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Research on the Value and Practice of STEM Curriculum Teaching Activities in Kindergartens

Yan Liu[1], Yuanbing Liu[2,*]

[1]*Furong College, Hunan University of Arts and Science, Changde 415000, Hunan, China*
[2]*Continuing Education College, Hunan University of Arts and Science, Changde, Hunan, 415000, China*
**Corresponding author*

Abstract: *STEM education (science, technology, engineering, and mathematics), as an interdisciplinary educational model, has received widespread attention in the global education system in recent years. For children in kindergarten, STEM education not only helps cultivate their scientific literacy, but also stimulates their curiosity, exploratory spirit, and creative thinking. This study adopts teaching methods such as case analysis, situational teaching, and game based teaching. Through on-site practice, learning in games, and exploring problems, science, technology, engineering, and mathematics elements are integrated into daily teaching activities. Scientifically based on the cognitive development characteristics of early childhood, STEM activity design principles that are suitable for their age groups are proposed. The article summarizes the experience accumulated in the practical process. A personalized teaching design should focus on the interests and comprehensive development of children, encourage teamwork, and scientifically evaluate the value of STEM teaching activities, providing valuable experience and feelings for other kindergarten teachers. Research has shown that science, technology, engineering, and mathematics have a positive promoting effect on children's cognitive development, scientific inquiry ability, and creative thinking in early childhood education.*

Keywords: *kindergarten, STEM education, instructional design, practical activities, cognitive development, creative thinking*

1. Introduction

With the rapid development of technology and the increasing demand for innovative talents, STEM education (science, technology, engineering, and mathematics education) has received widespread attention and promotion worldwide. STEM education not only emphasizes the learning of knowledge, but also focuses on cultivating students' innovative ability, critical thinking, and teamwork spirit in practical problem-solving. In recent years, the concept of STEM education has gradually entered China's education system, especially in kindergarten. As a critical period for children's cognitive development and ability cultivation, the introduction of STEM education has injected new vitality into traditional education models.

The kindergarten stage is an important period for children's development in various aspects such as language, cognition, hands-on ability, and social behavior. At this stage, the core goal of STEM education is not only to impart subject knowledge, but also to stimulate children's curiosity, cultivate their exploratory spirit and problem-solving ability through practical operation and exploration. Therefore, how to design and implement STEM activities that are in line with the developmental characteristics of children in kindergarten has become a focus of attention for educators.

Although STEM education is of great significance in kindergarten education, its practical implementation still faces many challenges. Firstly, many kindergartens have shortcomings in teaching resources, equipment, and teacher professional competence, making it difficult to carry out high-quality STEM activities; Secondly, the interdisciplinary integration of STEM education and the innovation of teaching methods have put forward high requirements for teachers' educational concepts and teaching skills; Thirdly, parents' cognitive biases towards STEM education may also affect their children's learning and growth at home. How to solve these problems and promote the effective implementation of STEM education in kindergarten is an urgent topic that needs to be explored.

This study focuses on four aspects: teaching objectives, activity content, implementation strategies,

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and evaluation methods, aiming to explore the teaching design and practice of STEM activities in kindergartens. In the research process, we follow the developmental characteristics, interest orientation, and emotional development needs of young children, and combine real teaching cases to design interdisciplinary and creative STEM activities in kindergartens. We strive to provide specific teaching frameworks and practical implementation plans for kindergarten teachers.

The aim of this study is to provide theoretical support and practical guidance for the implementation of STEM education in kindergartens, promote the widespread application of STEM education in China's kindergarten stage, advance the comprehensive development of children's qualities, and lay the foundation for the cultivation of innovative talents in the country in the future.

2. Theoretical basis and application background of STEM education in kindergartens

STEM education, as an interdisciplinary educational model, combines four fields: science, technology, engineering, and mathematics, aiming to cultivate students' comprehensive abilities, innovative consciousness, and problem-solving skills [1]. With the increasing global demand for innovative talents, STEM education has gradually become an important component of education systems in various countries. Especially in kindergarten, STEM education can lay a solid foundation for children's future development by stimulating their curiosity and exploratory spirit.

2.1 Definition and development of STEM education

STEM education originated in the United States with the initial aim of filling the global talent shortage in the field of science and technology [2]. STEM education not only focuses on imparting knowledge across disciplines, but also emphasizes interdisciplinary integration and the cultivation of practical skills. In STEM education, science and mathematics provide fundamental tools for understanding the world, while technology and engineering provide methods and ideas for solving practical problems. The core concept is to integrate knowledge and skills from these four fields into a unified teaching framework, emphasizing the cultivation of critical thinking, collaborative spirit, and innovative ability through practice, experimentation, and project-based learning, enabling students to solve practical problems.

