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Methodology For Developing Students' Skills By Using The "4k" Model In Teaching Programming In School

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Absrtact– **Teachers, working with the future generation and putting certain knowledge into them, should understand how the planet will change in a few years. Their competitiveness directly depends on skills. Therefore, it is recommended to focus on those skills that will be in demand in the future. To make it convenient to introduce any of the innovations, it will be useful to use the 4K model (Creativity, Critical Thinking, Collaboration and Communication).**

***Keywords*: 4K model, Creativity, Critical Thinking, Collaboration, Communication.**

INTRODUCTION

In 2016, the president of the World Economic Forum in Davos, Klaus Schwab, announced that the Fourth Technological Revolution had begun. This means that soon robots will do everything for us, and by 2020 every employee in demand will have to be able to:

- solve complex problems;
- think critically;
- think creatively;
- manage people;
- work in a team;
- recognize the emotions of other people and their own, manage them;
- form judgments and make decisions;
- focus on the client;
- negotiate;
- quickly switch from one task to another.

By 2020, critical thinking and creativity will be in the top 3 most in-demand skills, and in 2015 they were ranked 4th and 10th.

- Critical thinking;
- Creativity;
- Communication;
- Coordination (Coordinating With Others).People can show their characteristics in different industries. Regardless of the field of activity, it is impossible to avoid contact with people. Therefore, you will need to develop the appropriate skills.

The 4K model assumes the ability to get to know people, to clearly agree on the distribution of labor, to become a team, not to break deadlines, and to communicate effectively. Therefore, management knowledge will be needed by everyone, not only managers.

Creativity:all children are born active, inquisitive, but over time they lose it. it is important to keep them interested in the environment, constantly asking them various interesting questions, thinking together about how our planet will change, being interested in their opinion. it is necessary to develop imagination and purposefulness in children. so they learn to generate their own ideas and overcome difficulties.

Critical thinking:it is important to teach children to analyze information, think about it, form their own opinion and find solutions.

Communication and collaboration:Children must learn to interact with other people, distribute group values, speak clearly, briefly, clearly. In addition, it is very important that they themselves seek to understand the partner.

Thanks to these skills, it will be much easier for children not only to develop, but also to be realized in a certain industry. These are the very “soft skills” that are so valued by many employers.

I. MAIN PART

In today's dynamically changing society, the education system is undergoing major changes. What until today was broadcast from the pages of textbooks and was perceived as the original true, at the present time is losing its significance and relevance.

At the same time, the form of presenting up-to-date information remains the same, i.e. levels below the needs of the current generation of students[1].

Today's modern style of pedagogical interaction, integrated with the ever-expanding information field, leads to the constant development of one's own competencies, updating the format of knowledge, and the formation of new skills.

Knowledge takes the form of a context within which competence limited to one type of activity becomes insufficient, the possession of meta-competences becomes important, because it is this format that becomes necessary both for obtaining new knowledge and for translating it, and they are based on a variety of mental activity, collective intelligence, and empathy.

In the education system of Uzbekistan, 4K models have been actively spoken since 2020, and since 2023 this model has been promoted by the Foundation for New Forms of Education[2].

The teacher is a universal person who is both a teacher and a student. Each of his occupations is a performance in which he is an actor, writer, poet, artist. With his skill and skill, the teacher forms the personality of the students entrusted to him.

The goal of the program is to increase the teacher's competence in the field of knowledge translation, interpersonal communication and team collaboration.

The main objectives of the program are:

Development of the ability to solve complex problems;Formation and development of the skill of recognizing and controlling one's own emotions;Development of teamwork skills;Development of critical thinking;Developing the ability to quickly switch from one task to another; Development of information literacy.

We will reveal the idea of the program in more detail.

Taking into account the modern requirements for education in Uzbekistan, we come to the need to develop 4K competencies among teachers.

The program for improving the competence of teachers is based on training sessions and project-based learning, focused on the dynamic formation of requirements and ensuring their implementation as a result of constant interaction within self-organizing working groups.

The program makes it possible:

Development and adaptation of new forms of group interaction;Develop evaluative tools for personal growth of participants in the educational process;Broadcast your own experience through the creation of new methodological material;

The highest level of professional self-development of a teacher is not only the creation of an author's system of work and transmission of knowledge, but also a clear demonstration of his achievements in the face of the participants in the educational process[5].

