12 **VanderPlas J. Python Data Science Handbook: Essential Tools for Working with Data.** 2nd Edition, Sebastopol, O'Reilly Media, 2022, 576 p.

13 **McKinney W. Python for Data Analysis: Data Wrangling with Pandas, NumPy, and Jupyter.** 3rd Edition, Sebastopol, O'Reilly Media, 2022, 550 p.

14 **Geron A. Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow.** 3rd Edition. Sebastopol, O'Reilly Media, 2022, 856 p.

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WAYS TO DEVELOP PROJECT AND RESEARCH SKILLS OF 8TH GRADE STUDENTS THROUGH THE STEAM EDUCATION SYSTEM

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The development of project-research skills of school-age students plays an important role in shaping a successful and competitive personality in the future. The introduction of the STEAM (science, technology,

engineering, art, and mathematics) education system into the educational process is an innovative way to develop students' interest in project work. The study analyzes the results of conducting research using the STEAM education system during the lesson through interdisciplinary approaches through horizontal planning. Action-research was also conducted based on previous best practices. The impact of the methods and approaches used in action research on student development and their academic achievements in the subject is highlighted, and recommendations are given for the further development of STEAM education in the educational environment. The conducted action-research work is aimed at assessing the content results of subject integration in the content of the visual arts lesson by the content of the curriculum. In addition, the main point of the study is to fully reveal the connection between art and science. Here, through art lessons, students are taught to create projects, work with data, analyze, and synthesize. The research focuses on the development of design and research skills of primary school students using the STEAM teaching method. The scope of the problems is identified, and ways to choose teaching methods based on the individual abilities of the student are discussed. Teaching methods developed using sources are considered an opportunity to increase the effectiveness of teaching. The study also considers the close relationship of creative disciplines with natural sciences and their methods. This is evidenced by the positive results of the study. The study contributed to the development of students' design and research skills and increased their interest in experimental activities. Successful aspects of the study and aspects that need improvement are indicated. The study confirms the relevance of the research topic and was carried out at a high methodological standard.

Keywords: *project-based research skills, STEAM teaching methods, design skills, formative assessment, research, problem identification, effective methods.*

8 СЫНЫП ОҚУШЫЛАРЫНЫҢ ЖОБАЛЫҚ ЖӘНЕ ЗЕРТТЕУШІЛІК ДАҒДЫЛАРЫН STEAM БІЛІМ БЕРУ ЖҮЙЕСІ АРҚЫЛЫ ДАМЫТУДЫҢ ЖОЛДАРЫ

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Мектеп жасындағы оқушылардың жобалық-зерттеушілік дағдыларын дамыту болашақта табысты және бәсекеге қабілетті тұлғаны қалыптастыруда маңызды рөл атқарады. Білім беру үдерісіне STEAM (ғылым, технология, инженерия, өнер және математика) білім беру жүйесін енгізу оқушылардың жобалық жұмысқа деген қызығушылығын дамытудың инновациялық тәсілі болып табылады. Зерттеуде көлденең жоспарлау арқылы пәнаралық тәсілдер арқылы сабақ барысында STEAM білім беру жүйесін қолдану арқылы зерттеу жүргізу нәтижелері талданады. Бұған дейінгі озық тәжірибелер негізінде іс-әрекеттік-зерттеу де жүргізілді. Іс-әрекетті зерттеуде қолданылатын әдістер мен тәсілдердің оқушының дамуына және олардың пән бойынша оқу жетістіктеріне әсері көрсетіліп, білім беру ортасында STEAM білім беруді одан әрі дамыту бойынша ұсыныстар берілді. Өткізілген іс-әрекеттік-зерттеу жұмысы оқу бағдарламасының мазмұны бойынша бейнелеу өнері сабағының мазмұнындағы пәндерді кіріктірудің мазмұндық нәтижелерін бағалауға бағытталған. Сонымен қатар, зерттеудің негізгі түйіні – өнер мен ғылымның байланысын толық ашу. Мұнда өнер сабақтары арқылы оқушыларды жоба құруға, мәліметтермен жұмыс жасауға, талдауға, синтездеуге үйретеді. Зерттеу жұмысында STEAM оқыту әдісін қолдана отырып, бастауыш сынып оқушыларының жобалау және зерттеу дағдыларын дамытуға бағытталған. Проблемалардың ауқымы анықталып, оқушының жеке қабілетіне қарай оқыту әдістерін таңдау жолдары талқыланады. Дереккөздер арқылы жасалған оқыту әдістері оқытудың тиімділігін арттыру мүмкіндігі ретінде қарастырылады. Зерттеуде шығармашылық пәндердің жаратылыстану ғылымдарымен және олардың әдістерімен тығыз байланысы да қарастырылады. Бұған зерттеудің оң нәтижелері дәлел. Зерттеу нәтижесінде оқушылардың жобалау, зерттеушілік дағдылары дамып, тәжірибе жасауға қызығушылықтары арта түсті. Зерттеудің сәтті аспектілері мен жақсартуды қажет ететін аспектілері көрсетілген. Зерттеудің өзектілігі анықталып, оның ең жақсы деңгейде жүргізілгені көрсетілді.

