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DEVELOPING RESEARCH SKILLS IN PRIMARY SCHOOL STUDENTS USING STEM TECHNOLOGIES

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This article focuses on developing research skills in primary school students amid the digital transformation of education. The objective is to evaluate the effectiveness of STEM (Science, Technology, Engineering, and Mathematics) technologies as a tool for developing research competence. The theoretical *framework is based on an analysis of domestic and international publications on inquiry-based learning and STEM education, identifying key conditions for successful implementation: pedagogical support, integration of engineering design, advanced teacher training, and use of digital resources. The empirical component is a pedagogical experiment involving 62 students in grades 3-4, divided into control and experimental groups. Data collection included observation, questionnaires, analysis of activity products, and STEM tasks (robotics, digital labs, project-based activities). The results showed a steady increase in research skills among the experimental group across all criteria (asking questions, formulating hypotheses, planning an experiment, analyzing results, presenting), with the most pronounced improvement in hypothesis generation (+33%) and data analysis (+34%). Comparative analysis confirmed the advantages of STEM assignments over traditional learning. The practical significance lies in the integrated model for developing research skills, suitable for teachers and methodologists when organizing the educational process and designing supplementary programs.*

Keywords: *STEM technologies, pedagogical support, integration of engineering design, advanced training, digital resources, robotics, digital laboratories, project activities.*

БАСТАУЫШ СЫНЫП ОҚУШЫЛАРЫНЫҢ STEM ТЕХНОЛОГИЯЛАРЫН ҚОЛДАНУ АРҚЫЛЫ ЗЕРТТЕУ ДАҒДЫЛАРЫН ДАМЫТУ

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Бұл мақала білім берудің цифрлық трансформациясы жағдайында бастауыш сынып оқушыларының зерттеу дағдыларын дамытуға бағытталған. Мақсаты – зерттеу құзыреттілігін дамыту құралы ретінде STEM (ғылым, технология, инженерия және математика) технологияларының тиімділігін бағалау. Теориялық негіз сұранысқа негізделген оқыту және STEM білім беру бойынша отандық және халықаралық басылымдарды талдауға негізделген, табысты іске асырудың негізгі шарттарын анықтайды: педагогикалық қолдау, инженерлік дизайнды интеграциялау, мұғалімдердің біліктілігін арттыру және цифрлық ресурстарды пайдалану. Эмпирикалық компонент – бақылау және эксперименттік топтарға бөлінген 3-4 сыныптардың 62 оқушысын қамтитын педагогикалық эксперимент. Деректерді жинау бақылауды, сауалнаманы, белсенділік өнімдерін талдауды және STEM тапсырмаларын (робототехника, цифрлық зертханалар, жобаға негізделген әрекеттер) қамтиды. Нәтижелер барлық критерийлер бойынша (сұрақтар қою, гипотеза құрастыру, экспериментті жоспарлау, нәтижелерді талдау, ұсыну) эксперименталды топ арасында зерттеу дағдыларының тұрақты өсуін көрсетті, бұл гипотезаны құруда (+33%) және деректерді талдауда (+34%) айтарлықтай жақсарды. Салыстырмалы талдау STEM тапсырмаларының дәстүрлі оқытудан артықшылығын растады. Практикалық маңыздылығы оқу процесін ұйымдастыру және қосымша бағдарламаларды жобалау кезінде мұғалімдер мен әдіскерлерге қолайлы зерттеу дағдыларын дамытудың интеграцияланған моделінде жатыр.

Түйінді сөздер: *STEM технологиялары, педагогикалық қолдау, инженерлік дизайн интеграциясы, біліктілікті арттыру, цифрлық ресурстар, робототехника, цифрлық зертханалар, жобалық іс-шаралар.*

РАЗВИТИЕ ИССЛЕДОВАТЕЛЬСКИХ НАВЫКОВ У УЧАЩИХСЯ НАЧАЛЬНОЙ ШКОЛЫ С ИСПОЛЬЗОВАНИЕМ STEM-ТЕХНОЛОГИЙ

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Данная статья посвящена развитию исследовательских навыков у учащихся начальной школы в условиях цифровой трансформации образования. Цель исследования заключается в оценке эффективности STEM-технологий (Science, Technology, Engineering, Mathematics) как инстру-