Anyone can successfully develop 21st century skills. The main thing is desire and perseverance. The theory and practice of 4K in everyday life will help to master:

• extracurricular activities: circles, sections, events, volunteering;

• mentoring — the ability to exchange skills with partners, learn and teach at the same time;

• related literature:

The labor market will develop without interruption, the skills of the XXI century will be useful in the life of every person. Uzbek schools have switched to the 4K system, more and more projects are appearing in the country that teach creativity, communication, cooperation and critical thinking. You can study theory from books or trust teachers, and in any case, everyone is responsible for the use of soft skills[3].

The teacher should remember that the level of learning of the learner depends on the level of influence of teaching methods. It is known from experiments that the level of influence of teaching methods on the level of learning of the learner when teaching using information technologies is as follows:

- 5% by listening to a lecture;
- 10% by tuition
- audio visual method, 20% by demonstration
- debate - 40% through discussion
- 75% by working in small groups, design, independent reading, analysis and discussion, defense and presentation
- it is possible to remember 90% of the information given through the guidance text, problem situation, teaching others.

If the content of educational materials is quickly and easily assimilated into the minds of learners, the information will be stored in their memory for a long time[4].

The joint activity of students in the process of learning is understood as the individual contribution of each of them, the exchange of mutual knowledge, ideas and methods of activity. At the same time, all this is done in an atmosphere of mutual goodwill and support. This, in turn, not only gives an opportunity to acquire new knowledge, but also develops the cognitive activity itself and takes it to higher levels. Interactive activity in lessons provides for the organization and development of dialogic communication that leads to mutual understanding, working in cooperation, and solving common but important issues for each participant. The interactive method excludes the dominance of one speaker and one opinion over other opinions. In the process of dialogic teaching, students learn to think critically, to solve complex problems based on the analysis of conditions and relevant information, to evaluate alternative opinions, to make rational decisions, to participate in discussions, and to communicate with others. For this, individual, pair and group work is organized in the lessons, research projects, role-playing games are used, work is carried out with various sources of documents and information, and creative works are used. As an example of the control tasks for the robotics programming course, the exercise system can be given as follows:

1-level assignments.

1. Make a dot in the center of the computer screen.

2. Create a flashing dot in the center of the computer screen.

3. Move the point on the screen in a horizontal direction and stop at the specified place.

4. Move the point on the screen in the horizontal direction to the specified place, and perform actions to ensure that the point is deleted as a result of stopping.

5. Move the point diagonally on the screen and stop at the designated place.

6. Create a rectangle on the screen and make two horizontal points in its center.

7. Create an equilateral triangle on the screen and make two vertical points in its center.

8. Create an image of a square inside a circle on the screen.

Level 2 tasks.

9. Move the point horizontally on the screen and then return to the original position.

10. Move the point diagonally on the screen, and then perform the steps to return to the original position.

11. Create a rectangle on the screen and make a blinking dot in its center.

12. Create a sector on the screen.

13. Create a cube image on the screen.

14. Create a globe image on the screen.

3-level assignments.

15. Create a rectangle on the screen and two horizontal points in its center and move it together.

16. Create the initial letter of your name on the screen using straight lines and move it horizontally.

17. Create an equilateral triangle in the center of the rectangle on the screen and ensure that they flash in sequence.

18. Create nested recurring circles that appear one after the other on the screen.

4-level assignments.

19. Create an image that moves across the computer screen using the SPRITE operator.

20. Follow the steps to move your name across the screen in any direction.

Completion of education is evaluated according to the mastery coefficient: KA = A/R, where R is the number of control tasks, A is the number of correctly completed control tasks. $0 \leq KA \leq 1$. If $KA \geq 0.7$, the educational process is considered completed, students can improve their knowledge in the next educational process. The inclusion of the coefficient (KA) determining the quality of student learning in pedagogical processes allows to form one of the main criteria of pedagogical technology - the criterion of completion of education. In this case, if the student's movement is characterized only by its content, it can be considered a skill, and if the movement is characterized by speed, it can be considered a skill[6].

In order to determine the effectiveness of teaching programming courses based on the 4K model in the schools selected as the object of research, lessons were given to the students of the experimental group based on a specially developed methodology, while the students of the control group were taught in a traditional way. classes were conducted. At the end of the experimental test, the same test was taken from both groups and their results were summarized.