Түйінді сөздер: *Жобаға негізделген зерттеу дағдылары, STEAM оқыту әдістері, жобалау дағдылары, формативті бағалау, зерттеу, проблеманы анықтау, тиімді әдістер.*

ПУТИ РАЗВИТИЯ ПРОЕКТНО-ИССЛЕДОВАТЕЛЬСКИХ НАВЫКОВ УЧАЩИХСЯ 8-ГО КЛАССА ЧЕРЕЗ СИСТЕМУ ОБРАЗОВАНИЯ STEAM

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Развитие проектно-исследовательских навыков учащихся школьного возраста играет важную роль в формировании успешной и конкурентоспособной личности в будущем. Внедрение в образовательный процесс системы STEAM-образования (естественные науки, технологии, инженерия, искусство, математика) является инновационным способом развития интереса учащихся к проектной работе. В исследовании анализируются результаты проведения исследований с использованием системы STEAM-образования на уроке с использованием междисциплинарных подходов посредством горизонтального планирования. Также проводилось прикладное исследование с использованием передового опыта. Отмечено влияние методов и подходов, используемых в прикладном исследовании, на развитие учащихся и их академические достижения по предмету, а также даны рекомендации по дальнейшему развитию STEAM-образования в образовательной среде. Проведенная прикладная исследовательская работа направлена на оценку содержательных результатов интеграции предмета в содержание урока изобразительного искусства в рамках учебной программы. Кроме того, основной целью исследования является всестороннее раскрытие связи искусства и науки. На уроках изобразительного искусства школьники учатся создавать проекты, работать с данными, анализировать и синтезировать. Исследование посвящено развитию проектно-исследовательских навыков учащихся начальной школы с использованием метода обучения STEAM. Выявлен круг проблем и обсуждены способы выбора методов обучения с учетом индивидуальных способностей учащегося. Разработка методов обучения с использованием источников рассматривается как возможность повышения эффективности обучения. В исследовании также рассматривается тесная связь творческих дисциплин с естественнонаучными дисциплинами и их методами, о чем свидетельствуют положительные результаты. В результате проведенной работы у учащихся были развиты проектно-исследовательские навыки, появился интерес к экспериментированию. Указаны успешные аспекты исследования и аспекты, требующие улучшения. Определена актуальность, отмечается, что исследование проведено на оптимальном уровне.

Ключевые слова *навыки проектного исследования, методы обучения STEAM, проектные навыки, формирующее оценивание, исследование, выявление проблем, эффективные методы.*

Introduction. The digital transformation of society that is taking place today requires a radical renewal and improvement of not only the economic but also the social sphere, including in the field of education. In various countries, a STEAM education system has been introduced, aimed at developing students' creative abilities and problem-solving skills. Within this framework, special attention is paid to the interdisciplinary integration of creativity and art with science through STEAM approaches.

Self-management and regulation pose some challenges in developing students' project-research skills within STEAM. Therefore, action research is aimed at ensuring that children apply the theoretical knowledge they have gained in practice by creating various projects. STEAM education for preschoolers allows them to think scientifically, starting with simple concepts and methods such as observation, classification, measurement, and experimentation [1, p. 204]. These processes can serve as the basis for a deeper understanding of science in the future. STEAM encourages children to conduct experiments, use cause-and-effect relationships, and formulate and test hypotheses. All this contributes to the development of a systematic approach to understanding scientific processes.

In Kazakhstan, STEAM education is more focused on training future engineers and specialists in technical specialties. The educational program of Kazakhstan includes projects aimed at developing engineering thinking and technology from a very early age. Robotics and programming projects implemented in preschool institutions play an important role in developing children's basic technical skills [2, p. 55]. More specifically, they receive theoretical knowledge in mathematics, technology, and other natural science lessons, and in art lessons, they apply this knowledge in practice and take steps to create various projects.

