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METHODIK ZUR ENTWICKLUNG ALGORITHMIC DENKEN DER STUDENTEN ZUR PROGRAMMIERUNG IN HOCHSCHULEN

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Anmerkung. Dieser Artikel stellt ein Modell für die Entwicklung des algorithmischen Denkens von Studierenden in der Programmierung an Hochschulen sowie Vorschläge und Empfehlungen für seine Verwendung vor.

Schlüsselwörter: Programmieren, algorithmisches Denken, kognitives Denken, Unterrichtstechnologie.

METHODOLOGY OF DEVELOPING ALGORITHMIC THINKING OF STUDENTS ON PROGRAMMING IN HIGHER EDUCATIONAL INSTITUTIONS

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Abstract. This article presents a model for developing students' algorithmic thinking on programming in higher education institutions and shows suggestions and recommendations on the ways of its use.

Keywords: programming, algorithmic thinking, cognitive thinking, teaching techniques.

The aim of the research is to develop students' algorithmic thinking about programming in higher education institutions.

Materials and research methods. In the process of comparative and critical study and analysis of scientific, methodological, electronic sources on the subject the study and examination of state educational standards and qualification requirements of higher education institutions were used and best pedagogical practices used in the educational process were implemented, in order to find out the results of experimental work, methods of mathematical and statistical analysis were used.

Results. Based on the methodology developed in the study, it was found that students' algorithmic thinking level about programming in higher education institutions increased by 9.8%.

Introduction. Any process is done through algorithmic thinking. The art of creating and solving problems requires a special mental ability - algorithmic thinking. Algorithmic thinking is a set of mental actions and methods aimed at solving problems, which creates an algorithm that is a specific product of human activity [1].

This way of thinking is distinguished by the features of formality, logic, clarity, the ability to explain any abstract idea with consistent guidance. The problem will be solved by the gradual implementation of this idea. Moreover, it also helps to learn programming successfully [2-3].

One of the problems is to study the topics in the field of "Programming Languages", which are encountered by students of the major in computer science. In the study of these topics, students face various problems in performing tasks such as

creating a sequence of commands, step-by-step execution of a structured program [4-7]. One solution to these problems is to develop students ’algorithmic thinking.

For this reason, the development of students' algorithmic thinking about programming in higher education institutions remains one of the most pressing issues today. To overcome these problems, it is necessary to improve the forms, methods and tools of teaching programming techniques.

In this regard, scientists from our country and from the countries of the Commonwealth of Independent States, in particular, researchers and scientists such as A.A.Abdukadirov, N.A.Otakhanov, M.R.Fayziyeva, U.M.Mirsanov, N.M.Babakhodjayeva, O.K.Tikhomirov, M.V.Martinov, N.V.Gorodetskoy, S.I.Maradjabov, R.M.Magamedov, P.Bovi, J.K.Nurbekova, T.P.Pushkareva, A.I.Gazeikina, I.V.Gavrilova, T.N.Lebedova, A.N.Stas, N.F.Dolganova, F.V.Shkarban, S.O.Altukhova conducted research.

The analysis of the research of these scientists showed that the pedagogical research work in the field of algorithmic thinking in the Commonwealth of Independent States is mainly aimed at developing algorithmic thinking in programming of secondary school students.

However, among their research works there are not enough researches that have been done to improve the methodology of developing students’ algorithmic thinking on programming in higher education institutions.

Materials and research methods. In order to achieve the results of the educational goal in teaching programming in higher education institutions, it is necessary to form algorithmic thinking capacity in students [7-10].

In this regard, according to the researcher SIMaradjabov, in order to develop students' algorithmic thinking, it is necessary to pay attention to: identification of pedagogical and psychological conditions of algorithm development, development of specific actions and sequences, system of relations between object and subject improvement [11].

Based on these requirements, the formation of algorithmic thinking in the process of professional and pedagogical training in higher education forms the basis of the content of professional training of students and provides a special organization of the educational process aimed at the optimal ratio of theoretical and practical materials. Therefore, the development of algorithmic and logical thinking in algorithms and programming is of particular importance in the professional and pedagogical training of students.