TABLE 2. Preliminary and final results of the participants who took part in the test using "4K" model pedagogical technologies 7th grade computer science programming course

Class 7	Grades of students at the end of the experiment-test									
	Experiment					Control				
	Total number of students	5 (Excellent)	4 (Good)	3 (Well done)	2 (Unsatisfied)	Total number of students	5 (Excellent)	4 (Good)	3 (Well done)	2 (Unsatisfied)
7th school, Bukhara city, Bukhara region										
F/I	27	10	14	2	1	27	6	10	11	0
16th school, Bukhara city, Bukhara region										
A/B	22	5	14	2	1	23	6	5	9	3
16th school, Bukhara city, Bukhara region										
A/B	20	8	9	2	1	29	9	5	13	2
Total	69	23	37	6	3	79	21	20	33	5

We use the Xi square and Z criteria to check the reliability of the grades obtained by the students of the experimental and control groups through the following hypotheses.

H_0: there was no change in students' knowledge levels after the pilot test. An alternative hypothesis.

H_1: a significant change was observed in the students' knowledge levels during the observation period. (mathematical expectations of grades at the beginning and end of the experiment differ, M(Y)>M(X)).

When using the chi-square criterion, we proceed in the following equence.Taking the above results as selections 1 and 2, respectively, we create the following variation series (Table 2)

TABLE 2. General results of experimental work of students on the programming course

	Selection 1					
At the beginning of the experiment	X	5	4	3	2	Total
	n_{1j}	23	37	6	3	$n_1 = 69$
	Selection 2					
At the end of the experiment	Y	5	4	3	2	Total
	n_{2j}	21	20	33	5	$n_2 = 79$

With $k = 4 - 1$ degrees of freedom and $\alpha = 0,05$ significance level, we determine the ch_kuz value using the following formula where $\chi^2_{kr} = 7,815$.

7th school, Bukhara city, Bukhara region

$$\chi_{kuz} = \frac{1}{n_1 n_2}\sum_{j=1}^{m}\frac{\left(n_{1j}n_2 - n_{2j}n_1\right)^2}{n_{1j} + n_{2j}} = \frac{1}{27 \cdot 27}\left(\frac{(10 \cdot 27 - 6 \cdot 27)^2}{16} + \frac{(14 \cdot 27 - 10 \cdot 27)^2}{24} + \frac{(2 \cdot 27 - 11 \cdot 27)^2}{13} + \frac{(1 \cdot 27 - 0 \cdot 27)^2}{1}\right) = 8,90$$

$$\chi^2_{kuz} = 8,90 > \chi^2_{kr} = 7,815$$

16th school, Bukhara city, Bukhara region

$$\chi_{kuz} = \frac{1}{n_1 n_2}\sum_{j=1}^{m}\frac{\left(n_{1j}n_2 - n_{2j}n_1\right)^2}{n_{1j} + n_{2j}} = \frac{1}{22 \cdot 23}\left(\frac{(5 \cdot 23 - 6 \cdot 22)^2}{11} + \frac{(14 \cdot 23 - 5 \cdot 22)^2}{19} + \frac{(2 \cdot 23 - 9 \cdot 22)^2}{11} + \frac{(1 \cdot 23 - 3 \cdot 22)^2}{4}\right) = 9,79$$

$$\chi^2_{kuz} = 9,79 > \chi^2_{kr} = 7,815$$

3th school, Bukhara city, Bukhara region

$$\chi_{kuz} = \frac{1}{n_1 n_2}\sum_{j=1}^{m}\frac{\left(n_{1j}n_2 - n_{2j}n_1\right)^2}{n_{1j} + n_{2j}} = \frac{1}{20 \cdot 29}\left(\frac{(8 \cdot 29 - 9 \cdot 20)^2}{17} + \frac{(9 \cdot 29 - 5 \cdot 20)^2}{14} + \frac{(2 \cdot 29 - 13 \cdot 20)^2}{15} + \frac{(1 \cdot 29 - 2 \cdot 20)^2}{3}\right) = 8,23$$

