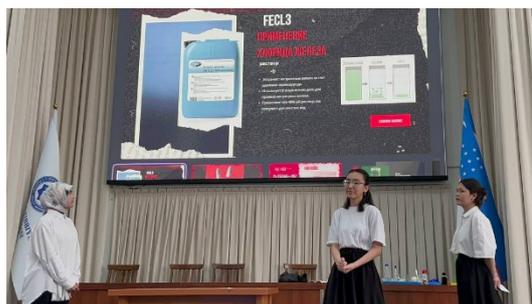
What were the students' tasks?

- choose one of 5 chemical reactions;
- study the history, preparation and chemical properties of this reaction;
- try to perform this chemical reaction yourself with a laboratory assistant;
- make an interesting presentation using the Canva application;
- work through the line and process of delivering a presentation and at the same time showing the audience's reaction (similar to a master class)

Each group had 2 weeks of preparation for this.

On the scheduled day, a presentation was made for each group and a master class was held on the above tasks and chemical experiments were presented to a wide audience. At the end of the

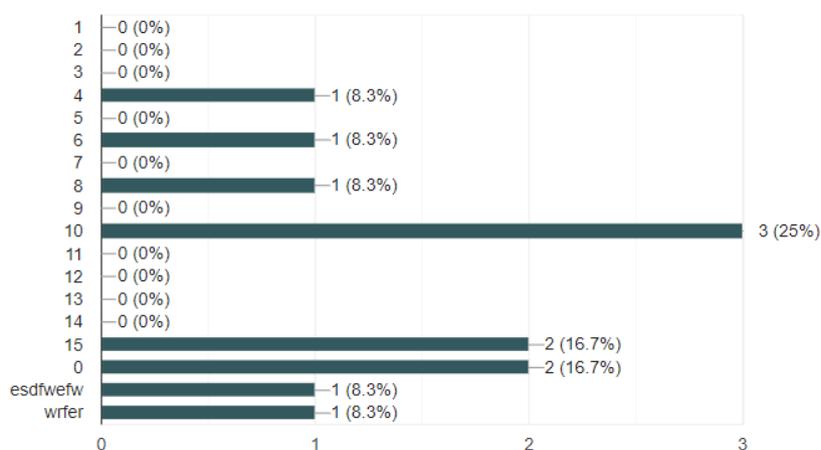
event, participants were presented with certificates from the TMA Academic Lyceum and New Uzbekistan University.



As a result of this project, students mastered the skills of self-presentation and team presentation, expanded their social circle, which contributes to collaboration in further education, the realization that chemistry is an interesting science that can be studied using different research methods, as well as with the help of information technology, which will further prepare them to future activities, because the next step is admission to higher educational institutions, recommending yourself as a leader and an interesting specialist, joint work with whom gives improved results of any work.

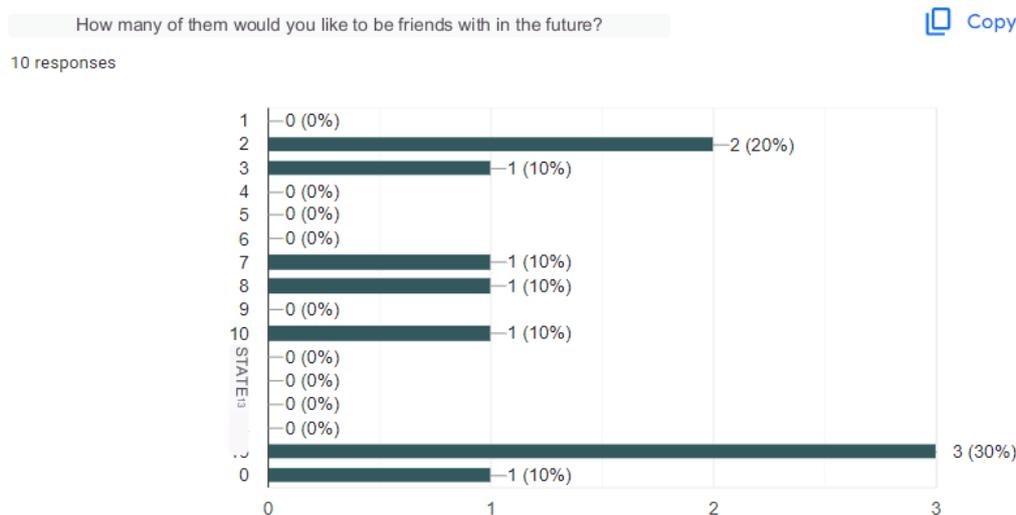
How many people have you met through this program?

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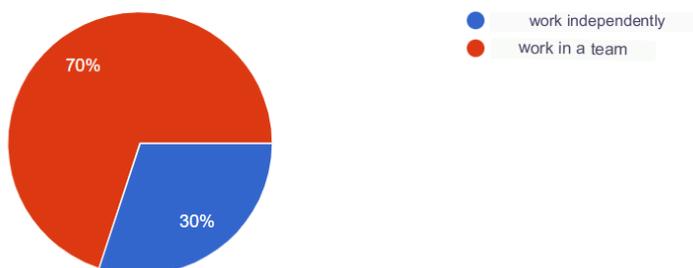
And the mentors (2nd year students of the academic lyceum) improved their leadership skills, acquired new skills and learned to properly guide their team, helping them not to lose morale

and cognitive interest. To check the effectiveness of the work, students completed an anonymous online survey ( <https://forms.gle/QY1H7MFrEThpLEcTA> ), where they shared their thoughts and impressions, which was an important part of our analyzes. Below are some questions, Fig. 1.



If you had a choice between “working independently” and “working in a team” for your next project, which would you choose?

