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Developing analysis and generalization skills in 12th grade students through the creation of algorithms for practical tasks

This article presents the results of action research aimed at developing 12th-grade students' skills in analysis and the formulation of conclusions through algorithm construction while solving practice-oriented tasks. The research, conducted in collaboration with Nazarbayev Intellectual Schools, aimed to address challenges identified among high school students. The goal was to enhance students' logical, analytical, and systematic thinking using algorithmic methods in problem-solving. The objectives of the research included the development and differentiation of tasks, selection of effective teaching strategies, algorithm construction, organizing collaborative analysis, creating assessment criteria and scoring rubrics, and fostering peer-assessment skills. In the course of the research, previous action research experiences and educational quality monitoring data were considered. Methods such as surveys, identification of individual student characteristics, differentiated instruction, and organization of work in a collaborative environment were employed. As a result of the research, students were able to correctly understand the content of the tasks and construct algorithms; they applied the constructed algorithms when completing the tasks; systematically described solution methods; developed skills in creating scoring rubrics; used those rubrics appropriately during assessment. These skills contributed to improving the quality of written work, helped students express their thoughts clearly and coherently, and supported the development of analytical and reasoning skills.

Keywords: research in action, algorithm creation method, markup scheme, assessment, analytical ability, analysis skill, ability to formulate conclusions.

Introduction

High school students demonstrate significant development in analytical-prognostic and analytical-reflective skills. The outcomes of analytical-prognostic skills, developed to obtain necessary information, are manifested in the form of projects and programs. The process of analyzing one's own activity over a defined period contributes to the formation of analytical-reflective competencies [1]. Analytical skill is defined as the ability to draw conclusions by deconstructing specific information into smaller categories. It encompasses logical reasoning, critical thinking, analysis, research, study, data processing, and generalization. Accordingly, in addressing emerging problems, we aimed to cultivate students' skills in analysis and generalization as a means of fostering their analytical capacities.

Recent research emphasizes that the development of algorithmic thinking is grounded in core cognitive processes—decomposition, abstraction, algorithmization, and debugging—which are activated when students engage with practical algorithmic tasks. Studies show that "algorithmatizing tasks" encourage students to apply these cognitive strategies consciously, thereby enhancing the quality of their analytical reasoning [2].

Moreover, the results of the final external summative assessment conducted at the end of Grade 10 proved to be unsatisfactory. This highlighted the need for effective utilization of formulas, geometric properties, and the importance of clearly outlining the steps taken when justifying conclusions. In Grade 11, the composition of each class changes according to elective subject choices. For the subject of mathematics, standard groups are allocated seven hours per week, while advanced groups receive ten hours. Given that students undergo an adaptation period, it was deemed appropriate to initiate action research starting from the third quarter of the academic year.

We considered it reasonable to promote the development of analytical and generalization skills through the complete elaboration of practical task solutions by means of algorithm construction. On one hand, this approach supports the development of writing skills necessary for the final external assessment in Grade 12. On the other, it fosters analytical abilities through both calculations and written work, thereby strengthening students' analytical thinking [3].

Other studies indicate that integrating algorithmic and computational thinking into the mathematics curriculum can significantly enhance students' ability to approach complex tasks systematically. Such an approach encourages the development of analytical reasoning and structured problem-solving skills, particularly when students construct algorithms for practical tasks. Research demonstrates that curriculum reforms emphasizing algorithmic thinking positively influence students' engagement and foster higher-order cognitive skills, supporting the development of generalization and analytical capacities [4]. Therefore, embedding algorithmic thinking exercises within regular mathematics instruction appears to be a promising strategy for promoting students' analytical and generalization skills.

Furthermore, research employing visual programming environments demonstrates that even relatively simple tasks involving the construction of algorithms for geometric figures can activate multiple components of computational thinking and foster a structured approach to analyzing mathematical objects [5].

Research topic: "Development of analytical and generalization skills in 12th-grade students through the construction of algorithms for practical tasks."

Research objective: To develop students' analytical abilities by applying the method of algorithm construction in the execution of practical tasks.

Research tasks:

– design practical tasks;

– apply active learning methodologies;

– conduct lesson observations.

Expected outcome: Increased academic engagement among students; development of assessment rubrics based on algorithms; enhancement of analysis and generalization skills through step-by-step task resolution.

Research methods: Utilization of findings from previous studies, surveys, analysis of psychological test results to determine individual abilities, implementation of active learning strategies, algorithm construction as a method for influencing analytical skill development, observation, comparison, and synthesis.

Research results: Students developed algorithms for practical tasks and organized assessment rubrics accordingly; collaborative analysis facilitated the drawing of conclusions.

Research novelty: Independent development of algorithms and assessment rubrics by students; advancement of forecasting skills through generalization.