$$\chi^2_{kuz} = 8,23 > \chi^2_{kr} = 7,815$$

Total

$$\chi_{kuz} = \frac{1}{n_1 n_2}\sum_{j=1}^{m}\frac{\left(n_{1j}n_2 - n_{2j}n_1\right)^2}{n_{1j} + n_{2j}} = \frac{1}{69 \cdot 79}\left(\frac{(23 \cdot 79 - 21 \cdot 69)^2}{44} + \frac{(37 \cdot 79 - 20 \cdot 69)^2}{57} + \frac{(6 \cdot 79 - 33 \cdot 69)^2}{39} + \frac{(3 \cdot 79 - 5 \cdot 69)^2}{8}\right) = 23,79$$

$$\chi^2_{kuz} = 23,79 > \chi^2_{kr} = 7,815$$

H_0 there is reason to reject the hypothesis.

Now we will conduct a statistical analysis of the reliability of the results using the Z criterion.
For this, in the 1st row, we find the mean values and variances for the 1st and 2nd samples.

7th school, Bukhara city, Bukhara region

$$\bar{X} = \frac{1}{n_1}\sum_{i=1}^{4} n_{1j}X_i = \frac{1}{27}(5 \cdot 10 + 4 \cdot 14 + 3 \cdot 2 + 2 \cdot 1) \approx 4,22$$

$$\bar{Y} = \frac{1}{n_2}\sum_{i=1}^{4} n_{2j}Y_i = \frac{1}{27}(5 \cdot 6 + 4 \cdot 10 + 3 \cdot 11 + 2 \cdot 0) \approx 3,81$$

$$S_x = \sum_{j=1}^{4}\frac{n_{1j}(X_j - \bar{X})^2}{n_1} = \frac{10 \cdot (5 - 4,22)^2 + 14 \cdot (4 - 4,22)^2 + 2 \cdot (3 - 4,22)^2 + 1 \cdot (2 - 4,22)^2}{27} \approx 0,5432$$

$$S_y = \sum_{j=1}^{4}\frac{n_{2j}(Y_j - \bar{Y})^2}{n_2} = \frac{6 \cdot (5 - 3,81)^2 + 10 \cdot (4 - 3,81)^2 + 11 \cdot (3 - 3,81)^2 + 0 \cdot (2 - 3,81)^2}{27} \approx 0,5953$$

Z_{kuz} and z_{kr} values $\alpha = 0,05$ comparison with value level.

$$Z = \frac{|\bar{X} - \bar{Y}|}{\sqrt{\frac{S_x}{n_1} + \frac{S_y}{n_2}}} = \frac{|4,22 - 3,81|}{\sqrt{\frac{0,5432}{27} + \frac{0,5953}{27}}} \approx 1,984.$$

$$\Phi(z_{kr}) = \frac{1 - 2\alpha}{2} = \frac{1 - 2 \cdot 0,05}{2} = 0,45$$

From the Laplace function table, we determine that $z_{kr} = 1,64$

$$Z_{kuz} = 1,984 > z_{kr} = 1,64 \ .$$

16th school, Bukhara city, Bukhara region

$$\bar{X} = \frac{1}{n_1}\sum_{i=1}^{4} n_{1j}X_i = \frac{1}{22}(5 \cdot 5 + 4 \cdot 14 + 3 \cdot 2 + 2 \cdot 1) \approx 4,045$$

$$\bar{Y} = \frac{1}{n_2}\sum_{i=1}^{4} n_{2j}Y_i = \frac{1}{23}(5 \cdot 6 + 4 \cdot 5 + 3 \cdot 9 + 2 \cdot 3) \approx 3,608$$

$$S_x = \sum_{j=1}^{4}\frac{n_{1j}(X_j - \bar{X})^2}{n_1} = \frac{5 \cdot (5 - 4,045)^2 + 14 \cdot (4 - 4,045)^2 + 2 \cdot (3 - 4,045)^2 + 1 \cdot (2 - 4,045)^2}{22} \approx 0,4979$$

$$S_y = \sum_{j=1}^{4}\frac{n_{2j}(Y_j - \bar{Y})^2}{n_2} = \frac{6 \cdot (5 - 3,608)^2 + 5 \cdot (4 - 3,608)^2 + 9 \cdot (3 - 3,608)^2 + 3 \cdot (2 - 3,608)^2}{23} \approx 1,0208$$

Z_{kuz} and z_{kr} values $\alpha = 0{,}05$ comparison with value level.