мента формирования исследовательской компетентности обучающихся. Теоретическая база основана на анализе отечественных и зарубежных публикаций по исследовательскому обучению и STEM-образованию, в котором определены ключевые условия успешной реализации: педагогическая поддержка, интеграция инженерного проектирования, повышение квалификации учителей и использование цифровых ресурсов. Эмпирический компонент представляет собой педагогический эксперимент с участием 62 учащихся 3-4 классов, разделенных на контрольную и экспериментальную группы. Сбор данных включал наблюдение, анкетирование, анализ результатов деятельности и выполнение STEM-заданий (робототехника, цифровые лаборатории, проектная деятельность). Результаты показали устойчивый рост исследовательских навыков учащихся экспериментальной группы по всем критериям (постановка вопросов, формулирование гипотез, планирование эксперимента, анализ результатов, презентация), с наиболее выраженным улучшением в генерациях гипотез (+33%) и анализе данных (+34%). Сравнительный анализ подтвердил преимущества STEM-заданий перед традиционным обучением. Практическая значимость заключается в комплексной модели развития исследовательских навыков, пригодной для использования преподавателями и методистами при организации образовательного процесса и разработке дополнительных программ.

Ключевые слова: *STEM-технологии, педагогическое сопровождение, интеграция инженерного дизайна, повышение квалификации, цифровые ресурсы, робототехника, цифровые лаборатории, проектная деятельность.*

Introduction. In contemporary didactics, research skills are viewed as a system of interrelated abilities: asking questions and problematizing; formulating hypotheses; planning and carrying out experiments (including identifying and controlling variables, taking measurements, and ensuring safety); recording and analysing data; interpreting results and substantiating conclusions; as well as arguing for and presenting findings in oral and written form. A meta-analysis of experimental and quasi-experimental studies on inquiry-based learning indicates that its effectiveness rises markedly when learners receive explicit pedagogical support (guidance) for cognitively demanding actions – from question generation through to data interpretation [1]. Empirical work on discursive practices in primary school shows that advances in children's scientific reasoning are linked to instruction in strategic questioning, collaborative hypothesis formulation, and joint argumentation grounded in observational and measurement data [2]. The "Science Skills" framework specifies operational descriptors of experimental skills (such as hypothesis generation, experimental design, work with evidence, and critical evaluation), thereby offering observable indicators for diagnosis and goal-setting in primary education [3]. These results align with studies on the integration of inquiry approaches into STEM subjects, which underline the importance of explicit process criteria and formative assessment for achieving stable improvements in skills [4].

In primary school settings, the most pronounced positive effects are associated with integrative STEM models that place engineering design at the centre as a framework for scientific activity (from problem formulation → setting criteria and constraints → creating prototypes → testing → revising), thereby facilitating the transfer of inquiry skills. Both local and large-scale evaluations of the Engineering is Elementary programme show significant improvements in subject knowledge and in pupils' understanding of engineering practices when learners consistently work through the stages of the design cycle [5; 6]. Classroom interventions in Grade 4 using an integrative STEM unit on simple machines reveal more positive attitudes towards science and higher involvement in inquiry tasks, while remaining compatible with the standard school schedule [7].

At the level of teachers, the format of professional development plays a decisive role: a systematic review of STEM-focused PD in K–12 indicates that design-based, practice-oriented and reflective programmes lead to substantial gains in teachers' self-efficacy (on average $g \approx 0.64$) and in the quality of their organisation of inquiry-based learning in the classroom [8]. Computational thinking is increasingly incorporated as a "digital scaffold" for STEM inquiry; systematic reviews show that, when implemented with age-appropriate tools (visual programming environments, educational robotics, unplugged activities), primary school pupils successfully acquire basic CT concepts and enhance their problem-solving and communication skills [9].

