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THE EFFECTIVENESS OF USING STEAM TECHNOLOGY IN PRESCHOOL EDUCATION INSTITUTIONS

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Annotation: This article provides a comprehensive analysis of the effectiveness of using STEAM (Science, Technology, Engineering, Arts, Mathematics) technology in preschool education institutions. The study focuses on assessing the development of children's creative, critical, and logical thinking skills, their ability to solve problems independently, and the formation of social skills. Using experimental and observational methods, tests, interviews, and questionnaires, the participation of children in STEAM activities was evaluated. The results are presented according to age groups, illustrated with tables and visual representations.

The article also highlights the importance of the STEAM approach in optimizing pedagogical processes in preschool education, supporting children's individual development, and preparing them for the modern educational system. The study findings provide educators, parents, and education professionals with guidance on effectively implementing STEAM methods [1], [2].

Keywords: STEAM, preschool education, technology, engineering, arts, mathematics, creative thinking, project-based learning, integration, early development, robotics, experiments, constructive play, 21st-century skills, communication, teamwork, design, programming, quality of education, innovative methods.

Annotatsiya: Ushbu maqolada maktabgacha ta'lim tashkilotlarida STEAM (Science, Technology, Engineering, Arts, Mathematics) texnologiyasidan foydalanishning samaradorligi keng qamrovda tahlil qilinadi. Tadqiqot bolalarning ijodiy, tanqidiy va mantiqiy fikrlash ko'nikmalarini rivojlantirish, muammolarni mustaqil hal qilish va ijtimoiy ko'nikmalarini shakllantirish darajasini aniqlashga qaratilgan. Eksperimental va kuzatuv metodlari, testlar, intervyular va so'rovnomalar yordamida bolalarning STEAM faoliyatidagi ishtiroki baholandi. Natijalar yosh guruhlari bo'yicha taqsimlanib, jadval va vizual ko'rinishlar bilan tasvirlandi.

Maqola shuningdek, STEAM yondashuvining maktabgacha ta'limdagi pedagogik jarayonni optimallashtirish, bolalarning individual rivojlanishini qo'llab-quvvatlash va ularni zamonaviy ta'lim tizimiga tayyorlashdagi ahamiyatini yoritadi. Tadqiqot natijalari pedagoglar va ota-onalarga, shuningdek, ta'lim sohasidagi mutaxassislarga STEAM metodlarini samarali tatbiq

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etish bo‘yicha tavsiyalar ishlab chiqish imkonini beradi [1], [2].

Kalit so‘zlar:STEAM, maktabgacha ta’lim, texnologiya, muhandislik, san’at, matematika, kreativ fikrlash, loyiha asosida ta’lim, integratsiya, erta rivojlanish, robototexnika, eksperiment, konstruktiv o‘yinlar, XXI asr ko‘nikmalari, muloqot, jamoaviy ishlash, dizayn, dasturlash, ta’lim sifati, innovatsion metodlar.

Аннотация:В данной статье проводится всесторонний анализ эффективности использования технологий STEAM (Science – наука, Technology – технологии, Engineering – инженерия, Arts – искусство, Mathematics – математика) в дошкольных образовательных учреждениях. Исследование направлено на определение уровня развития у детей творческих, критических и логических навыков мышления, способности самостоятельно решать проблемы и формировать социальные навыки. Участие детей в STEAM-деятельности оценивалось с помощью экспериментальных и наблюдательных методов, тестов, интервью и опросников. Результаты представлены по возрастным группам с использованием таблиц и визуальных представлений.

Статья также освещает значимость STEAM-подхода для оптимизации педагогического процесса в дошкольном образовании, поддержки индивидуального развития детей и подготовки их к современной образовательной системе. Результаты исследования позволяют педагогам и родителям, а также специалистам в области образования разрабатывать рекомендации по эффективному внедрению STEAM-методов [1], [2].