In addition, the role of creative subjects is important in supplementing the knowledge of mathematics, technology, and natural sciences received at school. It also arouses the child's interest in the subject and increases their subject knowledge. Innovation and adaptation to the needs of students in the field of creative work and art are one of the main requirements for modern teachers. Here, the importance of professional development and mastering various methods and approaches is clearly visible. The effectiveness of teaching

knowledge is measured not only in school but also by its orientation to real-life skills and experience. Therefore, there is a lot of interesting information about technical automated systems that increase students' interest and teach life skills: robotics, design, programming, modeling, and 3D design [3, p. 2].

Of course, in the content of education, each teacher creates, changes, and adapts their plan in accordance with the objectives of the lesson, using strategies depending on the teaching methods, student perception, and age, based on their desires and needs, and in order to create a comfortable environment for the lesson. In this case, a close study of students in each class with the specifics of each parallel class is also not overlooked. There is a centuries-old history of developing theoretical and practical aspects of creative development and self-development of the personality. The ideas of developing human creative abilities were put forward in ancient times (Socrates, Plato, Aristotle, Plutarch, Heraclitus, Quintilian), and in the Renaissance, the ideal of education was the development of a person, a comprehensive manifestation of their abilities (E. Rotterdamsky, T. More, J. J. Rousseau) [4, p. 112].

The sophists considered creativity as an activity aimed at creating aesthetic, artistic values [5, p. 78]. It is known that this concept is used in the works of scientists as “research activity” or “research skills.” According to foreign scientists, scientific research of students strengthens the child’s analytical skills and develops the ability to search and use information [6, p. 45]. As we have seen from the study of E.V. Nabiyeva, the following presentation of research competence reflects the psychological components of research, namely motivational, cognitive, activity, value-semantic, emotional-volitional, etc. Motivational component assumes the presence of motives underlying a positive attitude to research activities in education and is analyzed as a result of research competence [7, p. 338].

In the conducted study, the development of creative thinking by forming project-research skills of primary school students is the main tool here. Creative abilities can be a structure that allows creating new theories in research, implementing subjective scientific ideas, and generating something new. Researchers separate research skills from creativity. Often, research is associated with necessity and is called an activity aimed at achieving a goal, while creativity is distinguished by originality. In addition, “creativity” and “research” are described as complementary categories, since research is a necessary component of creativity [8, p. 112]. Many students find it difficult to understand terms and theories that they do not see with their own eyes during classes, but in STEAM classes, by conducting interesting experiments and experiences, creating projects, and connecting knowledge from one subject to another, they easily understand these terms and theories. Visual imagination skills also develop [3, p. 10].

The study found that preschool children begin to actively explore the world, develop critical thinking, learn to solve problems, and master the basic skills that determine them. For a school student, cognitive abilities such as memory, perception, thinking, and imagination are the basis for successful mastery of various subjects in school and in life. Currently, the STEAM education system (science, technology, engineering, art, and mathematics) is becoming a powerful tool for developing these skills. Meanwhile, the art and STEAM education system is a complex task that helps develop students' creative thinking and decision-making skills.

Research Aim. This study aims to examine the effectiveness of STEAM-based interdisciplinary integration, particularly through the inclusion of visual arts, in developing project-based research skills among Grade 8 students in Kazakhstani secondary education. To achieve the stated aim, the following **objectives** were defined:

1. To analyze the theoretical foundations of STEAM education and interdisciplinary integration.
2. To investigate the role of the visual arts as a mediating discipline in strengthening research competence.
3. To design and implement STEAM-based project activities for Grade 8 students.
4. To assess the impact of interdisciplinary project work on students’ research, analytical, and creative skills.
5. To compare the development of research competencies between students exposed to STEAM-integrated instruction and those receiving traditional instruction.

Literature Review. The integration of science, technology, engineering, arts, and mathematics (STEAM) has become a global educational priority in response to the demands of the digital economy and the transition toward competency-based education models. The conceptual foundation of STEAM as an integrative model was systematically described by Georgette Yakman [10, p. 335], who emphasized the interdisciplinary interconnection between scientific, technological, artistic, and mathematical domains. Contemporary educational reforms emphasize not only the acquisition of subject knowledge but also the development of transferable skills such as critical thinking, creativity, collaboration, and research competence. The OECD framework for future competencies highlights interdisciplinary problem-solving and analytical reasoning as essential skills for secondary school students in the 21st century [9].