Recent interventions at the primary school level indicate a rise in pupils' involvement in research-oriented practices within scientific inquiry and engineering design – from more active engagement in posing questions and formulating hypotheses to participation in testing procedures and data-based argumentation. These trends are corroborated both by recent field studies on the influence of inquiry on academic engagement among young learners [10] and by documented cases of engineering-focused modules [6; 7]. In the national and regional context (Kazakhstan), an expanding body of literature on the implementation of STEM and robotics in primary education demonstrates the practicality of integrating robotics modules and STEM components into the curriculum, outlines organisational models, and reports positive effects on the development of research skills and motivation [11].

At the same time, works devoted specifically to the formation of research skills in primary school describe effective formats of extracurricular and elective courses, as well as project-based activities, which are closely aligned with the inquiry-oriented structure of the lesson [12]. Overall, international and local evidence converges on the conclusion that clearly structured support for the inquiry process, the use of engineering design as an integrating framework for scientific practices, thoughtfully designed teacher professional development, and digital tools (including robotics and computational thinking) are key drivers of research skill development in primary school.

In Kazakhstan, an increasingly diverse body of research confirms that the STEM approach is effective for fostering research skills in primary-school pupils. These studies report a marked growth in cognitive and analytical competences when STEM modules are systematically integrated into both lessons and extracurricular formats. At the same time, national researchers emphasise the importance of considering the particularities of the local educational environment: from gaps in teacher preparation and limited material resources to the impact of cultural and gender stereotypes on attitudes towards STEM subjects [13-15].

The digital transformation of education places new demands on schools: it is important not only to impart basic knowledge, but also to purposefully develop children's skills needed in a rapidly changing world. One of the priorities is the development of research competencies in primary school students, since they lay the foundations for critical thinking, independent information search, and readiness for non-standard tasks.

In the logic of the STEM approach (Science, Technology, Engineering, Mathematics), research activities acquire an applied focus: children master elements of the scientific method through experiments, project work, robotics, and classes in digital laboratories. This format combines theory with practice and makes learning meaningful and active.

With the growing interest in STEM education, most studies focus on middle and high school, while primary school has been studied fragmentarily. Often, attention is paid either to subject results or to the development of ICT competencies, while holistic models for developing research skills in primary school students based on STEM tasks are rarely described. The practical aspect of early implementation of STEM has not been sufficiently developed: its impact on motivation, independence and interdisciplinary integration is covered sporadically.

The aim of the study is to evaluate the effectiveness of using STEM technologies in developing research skills in primary school students. To achieve this, the following **tasks** were set:

– to clarify the content and structure of research skills at the primary school level;

– to analyze modern approaches to STEM education and summarize domestic and foreign experience;

– to conduct a pedagogical experiment with the inclusion of STEM assignments and project activities in the educational process;

– to track the dynamics of research skills development and compare the indicators of the control and experimental groups.

The novelty of the study consists in the proposal and experimental verification of an integrated model for the formation of research competencies of primary school students based on STEM technologies, combining theoretical justification and practical validation.

The practical value of the work is that the developed methodological solutions and materials can be used by primary school teachers, methodologists and program authors when designing a learning environment that develops research activity and critical thinking in primary school students.

Thus, the study closes a gap in the literature: it provides a holistic view of the use of the STEM approach specifically in elementary school and empirically confirms its effectiveness in developing basic research skills.

Material and methods. The study was conducted on a sample of elementary school students in grades 3–4 (ages 9–10) from KSU IT School-Lyceum No. 28 named after Kulzhabay Kasymov and KSU Secondary School-Gymnasium No. 14 (Taldykorgan, Kazakhstan). Participants were divided into two groups: the experimental group used STEM technologies, while the control group studied in a traditional format.

Table 1 – Composition of the sample of students

Group	Number of Students	Age	Grade	Characteristics
Control group	30	9–10	3–4	Teaching according to the traditional program
Experimental group	32	9–10	3–4	Implementation of STEM tasks and projects
Total	62	9–10	3–4	Division based on the equivalence principle

The study utilized a combination of methods for a comprehensive analysis of the dynamics of research skill development:

- A pedagogical experiment – testing the impact of a STEM approach on the development of research skills.
- Observation – recording students' behavior and activity while completing assignments.
- Questionnaires – identifying students' attitudes toward research activities and STEM assignments.
- Analysis of student work products – evaluating the quality of completed projects, experiments, and presentations.