The development of STEM education has gone through several important stages. The initial STEM education mainly focused on senior students, especially at the secondary and tertiary levels, in response to the employment demands and industrial changes brought about by technological advancements. However, as awareness of the importance of early education deepens, more and more education researchers are paying attention to introducing STEM education into kindergarten and primary school stages. In kindergarten, children's cognitive development has a sensitive period, which is a critical period for cultivating basic scientific thinking and exploratory interests. Therefore, the application of STEM education at this stage helps to stimulate children's interest in science, technology, engineering, and mathematics, laying a good foundation for subsequent learning.

2.2 The value of STEM education in kindergartens

In the kindergarten stage, kindergarten education emphasizes the comprehensive development of children, and the core value of STEM education is not only reflected in the imparting of knowledge, but also in the cultivation of children's comprehensive qualities, which is exactly in line with the goals of STEM education.

The value of STEM education in kindergarten mainly lies in the following three aspects. Firstly, early childhood is a critical period for cognitive development. STEM education cultivates children's hands-on skills by allowing them to borrow external learning aids, enabling them to perceive the world through their eyes, ears, nose, and hands, satisfying their curiosity and thirst for knowledge, and thus stimulating their interests and hobbies in fields such as science, technology, engineering, and mathematics. Secondly, STEM education cultivates children's critical thinking and problem-solving skills through project-based learning. In the project-based learning process, children actively participate in activities, and through teacher guidance, students actively explore real-life problems, learning to think from multiple perspectives and propose solutions. This undoubtedly greatly develops children's logical thinking ability. Thirdly, STEM education emphasizes the integration of disciplines, promotes the integration and application of interdisciplinary knowledge, and enhances their overall quality and cognitive abilities. Fourthly, STEM education also exercises children's social skills in division of labor,

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collaboration, communication, and coordination through group cooperation. Fifthly, STEM education places special emphasis on practical operations, and children's hands-on abilities and creativity are greatly enhanced through participating in activities such as handcrafting, model building, and scientific experiments.

2.3 Challenges and opportunities of STEM education in kindergartens

Despite the significant value of STEM education in kindergarten, there are still some challenges in its practical promotion and implementation, which provide educators with opportunities to promote the development of educational practices. Firstly, many kindergartens face the problem of insufficient educational resources, lacking sufficient scientific experimental tools, technical support, and teaching materials, which is a major challenge for kindergartens with limited funds. Secondly, the lack of professional competence among teachers is also a major challenge. Many kindergarten teachers mainly receive traditional single subject teaching training, lacking interdisciplinary knowledge and project-based, exploratory learning abilities for STEM education, which makes it difficult to achieve high-quality STEM education. Furthermore, some parents have misunderstandings about STEM education, believing that it is too complex or not in line with the teaching focus of kindergarten, resulting in insufficient support for their children's participation in STEM activities. Therefore, how to help parents correctly understand STEM education and support its implementation has become an urgent problem to be solved. Finally, STEM education emphasizes the integration between disciplines. In the actual teaching process, teachers need to balance the independence and integration between disciplines, integrate interdisciplinary teaching resources that children can understand and accept, and teach these knowledge to children through teaching methods that are in line with the cognitive development characteristics of 3-6 year old children.

With the increasing demand for innovative talents in society, the educational philosophy of national and local governments is also changing. More and more education policies, research, funding, and teacher training are being strengthened, providing policy and financial support for STEM education in kindergartens. At the same time, the rapid development of information technology and continuous innovation in educational technology have provided rich teaching resources for STEM education. Through technological devices (tools), multimedia resources, virtual laboratories and other technological means, teachers can design and implement STEM activities more efficiently, providing technical support for STEM education in kindergartens. In addition, the emphasis on cultivating innovative talents by the country and society, the active participation and interaction of parents, the strengthening of global education cooperation, and the sharing of valuable experience and inspiration from successful education cases have promoted the innovation of China's local education model and provided resource guarantees for the development of STEM education in kindergartens.

Overall, the development of STEM education in kindergartens faces challenges in terms of society, education funding, and interdisciplinary resource integration. However, with the changing educational concepts of schools and parents and the support of national policies, these opportunities provide strong support and guarantee for kindergartens to carry out STEM education.