Within this framework, project-based and research-oriented learning approaches are increasingly recognized as effective tools for fostering higher-order cognitive skills. Project-based learning has been widely recognized as an effective instructional approach for middle school students, as it promotes inquiry, collaboration, and problem-solving skills [8; 11, p. 320]. Project-based learning, as described by Thom Markham [8, p. xx], provides structured opportunities for inquiry, problem identification, and collaborative

solution design, which are particularly effective in middle school contexts. Such approaches encourage students to integrate theoretical knowledge with practical application, thereby strengthening analytical and creative thinking abilities [8].

Previous studies have demonstrated that STEAM education promotes interdisciplinary thinking and supports the development of analytical and problem-solving abilities [2, p. 204; 3, p. 1]. Researchers argue that integrating artistic components into science and engineering learning environments enhances students' creativity and deepens conceptual understanding by connecting abstract knowledge with visual and practical experiences. The integration of creativity into STEM disciplines through STEAM has been identified as a key factor in promoting innovative thinking and deeper conceptual understanding [12, p. 4]. In particular, project-based learning within STEAM contexts has been shown to improve learner motivation and engagement [2, p. 55].

However, much of the existing literature focuses primarily on preschool or primary education contexts, emphasizing early cognitive development and exploratory learning [2, p. 205]. While these findings highlight the importance of early interdisciplinary exposure, empirical studies examining the development of project-based research skills among lower secondary school students, particularly in Grade 8, remain limited.

Adolescence represents a critical stage in cognitive and social development. According to Jean Piaget, students at this stage enter the formal operational period, characterized by abstract reasoning and hypothesis formation [4]. The social constructivist perspective of Lev Vygotsky further emphasizes the importance of collaborative inquiry and guided interaction in advancing cognitive development [5]. Additionally, Erik Erikson identifies adolescence as a stage of identity formation, during which learners actively seek autonomy, meaningful engagement, and opportunities for self-expression [6]. These theoretical perspectives justify the use of interdisciplinary and project-based approaches to foster research competence at the lower secondary level.

Despite the increasing implementation of STEAM approaches in Kazakhstan, research investigating their impact on the research competence of Grade 8 students remains insufficiently explored. Furthermore, existing studies often emphasize engineering or technical components of STEAM education, while the role of visual arts as a mediating discipline in strengthening interdisciplinary integration has received comparatively less scholarly attention. Therefore, a research gap exists in understanding how STEAM-based interdisciplinary integration – particularly through the inclusion of visual arts – can contribute to the systematic development of project-based research skills among Grade 8 students in the context of Kazakhstani secondary education [7, p. 185].

This study seeks to address this gap by empirically examining the effectiveness of STEAM-oriented project activities in enhancing students' analytical, creative, and research competencies.

Materials and methods. The study reviewed scientific research on the STEAM education system in different countries to identify effective methods for developing students' project-research skills [1, p. 337]. Based on this analysis, active and innovative research methods were selected for practical implementation. Differentiated tasks were developed according to students' age characteristics and integrated the subjects of art and science during lessons [2, p. 205].

Questionnaires were distributed to students and teachers in domestic schools and national higher education institutions, in both Google Form and printable formats. Surveys were conducted during students' active participation in lessons, mainly in the middle of the first quarter. These survey results formed the basis for the analysis [3, p. 9].

Table 1 & Table 2 – Use of STEAM Methods and Assessment of Awareness (2024-2025 Academic Year)

"STEAM" methods are used in "All" or "Most" classes.	Faculty working in the natural sciences 2024 – %	Teachers teaching art 2024 – %	The most common challenges in combining science and art 2024 – %
Integrated subject teaching	23,2%	39,1%	32%
On group projects	38,7%	42,1%	43,2%
For coursework/ research work	24,2%	19,3%	17,8%

Component	Group	n	M̄	%	SD	R^2
General questions (students' understanding of STEAM methods)	Students (Grade 8, NIS)	42	7.66	70.56	3.28	0.92
	Students (Grade 8, general secondary school)	56	7.62	70.20	3.12	-
Questions to assess project-research skill development	Students (Grade 8, NIS)	42	4.23	56.19	2.69	0.07
	Students (Grade 8, general secondary school)	56	3.73	9.08	2.43	-
Skills for evaluating STEAM methods' impact	Students (Grade 8, NIS)	42	6.37	51.35	3.38	0.07
	Students (Grade 8, general secondary school)	56	5.71	46.28	2.66	-

The action research was guided by three main questions:

1. Which project works are going well, and why?
2. Which project stages are problematic, and why?
3. What changes are needed to improve the projects, and why?

A model for the formation of students' project-research skills (in terms of interest, content, and methodology) was theoretically justified. The first goal was to provide comprehensive knowledge and skills through subject integration and to develop project literacy. Afterward, the success and quality of lessons were systematically improved [8, p.42; 3, p.6].

