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The Impact of Project-Based STEAM Exploring on First-Year Preschooler's Imagination

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Abstract

The significance of STEAM education in early years has drawn great attention in recent years. However, there is lack of empirical studies to understand the relationship between STEAM education and children's imagination since early years is critical for the development of children's imagination. The purpose of this study was to examine the impact of project-based STEAM exploration on the development of young children's imagination. A total of 41 first-year preschool children participated in the educational experiment. That is, a nearly one-semester experiment was carried out on STEAM project practice in natural classroom environment in preschool. The imagination of children from two first year classes was evaluated and compared with the "*Thinking Creatively in Action and Movement*" (*TCAM*) and the *Scientific Imagination Task* (*SIT*) which was developed in this study. It is founded that: 1) In terms of longitudinal changes in motor imagination, children's imagination in the class that implemented the STEAM project shows significant growth before and after the project was implemented ($p < 0.05$); children's imagination in the class that did not implement the STEAM project is in relatively stable state between the pre- and post-test. 2) The individual differences in motor imagination of children in practice class show a decreasing trend, while those in non-practical class show a widening trend. 3) There is no significant difference in the post-test of scientific imagination between children in practical and non-practical classes. These results indicate that STEAM project practice has a certain significant impact on children's imagination. Findings from this study provide insight into how to bridge research and practice around supporting preschool children's imagination.

Keywords

Project-Based STEAM Exploration, First-Year Preschool Children, Imagination

1. Introduction

Since STEAM education is proposed, many scholars believe that STEAM education has a huge potential. It is believed to help improve students' learning participation, creativity, innovation ability, problem-solving ability (Perignat & Katz-Buonincontro, 2019); it can help students meet the core competency challenges necessary in the 21st century (Sahin et al., 2024). Empirical exploration of the actual learning and development effects of STEAM has also emerged (Banerjee, 2016). For example, research found that STEM education based on the 5E model significantly improved students' creativity and academic achievements (Eroglu & Bektas, 2022; Shahbazloo & Mirzaie, 2023); the prepared STEM activities significantly improved children's creativity and problem-solving abilities (Yalçın & Erden, 2021). Scholars from China have also put forward positive expectations for STEAM education (Zhao & Lu, 2016; Mao, Wu, & Li, 2023). However, the learning effects of STEAM education were only discussed theoretically. As the concept of project inquiry is gradually integrated into STEAM education, what kind of learning implications do project-based STEAM inquiry have? What impact might STEAM project exploration have on children's development? Recently, there is very little empirical testing and systematic evidence accumulation to explore the possible potential of STEAM projects in preschool context.

Kuhn, a historian, and philosopher of science pointed out that scientific progress is not often through the accumulation of facts, but through imagination (Kuhn, 2022). Imagination is the source of scientific creation, it allows us to transcend reality and foresee the future (Poincaré, 2023). Active imagination is also critical to the development of individual creativity (Craft, 2001). Unfortunately, children's imagination nowadays is suffering from alienation and exhaustion. For example, among the 21 countries surveyed, Chinese students ranked first in terms of calculation ability, and last in terms of imagination (Cao, 2017). The China Association for Science and Technology and the China Science Popularization Institute conducted a survey on teenagers' creative imagination in 72 primary and secondary schools in nine provinces (municipalities) across the country. The total assessment score was 80 points, and the average score of students participating in the survey was only 29.97 points, which did not reach the passing mark (Shen, 2019). As the competition in science and technology among the world's major powers becomes increasingly fierce, achieving high-level self-reliance in science and technology, and building a strong country in education, science and technology cannot be separated from the solid foundation of scientific and technological innovation talents. As a result, the Central Committee of the Communist Party of China and the State Council have issued the "Outline for Scientific Literacy (2021-2035)", "Opinions of Eighteen Departments including the Ministry of Education on Strengthening Science Education in Primary and Secondary Schools in the New Era", and "Actions to Deepen the Reform of Basic Education Curriculum and Teaching" for three consecutive years. Policy documents such as "Plan" call for overcoming the phenomenon of simply teaching and studying knowledge, vigorously stimulating the curiosity and imagination of young people, and enhancing scientific interest, innovation consciousness and innovation ability (State Council of China, 2021; Ministry of Education of China, 2023a, 2023b). Children's education urgently needs the establishment of ontological value orientation of imagination, the protection of time and space of children's imagination, and build a good imagination ecology for children (Miao, 2024). In summary, it is of far-reaching significance to pay attention to the early development and cultivation of children's imagination in China. Especially scientific imagination in preschool STEAM education has rarely been mentioned either.