Table 2 – Research methods and tools

Method	Purpose	Tools Used	Expected Outcome
Pedagogical Experiment	To test the effectiveness of the STEM approach	STEM tasks, projects	Growth dynamics of research skills
Observation	To record students' activity and participation	Observation logs, checklists	Qualitative data on research activity
Questionnaire	To determine students' attitudes toward research	Questionnaires, survey forms	Subjective assessment of interest and motivation
Analysis of Work Products	To evaluate the results of research work	Projects, samples, presentations	Quality criteria and level of development

The experiment utilized a variety of STEM tools to engage students in research:
- Robotics – designing and programming simple models.
- Digital labs – working with sensors and computerized measurement systems to conduct experiments.
- Project-based activities – completing interdisciplinary projects (scientific, engineering, environmental).
- Online platforms – using educational digital resources to search for information and present results.

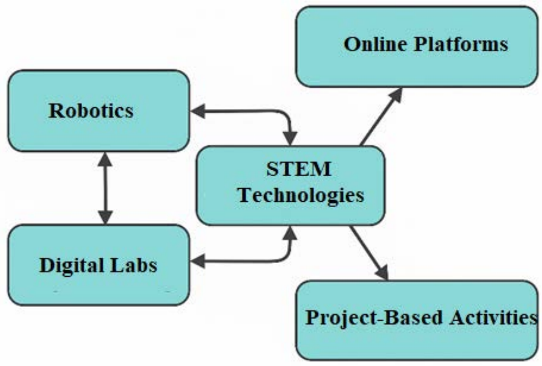

Figure 1 – Scheme of applied STEM technologies

The applied methodology provided a comprehensive study of the dynamics of research skill development in primary school students. A clearly defined sample enhanced the reliability of the results. The combination of methods – a pedagogical experiment, observation, questionnaires, and analysis of the results – provided both quantitative and qualitative data. The inclusion of STEM technologies (robotics, digital labs, project-based activities, and online platforms) integrated theory and practice, increased student engagement, and facilitated the development of key research competencies. The experiment's methodological framework proved its effectiveness and provided the conditions for an objective analysis of the impact of the STEM approach.

Results and Discussion. Effective STEM integration in primary school is based on practical tasks and research-oriented projects that help children pose questions, test hypotheses, and interpret the results. It is essential that these tasks are directed toward solving real-life problems, as this fosters an understanding of the practical significance of scientific knowledge. Samples of such tasks and projects are given in Table 3.

Table 3 – Sample instructional tasks and project examples

Task Type	Purpose	Research Skills Developed
Mini-experiment (observing plant growth under different conditions)	To understand the effect of factors such as light, water, and soil on the growth of living organisms	Formulating a hypothesis, controlling variables, recording results
Engineering task (building a bridge from paper or sticks)	To test the strength of structures and determine the optimal shape	Planning an experiment, strength testing, data analysis
Interdisciplinary project (constructing a model of the Solar System)	To integrate knowledge from astronomy, mathematics, and art	Information gathering and analysis, modeling, presenting results
Robotics (programming a simple robot to perform a specific task)	To develop algorithmic thinking and technical construction skills	Problem formulation, solution search, testing and refinement
Everyday-life investigation (determining which material retains heat best)	To compare the effectiveness of different materials	Experiment planning, data processing, justifying conclusions

As illustrated in Table 3, incorporating a variety of task formats (mini-experiments, engineering challenges, interdisciplinary projects, robotics activities, and investigations of everyday phenomena) helps younger learners acquire a wide spectrum of research skills – from formulating hypotheses and managing variables to interpreting data and drawing well-founded conclusions. Such activities combine knowledge from different subjects, are grounded in real-life contexts, sustain student engagement, and at the same time foster cross-curricular competencies, including critical and algorithmic thinking, teamwork, and communication skills.

Within the STEM framework, the teacher acts mainly as a facilitator rather than as a transmitter of ready-made knowledge. Their key roles include:

- Consultation – helping students formulate questions, clarify hypotheses, and choose appropriate research methods;
- Organization – designing the structure of tasks, distributing roles within groups, and providing the necessary materials and equipment;
- Support – fostering a motivating atmosphere, promoting cooperation, assisting in overcoming difficulties, and nurturing students' reflective abilities.