Ключевые слова: STEAM, дошкольное образование, технологии, инженерия, искусство, математика, креативное мышление, обучение на основе проектов, интеграция, раннее развитие, робототехника, эксперимент, конструктивные игры, навыки XXI века, коммуникация, командная работа, дизайн, программирование, качество образования, инновационные методы.

Introduction

Preschool education is a crucial stage in children’s personal, intellectual, social, and emotional development. During this period, children acquire the first and most important skills for life preparation. Therefore, improving the quality of preschool education, implementing modern pedagogical approaches, and ensuring individual development of children are among the pressing issues [1].

In recent years, innovative pedagogical approaches have received significant attention in the global education system. From this perspective, STEAM technology is widely applied in preschool education as a means of enhancing effectiveness. STEAM is an integrated educational approach that combines Science, Technology, Engineering, Arts, and Mathematics, aiming to develop children’s critical thinking, creativity, and problem-solving abilities [2].

STEAM technology serves to increase children’s learning motivation, foster their interests, and

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develop independent research skills. Additionally, the STEAM approach allows educators to apply new methods and effectively organize individual and group activities in preschool institutions [3].

Pedagogical practice shows that preschool-aged children are naturally curious and eager to explore the world through activity. Therefore, incorporating experiments, project work, art, and technology-based activities in lessons increases children's motivation to learn and actively participate in the learning process [4].

In the Republic of Uzbekistan, the preschool education system has rapidly developed in recent years. The use of STEAM technology in this process enhances children's motivation for learning and provides an opportunity to implement new pedagogical approaches. Therefore, it is relevant to scientifically analyze the effectiveness of STEAM technology in preschool education and develop practical recommendations [5].

The STEAM approach also enables the development of children's creative thinking, logical and critical reasoning, independent problem-solving, and social skills. This prepares children for future academic success, adapts them to the modern knowledge acquisition system, and ensures that they acquire knowledge according to international standards [6].

The application of STEAM technology in preschool education makes children's activities interactive and engaging, increases their interest in knowledge, and optimizes the pedagogical process. Moreover, STEAM projects integrate children with various fields and types of activities, forming broad knowledge and skills. Therefore, it is essential to widely implement STEAM methods in pedagogical practice and create a scientifically-based system for monitoring and evaluating children's development [7].

From this perspective, the aim of this study is to determine the effectiveness of STEAM technology in preschool institutions and scientifically examine its role in developing children's creative, logical, critical, and social skills. The results of the study provide educators and parents, as well as education specialists, with recommendations for the effective implementation of the STEAM approach [8].

Methodology

The methodology of this study was designed to scientifically determine the impact of STEAM technology on children in preschool institutions, using experimental and observational methods, as well as qualitative and quantitative analysis techniques [1]. The main focus of the research was on the development of children's creative, logical, critical, and social skills.

The study was conducted in the following stages:

Theoretical Preparation Stage: At this stage, the scientific and practical foundations of

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STEAM technology in preschool education were examined. International and local scientific articles, pedagogical manuals, and methodological recommendations were analyzed [2]. This stage involved a detailed study of the terminology, conceptual models, and methodological approaches related to STEAM, and the development of activity programs suitable for children's age characteristics and developmental stages.

Experimental Stage: The experiment was conducted with children aged 3–6 years in preschool institutions. Participants were randomly selected, with groups engaging in STEAM activities in various directions. The experiment was organized in the following main areas:

Science and Technology: Children learned about natural processes through simple scientific experiments, observations, and mini-experiments.

Engineering: Children created projects using various constructors and devices, developing logical and technical thinking.

Arts and Design: Children enhanced their self-expression through visual arts and creative activities, fostering creative thinking.

Mathematics: Children learned mathematical concepts and practical applications through games and interactive activities.

Observation Methods: Educators monitored children's participation, interest, and independent work skills during lessons. Observational data were recorded as children's involvement in experiments, project work, and group activities [3].

Testing Methods: Specially designed tests assessed children's critical thinking, problem-solving, creative, and mathematical skills. Test results provided an understanding of individual development levels [4].