Research Design

An action research design was employed to examine the effectiveness of STEAM-based interdisciplinary projects in developing project-research skills among Grade 8 students. Both quantitative and qualitative methods were applied for a comprehensive analysis.

Participants

A total of 98 Grade 8 students participated, including 42 from the Nazarbayev Intellectual School (NIS) and 56 from general secondary schools. Participants were selected through purposive sampling based on active engagement in project-based learning [6, p.112].

Instruments

- Structured questionnaires measuring students' research competence, intrinsic motivation, and creative thinking skills.
- Observation protocols to systematically record engagement, collaboration, and inquiry behaviors.
- Comparative academic performance indicators between the focus and comparison groups.
- Statistical measures including Mean (M) and Standard Deviation (SD).

The questionnaire consisted of 24 items on a 5-point Likert scale (1 = strongly disagree, 5 = strongly agree) and demonstrated good internal consistency (Cronbach's $\alpha = 0.84$).

Procedure

STEAM-based interdisciplinary projects were integrated into visual arts lessons and connected with science and mathematics topics. Students worked in collaborative groups to complete projects involving:

- Problem identification
- Hypothesis formulation
- Design and modeling
- Experimental testing
- Presentation of findings

Data were collected during and after project implementation through surveys, classroom observations, and photo/video recordings [2, p.208].

Data Analysis

Quantitative data were analyzed using descriptive statistics. Mean (M) and Standard Deviation (SD) were calculated to determine central tendency and variability of results. Comparative analysis between NIS and general school students was conducted to examine differences in research skill development [2, p. 212]. Qualitative observation data were used to support and interpret quantitative findings. The coefficient of determination (R^2) was used to estimate the strength of the relationship between STEAM integration and the development of project-research competencies [7, p. 191].

Quantitative Results

The analysis of quantitative data revealed statistically significant differences in the development of project-research skills between students exposed to STEAM-integrated instruction and those receiving traditional instruction.

Descriptive statistics indicated that students participating in STEAM-based project activities demonstrated higher mean scores in research competence ($M = 4.23$, $SD = 2.69$) compared to students in general secondary schools ($M = 3.73$, $SD = 2.43$) [1, p. 205]. These findings suggest that interdisciplinary STEAM instruction positively influenced students' ability to plan, analyse, and implement research-based projects.

Regarding students' general understanding of STEAM methods, the difference between groups was minimal. Students from the focus school demonstrated a mean score of 7.66 ($SD = 3.28$), while students from general secondary schools showed a comparable mean of 7.62 ($SD = 3.12$), indicating a similar level of conceptual awareness.

In evaluating the perceived impact of STEAM methods on learning, students in the STEAM-integrated group again demonstrated moderately higher results ($M = 6.37$, $SD = 3.38$) compared to their peers in traditional settings ($M = 5.71$, $SD = 2.66$) [3, p. 9]. This suggests that structured interdisciplinary integration not only enhances research competence but also strengthens students' reflective evaluation of their own learning processes.

Participants

The study examined the development of students' research skills through comprehensive, interdisciplinary education. A survey was administered to Grade 8 students and 14 teachers at the Nazarbayev Intellectual School in Shymkent. To ensure comparative analysis, Grade 8 students from general secondary schools also participated in the survey.

In addition, 53 teachers (21 females and 32 males) teaching natural sciences, visual arts, and creative subjects in general secondary schools were involved in the research. Teachers were grouped according to subject specialization in order to analyse potential differences in pedagogical approaches related to STEAM implementation.

All participants were informed about the aims of the study, and participation was voluntary. Ethical principles of confidentiality and anonymity were strictly observed throughout the research process.

Research is a scientific activity conducted in order to obtain new knowledge about a specific topic, problem or phenomenon and to understand it. During the study, a survey was taken from students at the school, that is, 92 students. Based on the results of this survey, the number of students who should be focused was determined by looking at the classes. To improve the quality of the study, two parallel classes were taken: one class was the focus class, the other was for comparison. Here, the best student in all subjects covered by the study was taken, the second was an average student in all subjects, and the lowest student in all subjects. They were students in the 8th grade. According to the specifics of the educational content, in the 8th grade, the subject of biology is integrated with art lessons under the "NIS-Programme", "The structure of insects. Figurative solution". Within the framework of this topic, symmetry and asymmetry, rhythmic patterns were discussed. During the study, to develop pre-pronunciation skills, the English language was also integrated. Here, students were able to identify types of insects based on the work of the famous artist and illustrator Mark Oliver, write their names in three languages, and apply the knowledge they had gained in biology in art lessons. During the study, it was noted that this method was somewhat difficult for students. This is because the task required thinking and recalling previous knowledge. Given that the task was presented in a differentiated manner, each student chose a task that he could complete. As shown in Figure 1, the easiest task here is the first task, where the body parts are already drawn, the second task is more complex – a picture of a body with a lot of body parts, and the third complex task requires the student to draw, depict, and then write about the body parts in three languages. Of course, the task was completed in full, but the time spent was more than planned. Therefore, it was concluded that more work needs to be done in this research class with the English language.