In this way, the teacher shapes a learning environment where students take on the role of investigators instead of passive learners. The diagram "Teacher as Facilitator" (highlighting the functions of consulting, organizing, and supporting) is presented in Figure 2.

Figure 2 – Teacher's roles in organizing students' research activities

The figure illustrates that within the STEM approach the teacher functions as a facilitator: they guide learners through consultation (supporting them in posing questions and formulating hypotheses), organize the learning process (designing tasks, distributing roles, supplying resources), and offer support (building a motivating atmosphere, encouraging cooperation, fostering reflection), thereby making learning active and inquiry-based.

Research activities in STEM follow the traditional sequence of scientific inquiry, modified to suit the primary school level (see Figure 3).

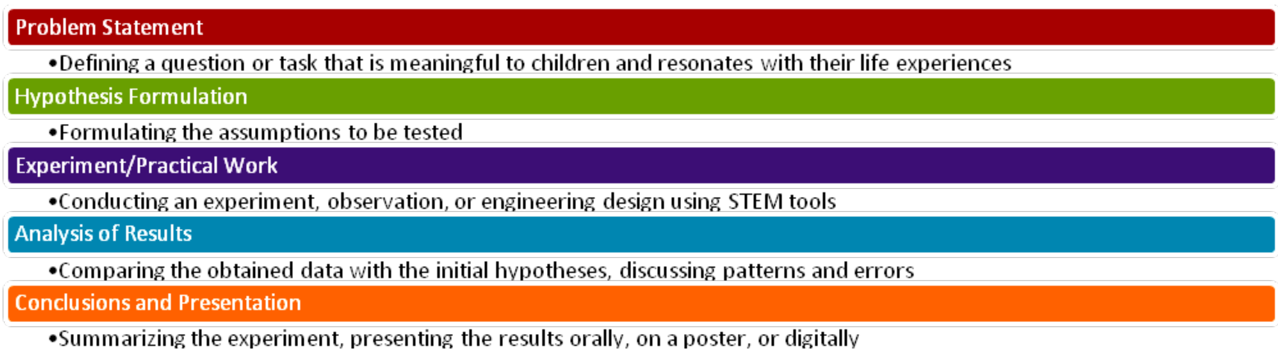

Figure 3 – Phases of a research project

Figure 3 presents the main stages of student research in the STEM context: starting with identifying the problem and formulating a hypothesis, followed by conducting experiments, analyzing the obtained data, and presenting the results. Such a sequence ensures the logical organization of the process, contributes to the development of scientific thinking, and supports independent inquiry in a clear and accessible form.

The pedagogical experiment showed that primary school students' research skills improved. Positive dynamics were noted for all criteria: from posing questions and proposing hypotheses to planning, analyzing, and presenting results. The most pronounced progress was in formulating hypotheses and interpreting findings, which confirms the effectiveness of experimental, project-based STEM tasks.

Table 4 – Dynamics of research skill levels

Criterion	Baseline level (%)	Final level (%)	Growth (%)
Asking questions	42	71	+29
Formulating hypotheses	35	68	+33
Experiment planning	38	66	+28
Analyzing results	40	74	+34
Presenting	44	70	+26

As seen in Table 4, primary school students showed steady improvement on all indicators of research skills: posing questions (+29%), formulating hypotheses (+33%), planning experiments (+28%), analyzing results (+34%), and presenting findings (+26%). The most significant progress was in hypothesis generation and data analysis, which supports the effectiveness of the STEM approach in fostering core components of scientific thinking and students' research autonomy.