According to Richard J.H., analytical skills are developed not through direct instruction, but through practical application. Scholars such as P.Ya. Galperin, L.V. Zankov, V.V. Davydov, M.I. Moro, L.P. Lyapina, and L.S. Vygotsky have examined the development of analytical skills in mathematics lessons through the use of game-based approaches and diverse practical tasks. Andy Jagger emphasizes the importance of varying active teaching methods in mathematics education. M. Suzanne Donovan and John D. [6] propose presenting students with two correct and one incorrect method for solving problems, thereby guiding them to construct a solution framework through joint analysis using guiding questions such as: "Why did this solution fail?", "Which method should have been used?", and "What steps should I take?"

Ya.I. Perelman proposed practical exercises involving physics, arithmetic, algebra, geometry, geometric puzzles, cubes, and other elements [7], whereby students were expected to construct task schemes based on situational contexts and achieve results accordingly. It is essential that students record each step, create diagrams, and systematically justify their solutions.

Although V.A. Baidak, S.I. Shapiro, V.M. Monakhov, N. Landa, Yu.A. Makarenko, and V.A. Dalinger have investigated the use of the algorithmic method and various types of algorithms in educational contexts, their studies focused primarily on generalized applications [8]. However, they did not sufficiently examine the methodologies for conducting and organizing lessons, the conditions and factors necessary for fostering cognitive engagement through algorithms, or individual age-related characteristics.

S.I. Shapiro conceptualizes the algorithm as an operational-logical model that integrates logic, intuition, and information encoding in solving mathematical problems [9]. A.F. Kastornov advocates for the advance recording of solution paths and their presentation in the form of block diagrams [10]. Classification by block diagram types ─ linear, branching, and cyclic ─ supports the development of students' analytical abilities.

Methods and materials

In the 12th grade study, 64 twelfth-grade students, along with their curator and school psychologist, participated in the activity. Based on the results of the psychological test, the majority of participants were identified as visual and discrete thinkers. To assess their learning modalities, we employed the VARK Questionnaire, introduced by Fleming N.D. and Mills C.[11]. Consequently, we aimed to ensure their presence in pairs and groups to facilitate the exchange of meaningful ideas, joint analysis, and the formulation of conclusions. Given their strong logical reasoning skills, our focus was placed on the development of algorithmic and written abilities. Data on students' perception of information and normal distribution for each group are shown (Diagrams 1-2).

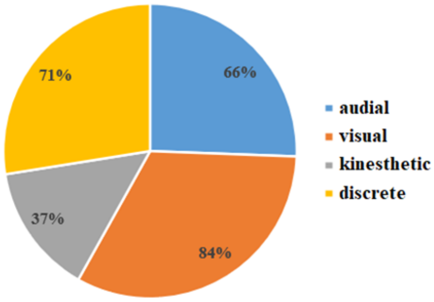

Diagram 1. Groups, by perception of information

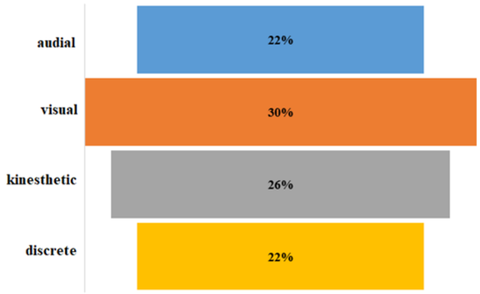

Diagram 2. Normal distribution of abilities in each group

In the third and fourth quarters of the 11th grade, the following sections were studied according to the program: “Exponential and logarithmic equations and inequalities”, “Vectors and coordinates”, “Elements of statistics”, “Calculus III”, “Equations and inequalities” [12]. In achieving the goal of our study, students were required to apply their knowledge, apply Bloom’s taxonomy, and develop high-level skills. Accordingly, the developed differentiation tasks were implemented in accordance with the following educational goals of the curriculum sections:

Section 11.3A: Exponential and Logarithmic Equations and Inequalities.

11.1.2.5 summarize the properties of the logarithm;

11.1.2.6 use the properties of logarithms when converting numerical expressions with logarithms;

11.2.2.3 solving exponential equations and inequalities that can be reduced to a quadratic equation or solved by factorization;

11.2.2.4 solve logarithmic equations and inequalities that can be reduced to a quadratic equation or solved by factorization.

Section 11.3C: Vectors and Coordinates.

11.3.4.4 using a mixed product of vectors when solving problems;

11.3.4.5 creating a plane equation in space;

11.3.4.6 creating an equation of a line in space;

11.3.4.7 determination of the relative position of two straight lines, a straight line and a plane, two planes specified by equations;

11.3.4.8 find the point of intersection of the line and the plane given by the equations;

11.3.4.9 find the distance between two lines, a line and a plane, given by the equations

11.3.4.12 find the lines given by the equation, the line and the plane and the angle between the planes;

11.5.3.1 solve practical problems using a vector.

Section 11.1C: Elements of Statistics.