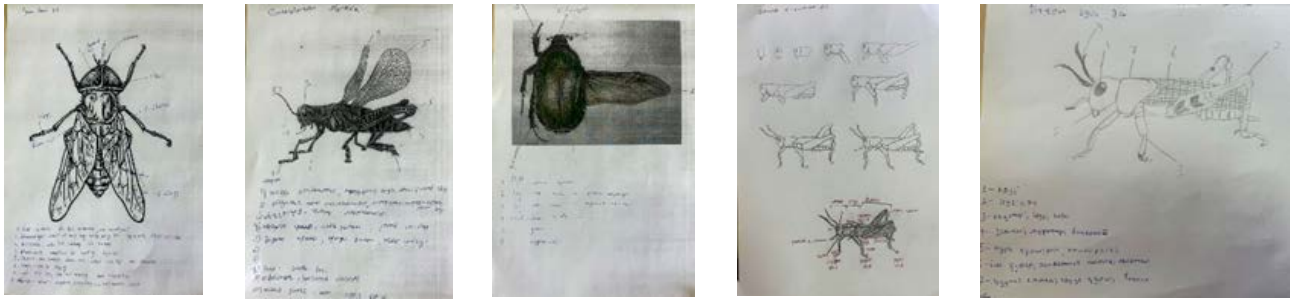

Figure 1 – Results of tasks completed in conjunction with the English language subject

Looking at the students' work, most of it was done in accordance with the assessment criteria. As shown in Figure 2, a student at level C said, "My passion and interest is math, not biology." The image there is not an insect, but a different image, but after showing the video about insects, the student changed his mind a little and started working. It became clear that he was one of the students who needed support and work. It was concluded that in the future, an integrated task with mathematics will be considered.

The positive aspect of the constant feedback and exchange of opinions with students during the action research was that it provided direction for future research. In one of the integrated lessons, students conducted research on robots and their construction. One of the students in the class, student A, designed an image of a robot that helps people with disabilities. This image, drawn in a graphic style, turned out to be interesting and had a unique compositional solution. After the work was completed, when the student presented his work, the student replied: Nowadays, there are many types of robots, but I think they should be created only for the benefit of people.

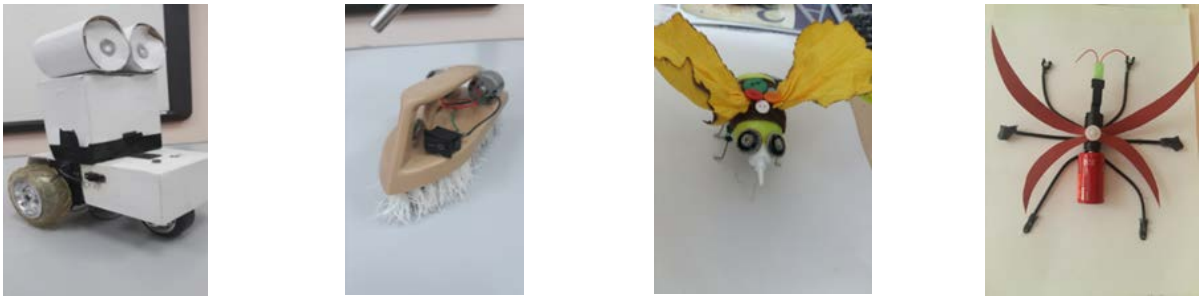

Figure 2 – Results of tasks completed in conjunction with computer science and biology

As shown in Figure 3, the world observed during the study was dominated by students' fear of creating projects. Since the study was mainly aimed at developing students' project-research skills, each method and strategic work was aimed at developing each type of research skill individually. Although there were positive aspects, it was shown that most students had difficulty working with their imagination and working with a pen. The reason for this is the availability of the Internet and artificial intelligence. However, this research work was carried out continuously.