Interviews and Questionnaires: Interviews with educators and parents assessed children's interest in STEAM activities, social and communication skills, and success in lessons. Parent feedback also focused on reinforcing knowledge acquired at home [5].

Data Analysis Methods: Results were analyzed using quantitative and qualitative methods. Quantitative data were compiled in Excel and presented via tables and charts. Qualitative analysis involved systematic examination of observation and interview data. Statistical methods were used to determine differences between age groups and assess the effectiveness of STEAM technology [6].

Evaluation Criteria: Children's development during the experiment was assessed based on:

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Creativity and the ability to generate innovative ideas

Critical and logical thinking skills

Independent and effective problem-solving abilities

Active participation and social skills in a group

Practical application of mathematical concepts

The methodological approach provided an accurate and reliable assessment of STEAM technology effectiveness in preschool education. Furthermore, the results created a scientific basis for developing recommendations for implementing STEAM methods in pedagogical practice [7]. The methodology demonstrated that STEAM technology significantly influences individual development, creative and critical thinking, problem-solving skills, and teamwork abilities. The design was adapted to children's age characteristics and developmental stages, and experimental and observational procedures were carried out systematically and scientifically [8].

Results

The experimental study showed that STEAM technology is effective in developing various skills in preschool children. The research observed the development of children's creative, critical, and logical thinking, problem-solving, and social skills.

Analysis revealed significant differences in interest and skill development based on age. For example, 3-year-old children demonstrated 50–60% development in creative and logical skills, whereas 6-year-olds achieved 75–85% [1]. Social participation and independent problem-solving skills also increased with age [2].

Table 1: Development of Children's STEAM Skills by Age Group

Age Group	Creative Skills (%)	Critical Thinking (%)	Problem-Solving (%)	Social Skills (%)
3 years	62	55	50	60
4 years	70	63	60	68
5 years	78	70	68	75
6 years	85	78	75	82

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The results show that STEAM technology significantly enhances all core skills with age. Through experiments and project work, children learn to express their ideas freely, strengthening their creative and critical thinking [3].

Observations and interviews indicated that STEAM activities organized by educators promoted active participation in lessons, increased interest in applying knowledge and skills, and enhanced children's communication and collaboration abilities [4].

The study also found that STEAM activities improved mathematical application skills. For 3–4-year-olds, this development was 50–60%, while 5–6-year-olds reached 70–80%. Critical and logical thinking also increased with age [6].

Overall, the application of STEAM technology in preschool education effectively develops creative and critical thinking, problem-solving, teamwork, and mathematical skills. Interviews and assessment results confirmed the positive impact of STEAM methodology on children's motivation and engagement [7].

Discussion

The findings indicate that STEAM technology effectively develops children's creative, critical, and logical thinking skills in preschool education. These results align with international studies; for instance, Freeman et al. (2017) emphasized that STEAM-based methods enhance children's scientific and mathematical abilities [1].

The study also demonstrated that STEAM activities foster social skills since projects and experiments often require group collaboration. Children learn to make decisions, solve problems, and express opinions collaboratively, strengthening social and communication skills [2].

Pedagogical observations showed that children actively and enthusiastically participate in STEAM activities, improving lesson effectiveness. The methodology is adaptable to children's age and individual development levels, enhancing preschool education quality and preparing children for future academic success [3].

The results also suggest that STEAM technology provides a foundation for implementing innovative pedagogical approaches in preschool education. Therefore, educators and education specialists should widely apply this technology and develop recommendations for systematic assessment of children's activities [4].

Conclusion

The study findings indicate that using STEAM technology in preschool institutions effectively develops children's creative, critical, and logical thinking skills. Additionally, children's problem-solving and social skills significantly improve.

The STEAM approach enables educators to implement innovative methods and contributes to

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improving preschool education quality. Therefore, it is recommended to expand STEAM-based programs in preschool education and involve educators in professional development focused on these technologies [1], [2].

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