11.4.3.4 creation of various graphs to display variation series (frequency polygon, histogram, stem-leaf diagram, cumulative);

11.4.3.6 calculation of measurements and indicators of the average process;

11.4.3.7 commenting on the values of variation indicators (range of variation, range of interquartile variation, dispersion, standard deviation);

11.4.3.8 determine which values of variation indicators can be used in a given situation;

11.4.3.9 build and interpret a “whisker” diagram using statistical data presented in the form of discrete and interval variation series.

Section 11.4A: Calculus III.

11.5.1.23 application of the second remarkable limit;

11.5.1.25 solving problems on differentiating logarithmic and exponential functions;

11.5.1.26 know and apply Lopital’s rule;

11.5.1.27 graph of a curve given by parametric equations and getting rid of the parameter (in simple cases);

11.5.1.28 finding the derivative of a parametrically expressed function;

11.5.1.29 finding the derivative of a given function in polynomial form;

11.5.1.32 use the partial integration method to find the indefinite integral of a function, as well as the functions arcsinx, logax;

11.5.1.33 integration of functions of the form $cos^m x \cdot sin^n x$, here m, n in simple cases;

11.5.1.34 integration of functions of the form $P_m(x)/Q_n(x)$ in simple cases, where m, $n \epsilon N$, $n \leq 3$; $P_m(x)$, $Q_n(x)$ are polynomials;

11.5.1.37 applies the Newton-Leibniz formula;

11.5.1.38 using a definite integral, find the area of a curved trapezoid;

11.5.3.2 know and use the formula for the arc length of a curve;

11.5.1.40 using a graph, evaluate whether the approximate value of the integral being determined, calculated using the trapezoidal rule, is greater or less;

11.5.1.42 evaluation of improper integrals in simple cases.

Section 11.4B: Equations and Inequalities.

11.2.2.7 solving equations and inequalities with modulus of the form;

11.2.2.8 solving irrational equations;

11.2.2.9 solving irrational inequalities;

11.2.3.2 use methods for solving trigonometric equations, including the method of additional arguments;

11.2.3.3 solving trigonometric equations by universal substitution;

11.2.3.4 solves trigonometric inequalities in simple cases (using trigonometric formulas, the method of intervals, the method of changing variables);

11.2.3.5 solving a system of trigonometric equations;

11.2.3.6 solving a system of simple trigonometric inequalities;

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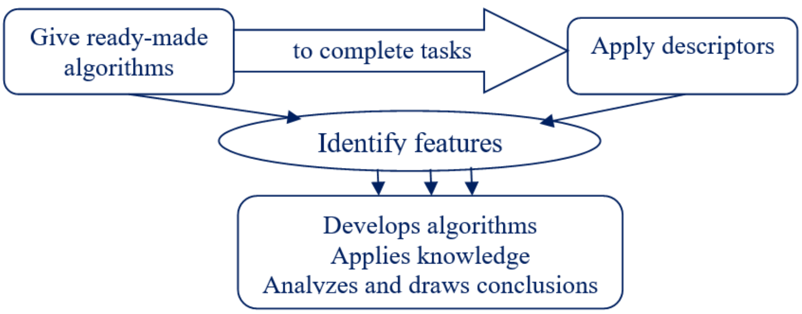
11.2.3.3 solving trigonometric equations by universal substitution;

11.2.3.4 solves trigonometric inequalities in simple cases (using trigonometric formulas, the method of intervals, the method of changing variables);

11.2.3.5 solving a system of trigonometric equations;

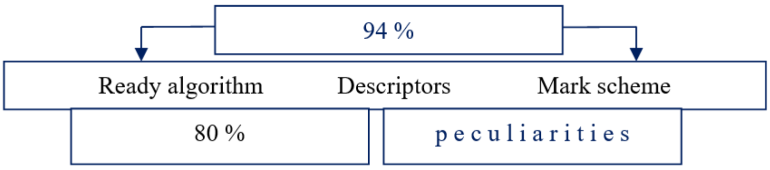
11.2.3.6 solving a system of simple trigonometric inequalities.

In the third quarter, we developed algorithms for practical tasks and presented the finished algorithms to the students. Then the students tried to explain and write down the solution to the problem for each part of the algorithm. Of course, since this was done in differentiated groups, the analysis and formulation were done together. Difficulties: misunderstanding of what each other wrote, errors in writing formulas for the corresponding properties. During the mutual assessment of tasks using descriptors, special attention was paid to the similarity of the descriptors with the sections of the algorithm. Brief description of the initial phase of practical research (Scheme 1).