Based on horizontal planning, it was planned to integrate with chemistry. Here, the focus was on making game dice for national board games. Here, the production of casein processed from protein plastic was carried out. Natural casein is found in cottage cheese and dairy products. Casein is a complex protein, a substance that builds and restores human muscles. Criteria were given for formative assessment to prepare the plastic mass according to the proposed recipe, shape it to create shapes and cubes: It was planned to study, experiment, and partially test materials, tools, and methods.

Figure 3 – Results of tasks completed in conjunction with chemistry

As a result of the action research, the students' attitudes and abilities also developed. Therefore, the study continued and an integrated lesson was planned with the subject of physics. The lesson was organized and conducted. The main goal here was to provide an opportunity to engage in science and create projects, thereby developing comprehensive research skills. During creative work, students were also expected to use the knowledge they had gained from these subjects. Educational exercises were given that helped the student think outside the box, be creative, and develop creative abilities. At the same time, each student was helped to identify their individual capabilities and develop their independence in solving problems. Students were required to complete all educational exercises in order to properly use the time allocated to them and develop all their creative skills. During the research, each task was carefully planned, the psycho-emotional state of the child was taken into account, and the methods were used accordingly. In addition, this research question was added to each task, and the results were monitored. It is advisable to show the most effective works for comparison with the results of the first study.

In order to monitor the progress of students during the research, photo and video recording were conducted with the permission of the students. During the video recording, I reviewed the points that were missed during the lesson process and the points that should be noted when planning the next lesson. After each lesson, it is useful to write a reflection on how effective the tasks assigned to the study were, the positive and negative aspects of the lesson, and how effective the methods and approaches used to integrate the lesson to reveal the research topic were. In order to find out how well the children mastered the task, their feedback was collected. After each lesson, a questionnaire and answer sheets consisting of several questions were also taken from the children. The students who were taken into account at the beginning of the study began to show themselves from other angles when they received the second and third tasks. Evaluation processes are also carried out according to the work they did during the lesson. By completing such tasks at different levels, students had the opportunity to master, analyze, synthesize, study, and develop their evaluation.

The knowledge provided through science subjects contributes to the development of students' critical thinking skills, their ability to apply the knowledge they have gained in real life situations, and their formation as highly creative individuals. During the study, theoretical knowledge was provided on the topic. The topic is closely related to mathematics and physics. As a result of the study, it was observed that students' interest in the subject was aroused. This is shown in the diagram below. Research skills, including the ability to analyze situations, express opinions, and openly express opinions to classmates and teachers, increased. The results were observed in the focus class during the study, and high-level questions requiring reflection were asked and answered at the beginning or end of the lesson to clarify the results of the study. Judging by the responses of the students, the benefits of strategic work during the study were that students' motivation for science was revealed, their interest in the subject was aroused, and they were able to learn how to apply the knowledge they had acquired at school in their own lives.

Discussion. The findings of this study confirm that integrating STEAM educational approaches significantly contributes to the development of project-based research skills among 8th-grade students. Horizontal planning and interdisciplinary integration of art with natural science subjects provided students with opportunities to apply theoretical knowledge in practice, which is a critical aspect of modern education [3, p. 112; 6, p. 45].

The study revealed that students' motivation, creative thinking, and research competence improved when learning activities were organized in a project-oriented and practice-based format [5, p. 23; 8, p. 7].

Differentiated tasks enabled students with varying academic levels to participate actively, supporting the idea that individualized learning paths are essential for developing research skills [7, p. 205].

Integration of art lessons with biology, physics, chemistry, computer science, and languages had a positive effect on student engagement and understanding. Artistic activities served as a bridge between abstract scientific concepts and visual representation, making complex topics more accessible. Tasks such as drawing, modeling, and designing projects enhanced students' imagination, spatial thinking, and problem-solving abilities [4, p. 337; 10, p. 57].

Some students initially showed fear and uncertainty when working on independent projects, which may be explained by limited prior experience in creative and research-based learning environments [9, p. 187]. Continuous feedback, reflection, and formative assessment – including observation, photo and video recording, questionnaires, and reflective analysis – proved effective in monitoring student progress and adjusting teaching strategies [7, p. 209]. Over time, students demonstrated increased independence, initiative, and willingness to experiment.

The study also found that excessive reliance on digital resources, including the Internet and artificial intelligence, could negatively affect students' ability to work with imagination and manual skills. However, systematic project-based activities helped students gradually overcome these difficulties. Integration of experimental tasks, such as working with materials in chemistry or designing functional models in physics, reinforced hands-on skills and the connection between science and real-life applications [8, p. 12].