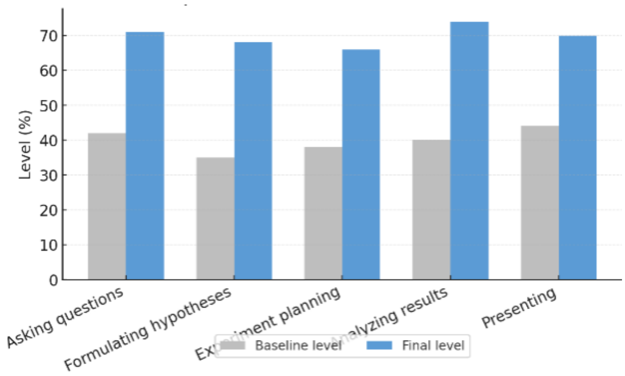

Figure 4 – Changes in students' research skills by criteria

As illustrated in Figure 4, there is a marked improvement in research skills across all criteria – from posing questions and formulating hypotheses to processing data and publicly presenting findings. The most substantial gains relate to hypotheses and data analysis, reflecting the development of critical thinking and a scientific mindset. Comparing the baseline and final results confirms that STEM-oriented tasks effectively support the targeted formation of research competencies.

A comparison of the control and experimental groups showed that the STEM-based model of organizing research activities is more effective. In the control group, progress in skills was less pronounced, especially in formulating questions and interpreting results, whereas in the experimental group stable improvement was noted across all indicators, which supports the inclusion of STEM tasks in the learning process.

Table 5 – Comparative indicators of the control and experimental groups

Criterion	Control group (%)	Experimental group (%)	Difference (%)
Asking questions	54	71	+17
Formulating hypotheses	50	68	+18
Experiment planning	49	66	+17
Analyzing results	52	74	+22
Presenting	55	70	+15

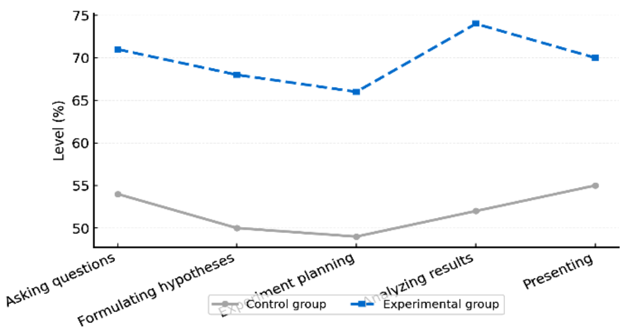

Figure 5 – Levels of research skills in the control and experimental groups

Figure 5 demonstrates that, for all criteria, the experimental group outperformed the control group in research skills. The most noticeable gaps were in result analysis and hypothesis formulation, which confirms the effectiveness of the STEM approach for developing key research competencies in primary school students.

The findings align with theoretical assumptions that research skills develop more successfully when cross-curricular tasks are used, when learning is grounded in engineering design, and when digital tools are applied. The marked growth in the indicators “hypothesis generation” and “result analysis” shows that STEM technologies not only support practice-oriented learning, but also foster the development of critical thinking and autonomy in primary school students.

Comparison with the control group shows that the traditional model develops research competencies only in a fragmented way, whereas the STEM approach ensures their comprehensive formation – from posing questions to substantiating conclusions. These results highlight the need for systematic integration of STEM technologies in primary school and for teacher training programs oriented toward supporting students’ research activities.

The study provides clear evidence of the effectiveness of the STEM approach in developing research skills among primary school students. Stable progress was recorded for all criteria, with the most marked improvements in “hypothesis generation” and “result analysis,” indicating the formation of critical thinking, autonomy, and readiness for research activity. Comparison with the control group showed that traditional methods contribute to the development of competencies only partially, whereas STEM technologies ensure their comprehensive formation. Thus, the findings support the theoretical rationale for integrating STEM into primary education and underline the practical importance of its systematic implementation to enhance the quality of training and maintain students’ motivation to learn.

Conclusion. The results of the study showed that incorporating STEM into the primary school curriculum effectively supports the development of research skills in younger students. The integrated model (Figure 8) brings together the theoretical basis – the structure of research skills and the stages of their formation – with experimental data that confirm the positive dynamics and the benefits of STEM tasks compared to traditional approaches.

The experimental findings indicate steady improvement among students for all evaluated criteria: posing research questions, formulating hypotheses, planning experiments, interpreting results, and presenting outcomes. The most pronounced progress was observed in hypothesis formulation and data analysis, which reflects the growth of critical thinking, research autonomy, and readiness to use the scientific method in real learning situations. Comparison of the control and experimental groups showed that students working with STEM tasks achieved higher results than those taught through traditional methods.