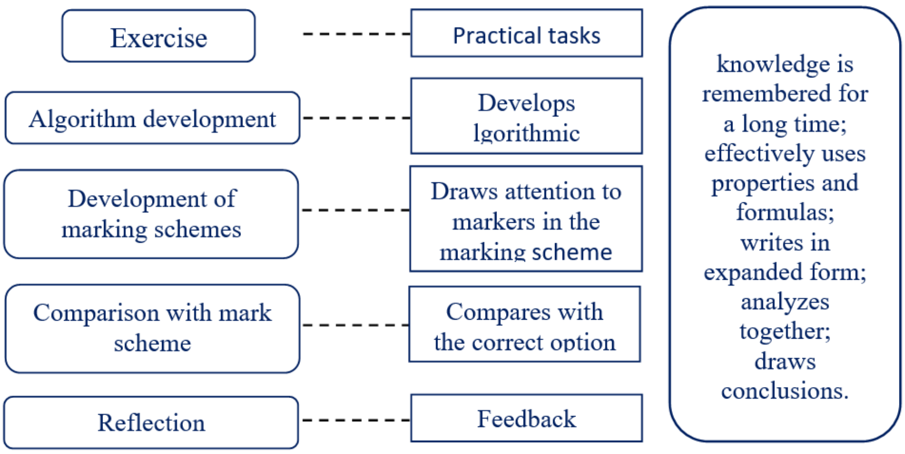
Scheme 1

We planned to conduct an action research study according to the above scheme. Action research is a way to improve teaching practice on a scientific basis, and questionnaires, observation and reflection are its main tools [13], [14]. In order to systematically prepare students, a study was conducted in the third quarter of the last academic year on the topic "Is the use of ready-made algorithms effective?" 61 % of all students answered this question "effective" and 39 % "no". Based on these results, we received written reflections from students. Then, students who answered "effective" explained that their essays were systematic and also convenient for joint analysis; It was found that most students who answered "no" were kinesthetic and discrete thinkers who said that they systematized their thinking and deepened logical thinking based on it, rather than relying on a specific ready-made algorithm. Students learn logical sequences by completing algorithmic tasks and are actively engaged in cognitive activity [15]. To solve practical tasks on the topics of the fourth quarter, ready-made algorithms, descriptors and assessment tables were provided. Results of interviews with students (Scheme 2).



Scheme 2

Then, based on the results of interviews with students, everyone understood their general characteristics, 80 % knew the similarity between the algorithm and descriptors, 94 % wrote that it would be effective to create a grading table based on a ready-made algorithm. Based on the analysis and analysis of the results obtained, we planned a research process scheme for developing algorithms for independent development by students of practical tasks in accordance with the sections of the current academic year, as well as grading tables using algorithms. The research's process structured assessment schemes using algorithms (Scheme 3).



Scheme 3

The effectiveness of creating algorithms when performing practical tasks included in the 3rd component of external summative assessment was determined by performing sample work in lessons. The tasks were mainly taken from the educational site savemyexams.com, since they are structured and practical tasks [16].

Question 1.
(a) Name one disadvantage of using quota sampling as compared to simple random sampling. (1)
At the university, 8 % of students are members of the university dance club.
36 students are randomly selected from the university.
The random variable X represents the number of students who are members of the dance club.
(b) Using an appropriate model for X, find
(i) $P(X = 4)$ (1) (ii) $P(X \geq 7)$ (2)
Only 40 % of the university dance club members can dance tango.
(c) Find the probability that a student is a member of the university dance club and can dance tango. (1)

50 students are randomly selected from the university.

(d) Find the probability that less than 3 of these students are members of the university dance club and can dance tango. (2)

Question 5.

The height of women from one country is usually distributed as follows:

• average height 166.5 cm; • standard deviation 6.1 cm

Considering that 1 % of women in this country have a height below k cm,

(a) find the value of k. (2)

(b) Find the proportion of women in this country whose height is between 150 cm and 175 cm. (1)

A woman is selected randomly from among those whose height is between 150cm, 175cm.

(c) Find the probability that her height is more than 160 cm. (4)

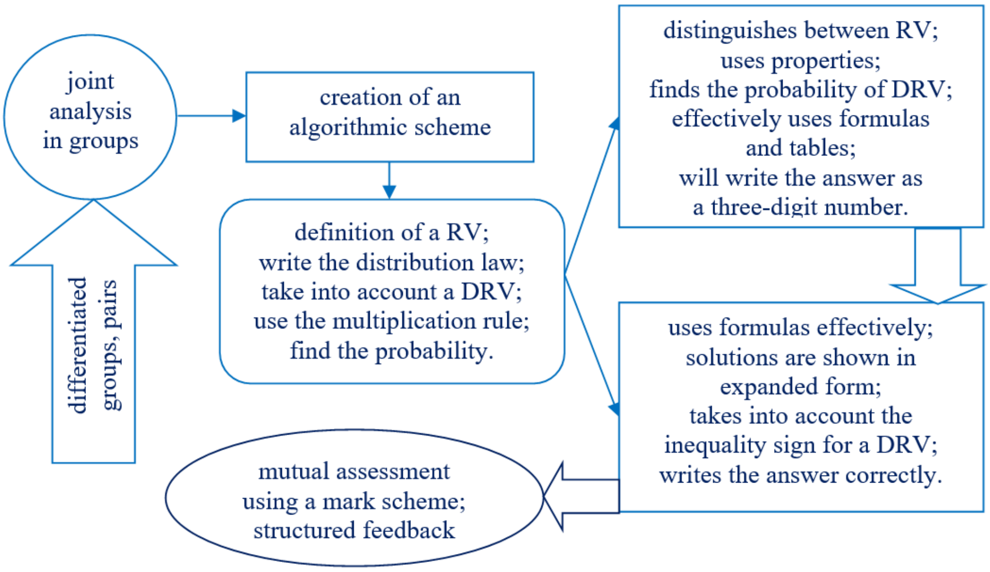
The heights of women from another country are normally distributed with a standard deviation of 7.4 cm. Mia finds that the average height of women from that country is less than 166.5 cm. Mia takes a random sample of 50 women from that country and finds that the mean of her sample is 164.6 cm.