10 responses



**Fig.1. Survey results.**

Analysis. Based on the goal of the project to implement the “Real Chemistry” program, we tried to verify the accuracy of information about the 5 qualities of the 21st century. In order to better understand all the methods that we used to achieve our goal, we identified the stages of work:

- 1) the initial goals of the program
- 2) observations during the implementation of the program
- 3) analyzes and summing up.

*Program goals:*

- 1) Sociability - increase the desire to communicate with peers, creating conditions in which they must work together to achieve a common desired goal (creating a presentation, speaking in front of an audience, laboratory work);

2) Creativity - creating criteria for laboratory work, according to which students must independently come up with new ways of using long-existing reactions;

3) Critical thinking is the analysis of available facts, evidence, observations and arguments in order to form a judgment through the application of rational, skeptical and unbiased analysis and evaluation. The process of searching for information for both presentations and the process of selecting necessary and at the same time interesting information for the presentation will help increase the level of critical thinking of students. Since students will search for information on their own, they will have to encounter many sources with different or the same information. Students will need to develop the ability to find the right information and source or use several sources at the same time;

4) Collaboration - conditions under which students are forced to work together to achieve a common and desired goal motivate them to accept each other's shortcomings and force them to provide mutual assistance to each other;

5) The right to choose - in the first stage of the program, a choice was given on the topic of the presentation, and throughout the entire program, students were deprived of complete freedom of action and decision, which gave them the right to choose.

*Observations during the program:*

1, 4) communication & collaboration - merely creating conditions in which students are forced to work together was not the most effective way to increase their motivation and desire to communicate and collaborate more with each other. This turned the whole program into something that the students were forced to deal with, rather than something they would do wholeheartedly, which turned their assignment into something that had to be done for someone (for organizers, mentors, fellow group members), but they never saw their benefit and interest in this; it is typical that they did not put all their energy into this matter. Shenkevich V.A. also mentioned this in his study, where he explained how important freedom is for the proper motivation of a child [7]. For example, students' answers to question No. 5 and question No. 7 (Fig. 2) show that many of them suffered due to the irresponsibility of their classmates and endured this because they were forced to.

**Question №5** *Describe the most serious conflict that arose during the program and how you resolved it.*

10 responses

- Our presentation at the 1st round was not so successful and many people had conflicts; I tried to calm everyone down as much as I could
- My team consisted of independent people, one might say, with no experience in teamwork, and it was a little difficult for me to bring them to a common opinion. But I think we did a great job with it)
- Our presentation
- There was no conflict

- Not the responsibility of others
- It's all because of Bob
- We had no conflicts
- They broke the flask and gave me a slap on the head
- There were no conflicts
- Responsibility of people. It was precisely this quality that was missing, I tried to close my eyes, which was difficult, but still it was of no use. With such a group it is better to do everything yourself, but I still think that teamwork is better.

**Question №7** *Imagine that you are participating in this program again and you get the same team. What do you think you would change about yourself to improve the overall group result?*

10 responses

- We have nothing and we have a great team
- I would develop the ability to persuade people in order to instill interest
- Would be more responsible
- I don't want to join the previous team, I want to join the new one
- Responsibility

- I won't participate

- Discipline

- Nothing

- Our team was one of the best teams

- I would do several rehearsals of presentation for the team the day before the performance

**Fig.2 Student answers to Question No. 5 and Question No. 7**

On the other hand, the overall result is quite good. Many students were able to make new acquaintances and have a desire to be in touch with their new friends. We can observe this from the answers to Questions No. 1, 2 and 4, Fig. 1.

It is worth noting that there were students whose love of science and whose interest in the topic motivated them to work with people they did not know well. This behavior was not an achievement of our program, since the program did not develop these qualities in them, but if there was a method for identifying these qualities.

2, 3) creativity & critical thinking - these qualities were not developed to the desired extent, for the simple reason that many students sometimes treated the project as something that they were forced to do, with people with whom they were forced to communicate and work together. Sarsenbaeva G.Kh. also mentioned such an abstract attitude. In his article "How to help a child learn" [8].

On the other hand, we encountered some creativity. This was not from a scientific point of view, that is, they did not come up with new ways to use the reactions, but rather they added interesting elements to their performance, which made the performances much more interesting for those watching. Also, the students themselves figured out adding mint esters to the soap formula to create scented soap. (Fig.3)



**Fig.3 Adding mint to soap**

5) The right to choose - since some students were forced to work together, as their fellow students were predetermined by the program, they did not have enough right to choose. At the same time, the fact that they independently chose topics for presentation in the first stage showed that many worked more diligently and efficiently when they are working on something that they themselves chose.

**Results.** It should be noted that the program was clearly insufficient for the development of 5 qualities of the 21st century students. But despite this, she was able to give the organizers a couple of important lessons about how such programs should be organized in the future:

1. Do not force students to choose a topic or classmates, but give them more freedom in choosing classmates. Create real life conditions for them, because in real life, people themselves choose their interests and those with whom they can develop together. Otherwise, students will spend their time trying to tolerate each other's temperament and will treat the project not as something that is supposed to help them in their development, but as something that they have to do for the organizers;

2. Use programs not to teach students the 5 qualities of the 21st century, but to study students who already possess these qualities. By observing such students, you can identify factors in their lives that contributed to the development of the 5 qualities of the 21st century and then try to cultivate these qualities in other students. When studying the methods of students, we can rely on the research of K.A. Alekseevna and G.M. Valerievna on the study of children's psychology [9].

3. Conduct interviews with selected students before and after the program to better understand the changes that have occurred in them. Students who show clear signs that they already possess the required qualities should be interviewed more often to better understand the reasons behind their actions and behavior.

4. Try to organize the whole process more professionally, follow the schedule and try not to go behind schedule. Select a team and initially explain to each team member his role in the group.

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