3. Teaching design framework for STEM activities in kindergartens

3.1 Basic principles of STEM activity design

The basic principle of designing STEM activities in kindergarten is that all educational activities should conform to the growth and cognitive development laws of children, while also being interesting and informative [3]. Firstly, instructional design should follow the principle of child centeredness, focusing on the interests and needs of young children, considering their cognitive development level and exploratory ability, and encouraging them to gain a sense of achievement through independent exploration and hands-on practice. Secondly, the principle of comprehensiveness emphasizes the organic integration of subjects such as science, technology, engineering, and mathematics, avoiding their isolation and helping children understand the intrinsic connections between these subjects. In addition, the principle of interactivity requires STEM activities to focus on the interaction between teachers and children, as well as between children, and to cultivate children's communication skills and teamwork spirit through cooperative learning, group discussions, and other methods. The principle of practicality emphasizes the importance of hands-on operation, encouraging children to deepen their understanding of abstract scientific concepts through practical operations such as experimentation,

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construction, and design, and to combine theory with practice. Finally, the principle of openness emphasizes that activities should allow children to ask questions, explore multiple solutions, and stimulate their creativity and imagination.

3.2 Setting of teaching objectives

The setting of teaching objectives is a core part of STEM activity design. In STEM activities in kindergarten, teaching objectives include four dimensions: cognition, skills, emotions, and attitudes. Firstly, cognitive goals aim to help children understand interdisciplinary concepts in science, technology, engineering, and mathematics after acquiring knowledge. Through their own understanding and application in practical life, teachers comprehensively evaluate whether children have achieved specific results or standards in the cognitive process through observation, conversation, group comparison, and other methods. Secondly, skill objectives require us to not only focus on students' memorization and imitation abilities, but also to emphasize the cultivation of their observation, thinking, self-learning, experimentation, hands-on operation, and innovation abilities. Through experiments, construction activities, or simple calculations and measurements, they learn how to solve problems and master the ability to use basic tools and equipment. Emotional goals aim to stimulate children's interest and curiosity, allowing them to experience joy in exploration and innovation, cultivate a sense of achievement, confidence, and teamwork spirit. Finally, the attitude goal emphasizes cultivating children's scientific attitude, encouraging them to demonstrate a thirst for knowledge, patience, and a positive spirit of experimentation when facing problems, learning to accumulate experience through failure and success, bravely facing challenges, and constantly trying new methods.

3.3 Selection and arrangement of teaching content

The content of STEM activities should be closely integrated with children's life experiences, in line with their cognitive level and interests, ensuring that the teaching content is both interesting and challenging. The activity content should match the developmental level of children, for example, preschool children can start with simple natural phenomena (such as water flow, object movement, etc.) and basic mathematical concepts (such as numbers, shape classification). The content should be closely related to children's daily lives, such as observing the growth of plants or exploring the structure of buildings, helping children connect abstract scientific principles with practical life, and making them easier to understand and apply. When designing, attention should also be paid to interdisciplinary integration, and science, technology, engineering, and mathematics should be organically combined. For example, in designing and constructing small projects, children should not only use mathematical knowledge to calculate the quantity of materials, but also apply engineering principles to structural design, and verify the results through experiments. The difficulty of the activity should be gradually increased, starting with simple tasks and guiding children towards more challenging explorations. This can ensure children's sense of achievement and avoid losing interest due to overly simple content.

3.4 Teaching methods and strategies

The teaching methods of STEM education in kindergartens should be diversified, aiming to stimulate children's interest in learning through interaction, practice, and exploration. Common teaching methods and strategies include heuristic teaching, where teachers stimulate children's thinking and exploration desires through questioning, guidance, and inspiration. For example, open-ended questions such as "Why is this object floating on the water?" guide children to observe, experiment, and discuss, and stimulate their curiosity. Project based learning designs STEM activities as complete projects, allowing children to learn structural mechanics, mathematical calculations, and other knowledge during the actual construction of projects such as "bridges". Cooperative learning promotes children to explore problems and share tasks together through group cooperation, thereby enhancing teamwork spirit and social skills. Learning through situational simulation and games, integrating role-playing and story scenarios into fun games, helps children learn scientific principles in a relaxed and enjoyable environment, and cultivates creativity and imagination. Hands on operation, practice, and experimental teaching are the core of STEM education. Teachers encourage children to solve practical problems through hands-on experience, deepen their understanding of scientific principles, and continuously improve their problem-solving abilities. By combining these teaching methods and strategies, STEM activities in kindergartens can not only stimulate children's interest, but also effectively promote their knowledge and ability development in fields such as science, technology, engineering, and mathematics, laying a solid foundation for future deep learning.