(d) Conduct an appropriate test to assess Mia's beliefs.

You should

• clearly formulate your hypotheses(1) • use 5 % significance level (3)

The algorithm for performing actions when completing this task is shown (Scheme 4).



Scheme 4

Solving practical problems by creating algorithms became more effective than using ready-made algorithms. Students created algorithmic schemes; tried to develop grading schemes based on the algorithm: B, M and A, and also focused on ft, dep grades; They rated each other, comparing with the correct options; They analyzed and formulated conclusions together, and changes were identified based on reflection. Novelty of the study: formation of basic knowledge by creating algorithms, unlike traditional teaching methods, and its long-term retention; fast and rapid acquisition of new knowledge; Increasing the internal motivation of middle school students and improving the quality of education.

Results and Discussion

The results of the average indicators of formative-evaluative work performed by students using ready-made algorithms in grade 11 and using their own algorithms in grade 12 are presented in the diagram (Diagram 3).

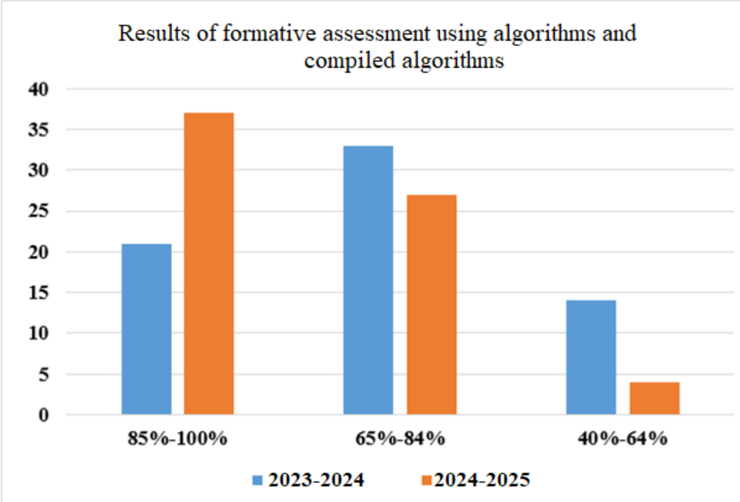


Diagram 3. Formative student assessment results

The division scales here mean that 85 — 100 % is a “5”, 65 — 84 % is a “4” and 40 — 64 % is a “3”. From here, based on the results of formative assessments of solving basic statistics problems, solving differential equations related to physics and biology this academic year, it is clear that it is effective to complete tasks by creating your own algorithms, that is, the number of students who received a “4” is 40 % from 49 %, but the number of “5” increased from 31 % to 54 %, and the number of “3” decreased from 21 % to 6 %.

Based on the results of the analysis of the survey results “Efficiency of creating algorithms” received from students at the end of the third quarter, the following percentages were obtained (Diagram 4). About 98 % of students showed performance in columns E, 97 % C, 94 % A and 89 % D and F.

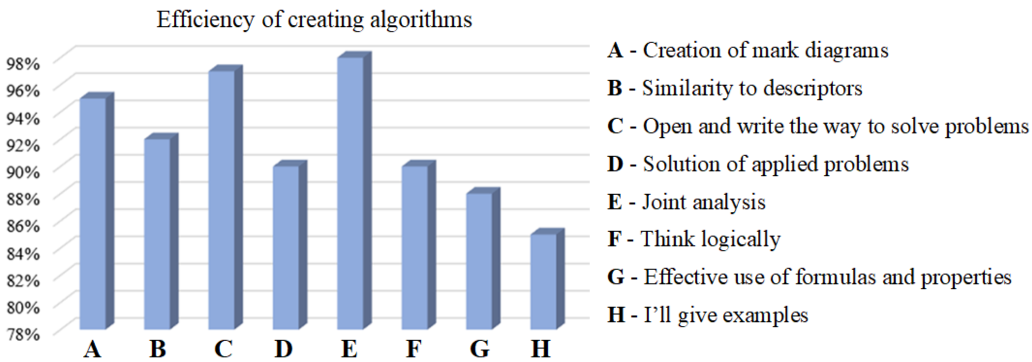


Diagram 4. The result of the survey “Efficiency of creating algorithms”

In addition to educational goals, we have achieved the goal of practical research, the expected results have been achieved and directions for development have been identified. By creating algorithms, students’ analytical and formulation abilities are developed when performing tasks, i.e.: increasing learning activity, creating assessment tables based on algorithms; we helped them jointly analyze and formulate, discover and write ways of issuing assignments.