$$Z = \frac{|\overline{X} - \overline{Y}|}{\sqrt{\frac{S_x}{n_1} + \frac{S_y}{n_2}}} = \frac{|4{,}045 - 3{,}608|}{\sqrt{\frac{0{,}4979}{22} + \frac{1{,}0208}{23}}} \approx 1{,}6871.$$

$$Z_{kuz} = 1{,}6871 > z_{kr} = 1{,}64 \ .$$

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$$\overline{X} = \frac{1}{n_1}\sum_{i=1}^{4} n_{1j}X_i = \frac{1}{20}(5 \cdot 8 + 4 \cdot 9 + 3 \cdot 2 + 2 \cdot 1) \approx 4{,}2$$

$$\overline{Y} = \frac{1}{n_2}\sum_{i=1}^{4} n_{2j}Y_i = \frac{1}{29}(5 \cdot 9 + 4 \cdot 5 + 3 \cdot 13 + 2 \cdot 2) \approx 3{,}72$$

$$S_x = \sum_{j=1}^{4} \frac{n_{1j}(X_j - \bar{X})^2}{n_1} = \frac{8 \cdot (5 - 4{,}2)^2 + 9 \cdot (4 - 4{,}2)^2 + 2 \cdot (3 - 4{,}2)^2 + 1 \cdot (2 - 4{,}2)^2}{20} \approx 0{,}66$$

$$S_y = \sum_{j=1}^{4} \frac{n_{2j}(Y_j - \bar{Y})^2}{n_2} = \frac{9 \cdot (5 - 3{,}72)^2 + 5 \cdot (4 - 3{,}72)^2 + 13 \cdot (3 - 3{,}72)^2 + 2 \cdot (2 - 3{,}72)^2}{29} \approx 0{,}96$$

Z_{kuz} and z_{kr} values $\alpha = 0{,}05$ comparison with value level.

$$Z = \frac{|\overline{X} - \overline{Y}|}{\sqrt{\frac{S_x}{n_1} + \frac{S_y}{n_2}}} = \frac{|4{,}2 - 3{,}72|}{\sqrt{\frac{0{,}66}{20} + \frac{0{,}96}{29}}} \approx 1{,}8516.$$

$$Z_{kuz} = 1{,}8516 > z_{kr} = 1{,}64 \ .$$

There is a reason to reject the hypothesis $H_0$with 95% certainty.

TABLE 3. General results of experimental work of students on the programming course

Tasks about the 4K model	**At the beginning**	**At the end of**	χ^2_{kuz}	Z_{kuz}	**At the beginning**	**At the end of**
	$\overline{X}$	$\overline{Y}$			S_x	S_y
Critical thinking	3,33	3,75	8,09	1,783	1,0	0,965
Creativity	3,35	3,97	8,68	2,721	1,0387	0,891
Communication	3,42	3,87	7,91	1,822	1,0822	0,822
Coordination	3,60	4,02	8,37	2,231	0,7851	0,764

It can be concluded from the obtained quantitative characteristics and the dynamics of students' learning that the indicators at the end of the experiment are higher than at the beginning.

We calculate these mastery rates in percentages:

$$\frac{\overline{X}}{4} \cdot 100\% - \frac{\overline{Y}}{4} \cdot 100\% = \frac{4{,}16}{4} \cdot 100\% - \frac{3{,}72}{4} \cdot 100\% = \frac{0{,}44}{4} \cdot 100\% = 11\ \%$$

From the above calculations, it can be seen that the indicator at the end of the experiment increased by 11% compared to the beginning.

II. Conclusions

The current development of the fields of science, education and production determines what a modern society should be. The most important characteristic aspect of modern society is that the process of globalization is effectively implemented in all spheres. In this work, the theoretical basis of the methodology of teaching the programming course using the "4K" model is explained. The content and analysis of the 4K model, the specific features of using it in the teaching of the programming course were considered. Also, the non-traditional forms and methods of using the 4K model in the teaching of the academic programming course were highlighted. Pedagogical experimental work on the research work was carried out in two stages. It was determined that the organization of experimental work and their results are an important resource for achieving efficiency in the educational process. Using educational and methodological materials aimed at developing modern methods of monitoring students' knowledge from the programming course, the effective organization of the teaching process and the high level of students' mastery have been proven with the help of mathematical and statistical analyses.

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