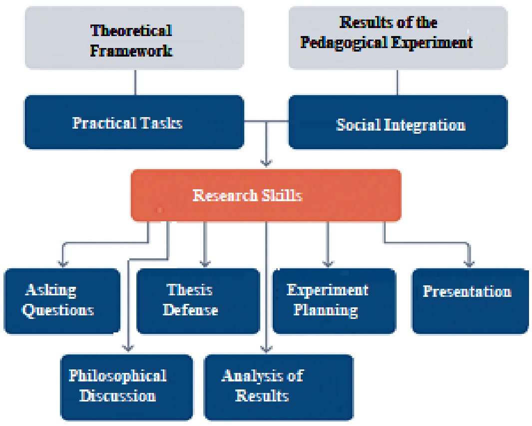

Figure 6 – The integral model

The model proposed by the authors reflects a complete research cycle in primary school: practical activities, teacher guidance, and cross-curricular links contribute to the formation of essential skills – from posing questions and testing hypotheses to processing data and presenting findings. The visual represent-tation highlights the importance of integrating theory and practice and illustrates the advantages of the STEM approach as an effective way to foster critical thinking, autonomy, and learning motivation in younger students.

The practical significance of the study is that its results can be applied by primary school teachers, methodologists, and curriculum designers. The use of STEM tasks and projects helps create an active learning environment in which children collaborate, strengthen critical and algorithmic thinking, develop communication skills, and learn to solve problems independently. For teachers, the described model can be used as a means of organizing and supporting the learning process, while for methodologists it may serve as a basis for updating enrichment programs and teaching materials.

Future studies should aim to broaden the age range of participants in order to identify the particular features of research skill development in middle and high school students. It is also relevant to explore the integration of the STEM approach with modern digital platforms, adaptive learning systems, and virtual laboratories, which can enhance the accessibility and flexibility of research activities. In addition, the long-term consequences of implementing STEM technologies, including their influence on academic achievement, stable learning motivation, and students' educational choices, require dedicated investigation.

Thus, integrating STEM into primary education is a relevant and practically important direction that supports the comprehensive development of research competences and prepares students to continue learning in a rapidly changing world.

REFERENCES:

1 **Furtak E.M., Seidel T., Iverson H., Briggs D.C. Experimental and quasi-experimental studies of inquiry-based science teaching: a meta-analysis.** *Review of Educational Research*, 2012, vol. 82, iss. 3, pp. 300-329. https://doi.org/10.3102/0034654312457206.

2 **Gillies R.M., Nichols K., Burgh G., Haynes M. Primary students' scientific reasoning and discourse during cooperative inquiry-based science activities.** *International Journal of Educational Research*, 2014, vol. 63, pp. 127-140. https://doi.org/10.1016/j.ijer.2013.01.001.

3 **Stone E.M. Guiding students to develop an understanding of scientific inquiry: a science skills approach to instruction and assessment.** *CBE – Life Sciences Education*, 2014, vol. 13, iss. 1, pp. 90-101. https://doi.org/10.1187/cbe-12-11-0198.

4 **Ješkova Z., et al. Active Learning in STEM education with regard to the development of inquiry skills.** *Education Sciences*, 2022, vol. 12, iss. 10, article 686. https://doi.org/10.3390/educsci12100686.

5 **Cunningham C.M., et al. The impact of engineering curriculum design principles on elementary students' engineering and science learning.** *Journal of Research in Science Teaching*, 2020, vol. 57, iss. 3, pp. 423-453. https://doi.org/10.1002/tea.21601.

6 **Lottero-Perdue P.S., et al. Engineering mindsets and learning outcomes in elementary school.** *Journal of Engineering Education*, 2020, vol. 109, iss. 4, pp. 640-664. https://doi.org/10.1002/jee.20350.

7 **Toma R.B., Greca I.M. The effect of integrative STEM instruction on elementary students' attitudes toward science.** *EURASIA Journal of Mathematics, Science and Technology Education*, 2018, vol. 14, iss. 4, pp. 1383-1395. https://doi.org/10.29333/ejmste/83676.