Conclusion

The main objectives of our research in action were fulfilled: we made sure that knowledge is remembered for a long time during the use of formulas; created algorithms, paid attention to reading task conditions when performing a task, discovered and recorded exit paths; Among the active teaching methods, especially when using the “carousel”, he paid attention to the correctness of writing, since the next student needs to understand the previous student's writing when he continues the task; jointly analyzed and contributed to the formulation. Weaknesses of the study: in the 11th grade we used the results of the 10th grade psychophysiological test; A lot of time is wasted on developing algorithms because the student does not remember basic knowledge. Having studied the results of surveys, interviews, monitoring sessions, taking into account their written opinions, we determined the direction of our development for the effective development of the meth-

od: forming work with a constantly differentiated group/pair; taking into account the personal and information-perceiving abilities of the student when completing the task; structured feedback from teacher/peer. To summarize, we helped 12th grade students develop analytical skills by creating algorithms for solving practical problems. And this contributes to the development of students' analytical and conceptual abilities.

References

1 Саенко Л.А. Развитие аналитических умений у обучающихся на разных возрастных этапах в процессе экспериментирования / Л.А. Саенко, Г.Н. Соломатина // Вестник Северо-Кавказского федерального университета. — 2022. — № 4 (91). — С. 260–265. https://doi.org/10.37493/2307-907X.2022.4.30.

2 Timothy H.L. How current perspectives on algorithmic thinking can be applied to students' engagement in algorithmatizing tasks / H.L. Timothy // Mathematics Education Research Journal. — 2024. — Vol. 36, No. 3. — 609–643. https://doi.org/10.1007/s13394-023-00462-0.

3 Кавашима Р. Японская система развития интеллекта и памяти. Программа «60 дней» / Р. Кавашима. — СПб.: Питер — 2012. — 192 с.

4 Kadijevich D.M. Emergence of Computational/Algorithmic Thinking and Its Impact on the Mathematics Curriculum / D.M. Kadijevich, M. Stephens, A. Rafiepour // Mathematics Curriculum Reforms Around the World. Springer, Cham. — 2023. https://doi.org/10.1007/978-3-031-13548-4_23.

5 Carina B. Differences in students' computational thinking activities when designing an algorithm for drawing plane figures / B. Carina // International Journal of Science and Mathematics Education. — 2024. — Vol. 23, No. 2. — P. 365–386. https://doi.org/10.1007/s10763-024-10465-3.

6 Donovan M.S. How students learn: Mathematics in the classroom [Electronic resource] / M.S. Donovan, B.D. Joh. — Washington, DC: National Academies Press, 2005. — Access mode: https://nap.nationalacademies.org/catalog/11101/how-students-learn-mathematics-in-the-classroom.

7 Перельман Я.И. Занимательные задачи и опыты / Я.И. Перельман. — Москва: Министерство Просвещения РСФСР, 1959. — 529 с.

8 Мумряева С.М. Алгоритмический подход к изучению математического анализа в педвузе в условиях дифференцированного обучения: автореф. дис. … канд. пед. наук : 13.00.02 [Электронный ресурс] / С.М. Мумряева. — Саранск: Мордовский государственный пед. ин-т им. М.Е. Евсевьева, 2001. — 12 с. — Режим доступа: //www.dslib.net/teoria-vospitania/algoritmicheskij-podhod-k-izucheniju-matematicheskogo-analiza-v-pedvuze-v-uslovijah.html.

9 Шапиро С.И. От алгоритмов — к суждениям. Эксперименты по обучению элементам математического мышления / С.И. Шапиро. — Москва: «Советское радио», 1973. — 288 с.

10 Касторнов А.Ф. Совершенствование методики решения задач с помощью применения схем и программ: автореф. дис. … канд. пед. наук: 13.00.02 [Electronic resource] / А.Ф. Касторнов. — Москва, 1979. — 187 с. — Access mode: https://www.mathedu.ru/text/kastornov_sovershenstvovanie_metodiki_resheniya_zadach_s_pomoshhyu_primeneniya_shem_i_programm_1979/p0/.

11 Fleming N.D. Not Another Inventory, Rather a Catalyst for Reflection [Electronic resource] / N.D. Fleming, C. Mills // To Improve the Academy. — 1992. — Vol. 11, No. 1. — P. 137–155. — Access mode: https://vark-learn.com/wp-content/uploads/2014/08/not_another_inventory.pdf

12 Curriculum of the educational organization "Nazarbayev Intellectual Schools" — NIS program, Curriculum for the subject «Mathematics». Grades 11 and 12, Nur-Sultan. — 2021.