Therefore, in the process of professional and pedagogical training, it is advisable to form the algorithmic thinking of students in the following stages:

1. Organizational stage. This stage consists of a series of interrelated components: adapting the student learning environment to individual characteristics; developing skills and competencies in the learning process; to form students' inner attitude and positive motivation to change reality.

2. Practical stage. This phase consists of the following components: awareness of the problem situation, which is the basis for changing educational activities aimed at increasing the effectiveness of students' learning; diagnosing a

problem situation: formulating relevant, important tasks, monitoring students' actual knowledge, skills, and competencies.

3. The final stage. This stage is characterized by the transition to independent professional and pedagogical activities. The gradual transition from one stage to another is a pedagogical activity that takes into account the motivational, meaningful and guiding components aimed at identifying the main reasons for students' learning activities, primary education skills and abilities, and their readiness for an independent profession.

Based on these stages, different studies have been conducted by various researchers to develop students' algorithmic thinking. In particular, R.M. Magamedov studied the problems of forming a system-logical thinking of a future computer science teacher on object-oriented programming. According to him, the process of algorithmic thinking is formed as a certain activity - analysis, synthesis, comparison, generalization, thinking ability, and develops creative thinking ability. To accomplish this goal, the development of system-logical thinking requires the development of its components (analysis, synthesis, comparison, generalization, classification) [12]. I.V. Gavrilova conducted research on algorithmic problems in school computer science classes. She suggested using the treat-methodology to develop students' algorithmic thinking about programming. In her view, the low level of ability to create algorithms, which is determined by the level of development of algorithmic thinking, is due to the following reasons [13]: the difficulty of linking mathematics to programming; there is a lack of practice in existing methods of teaching algorithms, insufficient attention is paid to the cognitive thinking of students.

In order to overcome the above-mentioned problems, we developed a model for the development of students' programming algorithmic thinking as part of the research (Figure 1).