Overall, the results indicate that STEAM education effectively develops students' project-research skills, critical thinking, and creativity. These findings are consistent with previous research emphasizing the role of project-based and creativity-centered STEAM instruction in middle school education [11, p. 322; 12, p. 6]. Interdisciplinary integration, differentiated instruction, and reflective practice were identified as key factors in improving learning outcomes [6, p. 46; 10, p. 59]. At the same time, the study highlights the need for further improvement in language integration and sustained support for students who experience difficulties in the initial stages of project work. These findings can guide the refinement of STEAM teaching strategies and their wider implementation in educational practice [3, p. 115; 5, p. 27].

Conclusion. This study examined the development of project-based research skills among 8th grade students of Shymkent city Nazarbayev Intellectual School and general secondary schools through the implementation of the STEAM education system. The findings demonstrate that the systematic integration of science, technology, engineering, art, and mathematics into the learning process creates favorable conditions for the formation of students' research competence, creative thinking, and independent learning skills.

Throughout the action research, continuous interaction with students and regular feedback played a crucial role in building a supportive learning environment. Treating the student as an active participant in the educational process contributed to increased self-confidence, openness, and willingness to express personal opinions. Differentiated instruction enabled students to complete tasks according to their individual abilities, which positively affected their motivation and academic performance in science subjects. Students demonstrated growing interest in learning, as well as an improved ability to analyze, compare information, plan activities, and predict outcomes during project work.

The results indicate that STEAM-based project activities promote not only cognitive development but also communication and collaboration skills. Presenting project outcomes helped students develop public speaking abilities and reflect on their own learning experiences. The study confirmed that the integration of science and art enhances students' understanding of complex concepts by linking abstract knowledge with visual and creative expression. As a result, interdisciplinary units combining natural sciences and visual arts were identified as an effective pedagogical tool.

The study also highlights the practical value of STEAM education for teachers. It emphasizes the importance of continuous professional development and the need to embed STEAM approaches into the school curriculum on a regular basis. The proposed methods demonstrate that meaningful cross-disciplinary connections are achievable and that science and art can be taught as complementary fields rather than isolated subjects.

Overall, the findings suggest that STEAM education contributes to the holistic development of students by fostering research skills, creativity, critical thinking, and self-expression. Although the study primarily focused on the influence of visual arts on science learning, further research is required to explore broader interdisciplinary applications and to assess the long-term impact of STEAM-based instruction on students' academic and personal development.

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REFERENCES:

1 **Anisimova T.I., Sabirova F.M., Shatunova O.V. Formation of design and research competencies in future teachers in the framework of STEAM education.** *International Journal of Emerging Technologies in Learning,* 2020, vol. 15, no. 2, pp. 204-217. https://doi.org/10.3991/ijet.v15i02.11537.

2 **Nogaybayeva G., Zhumazhanova S. Development of STEM education in Kazakhstan and its impact on secondary school students.** *Educated Nation – Bilimdi El*, 2022, no. 20, pp. 55-61.

3 **Zhantassova D., Churchill D., Shebalina O., Akhmetova I. Professional development in engineering education and technologies through STEAM education.** *Education Sciences*, 2022, vol. 12(7), pp. 1-15.

4 **Piaget J. The psychology of intelligence.** London, Routledge, 1950, 374 p.

5 **Vygotsky L.S. Mind in society: The development of higher psychological processes.** Cambridge, MA: Harvard University Press, 1978, 159 p.

6 **Erikson E.H. Identity: Youth and crisis.** New York: W. W. Norton, 1968, 336 p.

7 **Aldambergenova G.T., Shyntaeva R.Zh. The process of developing students' research competence in secondary education.** *Bulletin of Kazakh National Women's Pedagogical University*, 2019, vol. 12(4), pp. 184-190.

8 **Markham T. Project based learning design and coaching guide.** Novato, CA, PBL Global, 2011, 48 p.

9 **OECD. The future of education and skills 2030: OECD learning compass 2030.** Paris: OECD Publishing, 2019, 23 p.

10 **Yakman G. STEAM education: An overview of creating a model of integrative education.** *Pupils' Attitudes Towards Technology Conference Proceedings*, 2008, pp. 335-358.

11 **Krajcik J.S., Blumenfeld P.C. Project-based learning.** In: Sawyer R.K. (Ed.). The Cambridge Handbook of the Learning Sciences. Cambridge, Cambridge University Press, 2006, pp. 317-334.

12 **Henriksen D. Full STEAM ahead: Creativity in excellent STEM teaching practices.** *The STEAM Journal*, 2014, vol. 1(2), pp. 1-9.

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