13 Richardson G. Applied research methods: An authentic response to professional problems in education / G. Richardson, R. Chodzinski // Teaching and Learning, Brock University. — 2007. — Vol. 4, No. 2. — P. 5–7. https://doi.org/10.26522/tl.v4i2.19.

14 Víctor M.L. Fifteen years of action research as professional development: seeking more collaborative, useful and democratic systems for teachers / M.L. Víctor., R. Monjas., J.C. Manrique // Educational Action Research. — 2011. — Vol. 19, No. 2. — P. 153–170. http://dx.doi.org/10.1080/09650792.2011.569190.

15 Lehmann T.H. How can modern views on algorithmic thinking be applied? / T.H. Lehmann // Journal of Research in Mathematics Education. — 2023. — Vol. 36, No. 3. — P. 609–643. https://doi.org/10.1007/s13394-023-00462-0.savemyexams.com. Copyright 2015-2023 Save My Exams Ltd.

Г.К. Сыздыкова, С.Т. Махашев, Ә.А. Сқақов, Е.С. Ниятбай

Практикалық қолданыстағы тапсырмаларға алгоритмдер құру арқылы 12-сынып оқушыларының талдау, тұжырымдау дағдыларын дамыту

Мақалада 12-сынып оқушыларының практикалық бағыттағы тапсырмаларды шешу барысында алгоритм құру арқылы талдау және тұжырымдау дағдыларын дамытуға бағытталған іс-әрекеттегі зерттеу нәтижелері ұсынылған. Жоғары сынып оқушыларында анықталған мәселелер бойынша Назарбаев зияткерлік мектептерінің мұғалімдерімен арнайы зерттеу жүргізіліп, оң нәтижелер алынды. Зерттеу мақсаты нақты өмірлік жағдайларға негізделген есептерді шығару кезінде алгоритмді құру әдісін қолдана отырып, оқушылардың логикалық, аналитикалық және жүйелі ойлау қабілеттерін дамыту. Зерттеудің міндеттері тапсырмаларды әзірлеу, саралау, тиімді оқыту стратегияларын таңдау, алгоритмдерді құрастыру, бірлескен талдау ұйымдастыру, бағалау критерийлері мен балл қою кестесін құрастыру, оқушылардың өзара бағалау дағдыларын қалыптастыруды қамтыды. Зерттеу барысында алдыңғы іс-әрекеттегі зерттеу тәжірибелері, білім сапасының мониторингтері ескерілді. Сауалнама жүргізу, оқушылардың жеке ерекшеліктерін анықтау, саралап оқыту, коллаборативті ортада жұмыс ұйымдастыру әдістері қолданылды. Арнайы зерттеу нәтижесі бойынша оқушылар тапсырманың мазмұнын дұрыс түсініп, алгоритм құрастыра алды; тапсырманы орындауда құрастырылған алгоритмдерді қолдана білді; шығарылу жолдарын жүйелі түрде жаза білді; балл қою кестесін құрастыру дағдылары дамыды; бағалау барысында балл қою кестесін орынды пайдаланды. Бұл дағдылар жазбаша жұмыс сапасын арттырып, өз ойларын нақты және түсінікті жеткізуіне мүмкіндік беруімен қатар, оқушылардың талдап, тұжырымдау дағдыларының қалыптасуына ықпалын тигізді.

Кілт сөздер: іс-әрекеттегі зерттеу, алгоритм құру әдісі, балл қою кестесі, бағалау, аналитикалық қабілет, талдау дағдысы, тұжырымдау дағдысы.

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Развитие навыков анализа и обобщения у учащихся 12-классов через создания алгоритмов для практических заданий

В данной статье представлены результаты исследования в действии, направленного на развитие у учащихся 12-го класса навыков анализа и формулирования выводов через построение алгоритмов при решении заданий практической направленности. По выявленным у старшеклассников проблемам было проведено исследование в действии совместно с преподавателями Назарбаевских интеллектуальных школ, что позволило получить положительные результаты. Цель исследования заключалась в развитии логического, аналитического и системного мышления учащихся с использованием метода построения алгоритмов при решении задач, основанных на реальных жизненных ситуациях. Задачи исследования включали разработку, дифференциацию заданий, выбор эффективных стратегий обучения, построение алгоритмов, организацию совместного анализа, составление критериев оценивания и таблиц баллов, формирование навыков взаимной оценки у учащихся. В процессе исследования были учтены предыдущие исследования в действии и мониторинг качества образования. Использовались методы анкетирования, выявления индивидуальных особенностей учащихся, дифференцированного обучения, организации работы в коллаборативной среде. По результатам исследования в действии учащиеся правильно понимали содержание заданий и могли строить алгоритмы; применяли составленные алгоритмы при выполнении заданий; системно описывали пути решения; развили навыки составления таблиц баллов; адекватно использовали таблицы баллов при оценивании. Эти навыки способствовали улучшению качества письменных работ, позволяли чётко и понятно выражать свои мысли, а также способствовали формированию навыков анализа и формулирования выводов у учащихся.