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4. Strategies and suggestions for implementing STEM curriculum teaching activities in kindergartens

In the current educational context, the implementation of STEM education in kindergartens requires not only scientific educational concepts and effective teaching methods, but also strong strategies and support systems to ensure its smooth implementation.

4.1 Improve STEM education concepts and policy support

To promote the effective implementation of STEM education in kindergarten, it is necessary to first improve relevant educational concepts and policy support at the national and local levels. The government and education departments should introduce clear STEM education policies to encourage the integration of science, technology, engineering, and mathematics into daily teaching in kindergartens. At the same time, policy guidance and resource allocation for STEM education should be strengthened to ensure balanced development in different regions and schools. This not only includes establishing a special fund for the promotion of STEM education, but also developing specific evaluation criteria to ensure the quality and effectiveness of education. Through policy support and guidance, create a more favorable environment and conditions for STEM education in kindergartens, thereby stimulating active participation of teachers and students.

4.2 The path of teacher professional development

Teachers are the core elements of implementing STEM education, therefore, their professional development is the key to the success of STEM education in kindergartens. Kindergarten teachers not only need to have solid subject knowledge, but also need to master interdisciplinary teaching methods and skills. Therefore, establishing a comprehensive teacher training mechanism is crucial. Firstly, teachers should receive basic training related to STEM and understand the basic concepts and methods of STEM education. Secondly, in response to the teaching characteristics of kindergarten stage, regular vocational skills improvement and seminar activities should be carried out to help teachers master how to design and implement STEM activities in daily teaching. Thirdly, by organizing teachers to participate in training classes, learning exchanges, and workshops, we can enhance their innovative teaching abilities and problem-solving skills. Fourthly, promote cooperation and interaction among teachers, and achieve overall improvement of teachers' professional quality through team learning and experience sharing.

4.3 Optimizing teaching environment and resource allocation

A good teaching environment and sufficient educational resources are the foundation for the successful implementation of STEM curriculum teaching activities. In kindergarten, the rational allocation of teaching resources, optimization of the layout of physical spaces inside and outside the classroom, in simple terms, optimizing the teaching environment and rational allocation of teaching resources are key factors for the successful implementation of STEM curriculum teaching activities. Kindergartens should design learning areas suitable for children's exploration and practice based on the requirements and characteristics of STEM curriculum teaching activities, and equip them with corresponding learning tools and materials, such as science experiment areas, technology learning areas, engineering construction areas, mathematics game areas, etc., to meet children's needs for hands-on operation, experimentation, and exploration. In addition, in order to stimulate children's interest and potential, kindergartens should actively introduce modern educational technology resources, such as multimedia, intelligent learning tools, educational software, interactive whiteboards, etc. These tools can help teachers better organize classroom teaching and stimulate children's learning interest.

4.4 Construction of support system for family and society

The education of children is not only the responsibility of schools, but also the active participation and support of families and society. Children spend most of their time at home - this specific environment where they interact with their parents, their parents' values, knowledge reserves, and educational beliefs directly affect their learning interests and values. Therefore, schools should regularly organize parent training or parent teacher conferences to help parents understand the significance and methods of STEM education, encourage them to create a good learning atmosphere and conditions at home, discuss and solve problems with their children, and cultivate their exploratory

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spirit and cooperation ability.

The support of society cannot be ignored either. Society should provide more STEM education resources, such as community science popularization activities, visiting outdoor venues such as science museums, and inviting scientists or engineers into school classrooms. These activities can enhance children's practical perception and help them better understand how STEM knowledge can be applied in real life. In addition, social enterprises and research institutions collaborate with schools to provide expert and technical support, providing a broader development platform for STEM education.

5. Conclusion

STEM education plays a crucial role in the growth stage of young children. The design of STEM curriculum teaching activities in science can not only stimulate children's problem-solving psychology and curiosity, but also cultivate their creativity and critical thinking. By careful observation, hands-on operation, reflection and improvement, help children establish a preliminary understanding of science, technology, engineering, mathematics and other fields.

Scientific teaching design can promote children's multidimensional development, and STEM teaching activities provide them with a comprehensive and practical learning platform, allowing them to solve problems through communication, cooperation, and hands-on practice. This has a profound impact on the overall quality improvement and future learning ability development of children. Interdisciplinary integration integrates science, technology, engineering, and mathematics organically, enhancing children's subject interests and practical problem-solving abilities. The cooperative learning model enhances children's communication and teamwork abilities through group collaboration, promoting their social and emotional development. The dynamic evaluation mechanism focuses on learning and growth during the process. Through multidimensional evaluation, teachers can optimize teaching strategies, ensure that each child receives personalized support, and thus improve teaching quality.

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