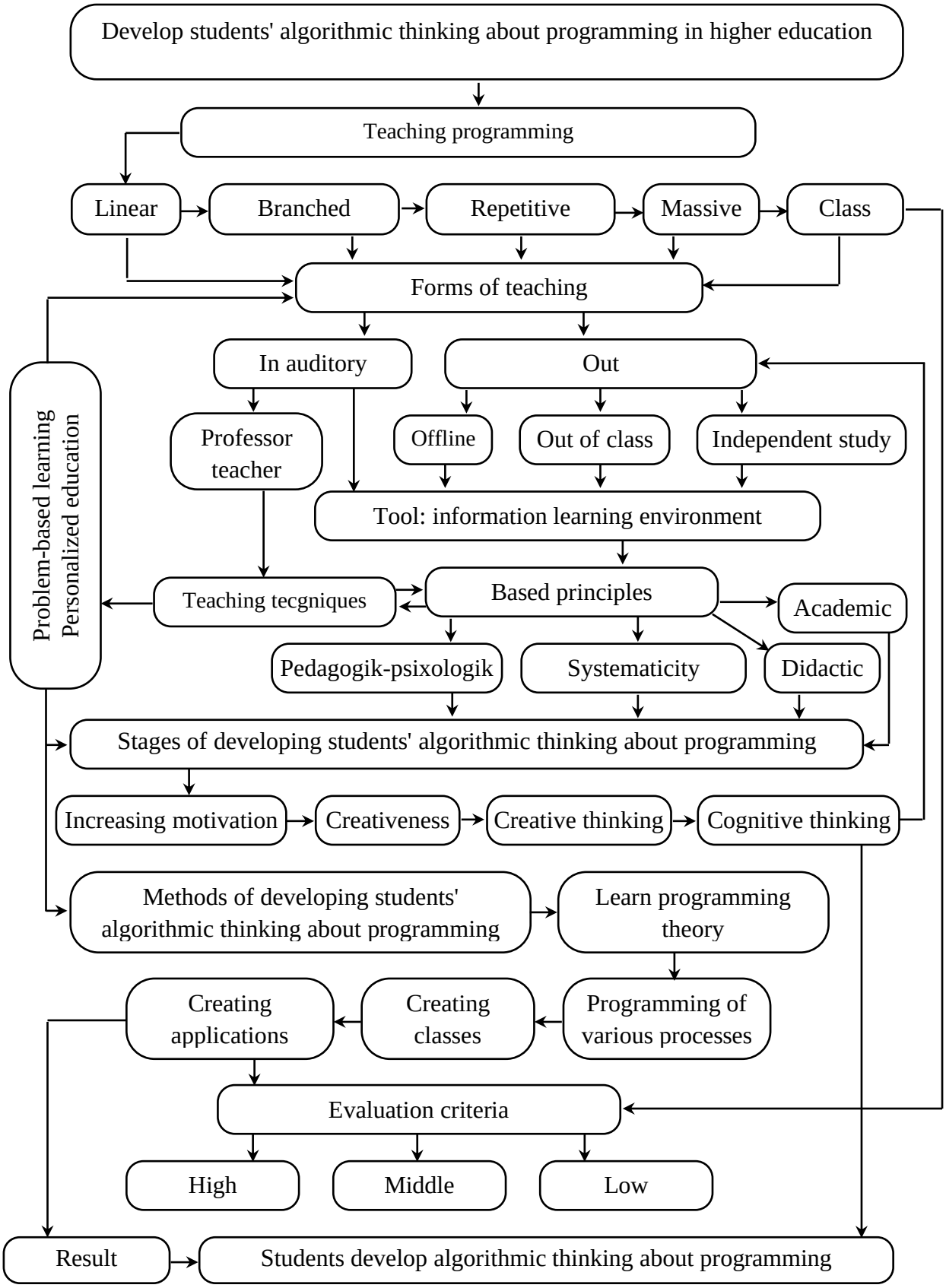

Figure 1. A model for developing students' programming algorithmic thinking.

The model shown in Figure 1 is aimed at developing students 'programming algorithmic thinking in higher education institutions. This model proposes to organize students' in-class and out-of-class learning activities on the basis of problem-based learning, person-centered learning technologies, which results in:

- skills in working with programming languages will be formed and developed;
- experience in programming various issues will be gained;
- competence in the development of various applications and projects using programming languages will be achieved.

Research results. Experimental work was carried out to develop students' algorithmic thinking about programming. Experimental work was carried out in 2021 among students of the 3rd year of study at the Navoi State Pedagogical Institute in the field of "Methods of teaching computer science."

In our experiment, a total of 67 students were involved for the experimental and control groups. The experiments were conducted in three stages: emphatic; shaper; closing. During the highlighting phase of the experiment, students were interviewed and observed about the key features of programming languages.

At the formative stage, the proposed model was applied to the experimental group.

In the final stage, a mathematical-statistical analysis based on the Student-Fisher criterion was performed in order to check the reliability of the results of the students in the experimental and control groups.

In the process of using this criterion, formulas were used to determine the appropriate mean values for the samples $\overline{X} = \frac{1}{n}\sum_{i=1}^{4} n_i X_i$, scattering coefficients $D_n = \sum_{i=1}^{3} \frac{n_i (x_i - \bar{X})^2}{n-1}$, standard deviations $\tau_n = \sqrt{D_n}$, variance ratios $\delta_n = \frac{\tau_n}{X}$, reliable deviations of the estimates $\Delta_n = t_{kн} \cdot \frac{D_n}{\sqrt{n}}$, and mastery indices were found out by the formula $P = \frac{\vec{X}}{3} \cdot 100\% - \frac{\vec{Y}}{3} \cdot 100\%$. The calculation showed that the average mastering rate of the experimental group was higher than that of the control group, an increase of 9.8%.

Conclusions.

1. We recommend using the above model in developing students' algorithmic thinking about programming. This model enhances students' programming motivation and creativity, and develops their creative and cognitive thinking as well as practical skills. As a result, students develop the necessary competencies in programming.

2. In the development of algorithmic thinking of students in higher education institutions, it is advisable to organize lessons on the basis of integration of person-centered and problem-based learning technologies with modern e-learning resources.

3. In the development of algorithmic thinking of students in higher education institutions, it is required strengthening the didactic support for the organization of their independent learning activities.

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