Ключевые слова: исследование в действии, метод создания алгоритма, марк-схема, оценивание, аналитическая способность, навык анализа, навык формулирования выводов.

References

1 Saenko, L.A., & Solomatına, G.N. (2022). Razvitie analiticheskikh umenii u obuchaiushchikhsia na raznykh vozrastnykh etapakh v protsesse eksperimentirovaniia. *Vestnik Severo-Kavkazskogo Federalnogo universiteta — Bulletin of the North Caucasus Federal University,* 4 (91), 260–265. https://doi.org/10.37493/2307-907X.2022.4.30.

2 Timothy, H.L. (2023). How current perspectives on algorithmic thinking can be applied to students' engagement in algorithmatizing tasks. *Mathematics Education Research Journal, 36,* 3, 609–643. https://doi.org/10.1007/s13394-023-00462-0.

3 Kavashıma, R. (2012). *Yaponskaia sistema razvitiia intellekta i pamiati. Programma «60 dnei»* [The Japanese system for developing intelligence and memory: The "60 days" program]. Saint Petrersburg: Piter [in Russian].

4 Kadijevich, D.M., Stephens, M., & Rafiepour, A. (2023). Emergence of Computational/Algorithmic Thinking and Its Impact on the Mathematics Curriculum. *Mathematics Curriculum Reforms Around the World.* Springer, Cham. https://doi.org/10.1007/978-3-031-13548-4_23.

5 Carina, B. (2024). Differences in students' computational thinking activities when designing an algorithm for drawing plane figures. *International Journal of Science and Mathematics Education*, *23*(2), 365–386. https://doi.org/10.1007/s10763-024-10465-3.

6 Donovan, M.S., & John, B.D. (2005). *How students learn: Mathematics in the classroom.* Washington, DC: National Academies Press. *nap.nationalacademies.org.* Retrieved from https://nap.nationalacademies.org/catalog/11101/how-students-learn-mathematics-in-the-classroom.

7 Perelman, Ya.I. (1959). *Zanimatelnye zadachi i opyty* [Entertaining problems and experiments]. Moscow: Ministerstvo Prosveshcheniya RSFSR [in Russian].

8 Mumriaeva, S.M. (2001). Algoritmicheskii podkhod k izucheniiu matematicheskogo analiza v pedvuze v usloviiakh diferentsirovannogo obucheniia [Algorithmic approach to learning mathematical analysis in a pedagogical university under differentiated instruction]. *Candidate's thesis.* Saransk: Mordovski gosudarstvennyi pedinstitut imeni M.E. Yevseveva. Retrieved from http://www.dslib.net/teoria-vospitania/algoritmicheskij-podhod-k-izucheniju-matematicheskogo-analiza-v-pedvuze-v-uslovijah.html [in Russian].

9 Shapiro, S.I. (1973). *Ot algoritmov — k suzhdeniiam. Eksperimenty po obucheniiu elementam matematicheskogo myshleniia* [From algorithms to reasoning. Experiments in teaching elements of mathematical thinking]. Moscow: "Sovetskoe radio" [in Russian].

10 Kastornov, A.F. (1979). Sovershenstvovanie metodiki resheniia zadach s pomoshchiu primeneniia skhem i programm. [Improving the methodology of solving problems using schemes and programs]. *Candidate's thesis*. Moscow. Retrieved from//www.mathedu.ru/text/kastornov_sovershenstvovanie_metodiki_resheniya_zadach_s_pomoshhyu_primeneniya_shem_i_program_1979/p0/ [in Russian].

11 Fleming, N.D., & Mills, C. (1992). Not Another Inventory, Rather a Catalyst for Reflection. *To Improve the Academy, 11*(1), 137–155. Retrieved from https://vark-learn.com/wp-content/uploads/2014/08/not_another_inventory.pdf

12 (2021). Curriculum of the educational organization "Nazarbayev Intellectual Schools" — NIS program, *Curriculum for the subject "Mathematics".* Grades 11 and 12, Nur-Sultan.

13 Richardson, G., & Chodzinski, R (2007). Applied research methods: An authentic response to professional problems in education. *Teaching and Learning, Brock University, 4*(2), 5–7. https://doi.org/10.26522/tl.v4i2.19.

14 Víctor, M. L., Monjas, R., & Manrique, J.C (2011). Fifteen years of action research as professional development: seeking more collaborative, useful and democratic systems for teachers. *Educational Action Research*, *19*(2), 153–170. http://dx.doi.org/10.1080/09650792.2011.569190.

15 Lehmann, T.H (2023). How can modern views on algorithmic thinking be applied? *Journal of Research in Mathematics Education, 36*(3), 609–643. https://doi.org/10.1007/s13394-023-00462-0.*savemyexams.com.* Copyright 2015-2023 Save My Exams Ltd.

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