8 **Zhou X., et al. The effect of professional development on in-service STEM teachers' self-efficacy: A meta-analysis of experimental studies.** *International Journal of STEM Education*, 2023, vol. 10, art. 37. https://doi.org/10.1186/s40594-023-00422-x.

9 **Su J., Yang W. A systematic review of integrating computational thinking in early childhood education.** *Computers & Education Open*, 2023, vol. 4, article 100122. https://doi.org/10.1016/j.caeo.2023.100122.

10 **Taylor J.C., et al. The effects of science inquiry on engagement for elementary students with disabilities.** *School Science and Mathematics*, 2025, vol. 125, iss. 1, pp. 33-47. https://doi.org/10.1111/ssm.12637

11 **Nishanbaeva S.Kh., Nishanbaeva S.Z., Alimbekova L. E'ffektivnost' ispol'zovaniya «STEM» obrazovanie v nachal'ny'h klassah** [Effectiveness of using STEM education in primary school]. *Vestnik KazNPU imeni Abaya. Seriya: Pedagogicheskie nauki*, 2021, vol. 71, no. 3, pp. 190-200. https://doi.org/10.51889/2021-3.1728-5496.19. (In Russian)

12 **Kryuchkova T.A. Razvitie issledovatel'skih umenij mladshih shkol'nikov sredstvami fakul'tativnogo kursa «Uchis' uchit'sya»** [Development of younger schoolchildren research skills by means of the extracurricular subject "Learn to study"]. *Vestnik ShGPU*, 2022, no. 2(54), pp. 83-87. https://doi.org/10.52772/25420291_2022_2_83. (In Russian)

13 **Baimakhanbetova M., et al. The implications of stem training on the development of younger students' research abilities: An exploration of practices.** *Journal of Education and E-Learning Research*, 2023, vol. 10, no. 4, pp. 845-854. https://doi.org/10.20448/jeelr.v10i4.5269.

14 **Abildina S., et al. Development of transversal skills in primary school children.** *Bulletin of the National Academy of Sciences of the Republic of Kazakhstan*, 2023, vol. 6, no. 406, pp. 28-37. https://doi.org/10.32014/2023.2518-1467.614.

15 **Zhumabay A., et al. Mapping the Kazakhstani STEM education landscape: a review of national research.** *European Journal of STEM Education,* 2024, vol. 9, iss. 1, article 16. https://doi.org/10.20897/ejsteme/15576.

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ҚАЗАҚСТАН ТАРИХЫ ПӘНІ БОЙЫНША ОЛИМПИАДАЛЫҚ ДАЙЫНДЫҚТЫ ҰЙЫМДАСТЫРУДЫҢ МИКРО-ЦИКЛДІК МОДЕЛІ

Қайрғали Н.Қ. – «Тарих» білім беру бағдарламасы бойынша педагогика ғылымдарының магистрі, тарих пәні мұғалімі, педагог-сарапшы, «Озат» мамандандырылған ақпараттық технологиялар мектеп-лицей-интернаты, Қостанай қ., Қазақстан Республикасы.*

Ахметов Т. А. – педагогика ғылымдарының кандидаты, педагогика, психология және арнайы білім беру кафедрасының қауымдастырылған профессоры, Ахмет Байтұрсынұлы атындағы Қостанай өңірлік университеті, Қостанай қ., Қазақстан Республикасы.

Сартаев Р.Н. – «Тарих» білім беру бағдарламасы бойынша педагогика ғылымдарының магистрі, тарих пәні мұғалімі, педагог-модератор, Дарынды балаларға арналған БІЛІМ-ИННОВАЦИЯ лицей-интернаты, Қостанай қ., Қазақстан Республикасы.

Мақалада қазіргі білім беру жүйесіндегі олимпиадалық дайындықтың маңызы Қазақстан тарихы пәні аясында жан-жақты талданады. Олимпиада педагогикасы дарынды оқушыларды анықтаудың, олардың зерттеушілік және аналитикалық қабілеттерін дамытудың тиімді құралы ретінде қарастырылады. Авторлар олимпиадалық дайындықтың негізі болып табылатын микроциклдік тәсілдің теориялық және практикалық қырларын жүйелейді. Қазақстан тарихы бойынша