Based on above literature, the research question is proposed: what is the impact of quality STEAM project practice on first-year preschool children's imagination? Or whether the practice of the quality STEAM project has a significant influence on children's imagination? The research hypothesis is that quality especially high quality STEAM project exploration will propel the development of children's imagination (both their motor imagination and scientific imagination). This research might fill the gap in evidence on the learning effects of preschool STEAM project exploration from the perspective of imagination; it might provide reference for promoting preschool STEAM education on a high-quality track.

2. Method

2.1. Participants

Participants in this study were 52 children from two first-year public preschool classes in S city in China. Due to sometimes one or several children do not come to preschool, some children participated in the pre-test but not the post-test, or the opposite, a total of 18 children (11 boys and 7 girls) completed the pre- and post-test in the STEAM-practice class. A total of 23 children (14 boys and 9 girls) completed the pre- and post-tests in the non-STEAM practice class. In total, 41 first-year preschool children were included in this study. They were from two groups: the STEAM-practice group (the experiment class) and the non-STEAM practice group (the control class). All participants provided informed consent through their parents, preschool teachers, and the principal prior to their participation in the study.

2.2. Practice Process

Based on the previous theoretical exploration of high-quality preschool STEAM education (Peng, 2023a, 2023b), this study developed a STEAM project suitable for preschool children to explore. It originated from the cutting-edge real question "How do we 'ask' nature to develop highly integrated, intelligent, repairable bionic systems?" (Sina Science and Technology Comprehensive, 2021) which can also be understood as: "How can we learn from the nature (or how can we learn from animals and plants around us?)" "How can we learn the magical skills or typical characteristics of animals and plants to design or make reusable items?" Based on this, the STEAM bionic project "How to learn from nature" was initially formed. Combine children's interests, concerns, questions (e.g., what are the powerful skills of kittens/bats? What can we learn from lotus leaves? Can we design different houses/skirts like…? What objects in life are "imitated" small animals or plants, etc.), dynamically generating the problem space and project activities for the project's progressive exploration.

In the preschool, all first-year classes are going to implement project-based curriculum this semester. Therefore, we randomly selected one class as project-based STEAM exploration class (STEAM-practice class, the experiment group), the others just followed project-based curriculum, and then we also randomly selected one class as non-STEAM practice class (the control group). In consideration of the challengeable work of project-based STEAM exploration, the practical STEAM class is led by researchers, and the class teachers are fully involved during the process, conducting quasi-experimental research in natural classroom environment.

The project exploration and practice ultimately lasted nearly one semester and included a variety of STEAM exploration activities, such as: 1) "Widening Horizon: Bionics Around You". Through multi-channel and multi-modal presentation of typical phenomena, children can experience the powerful or amazing capacities of animals and plants around them and their bionic applications in life. 2) "Little Investigator". Let young children, with the help of their parents, observe, inquire, and record items at home that are made by "imitating" the animals and plants around them. 3) "To Seek Friends". By presenting a series of "animals and plants-bionic applications" pictures to children, let them connect to "find friends" or pair up to "find friends." 4) "Let Me Try". For example, blindfold the children and let them experience the difference between ordinary wooden sticks and guide canes. 5) "Little Science Experiment". Such as testing the bearing capacity characteristics of ostrich eggshells. 6) "Smooth Imagination Design and Production". For example, children can be presented with "hide-and-seek" clothing designs in specific situations; or materials and tools can be provided to allow children to imagine, design and make their favorite items (such as learning from Morning Glory to design skirts and make hats, etc.). At the end of each activity, questions and communication and summary activities were provided.

2.3. Measures

Imagination is a cognitive mechanism that promotes the emergence of new ideas (Magid, Sheskin, & Schulz, 2015). Human imagination can bridge "images" and "ideas," makes analogies between things that had not previously seemed connected and enables a process of crystallizing mental images (Liu & Noppe-Brandon, 2009; Vygotsky, 2004). Combining the nature of imagination, this research adapted two instruments to examine children's imagination.

2.3.1. TCAM

Based on one of imagination test tasks of the "Thinking Creatively in Action and

Movement" (TCAM) developed by Torrance (Torrance, 1981) to assess children's imagination. Select the task of pretending to be a rabbit, that is, "If you are a little white rabbit and imagine someone is chasing you from behind, what will you (the little rabbit) do? (Can you make movements like a rabbit?) What do you want to do? You can do (actions). "Imagination uses a five-point score to evaluate whether the actions performed by children fit the corresponding scene. If there is no/no response, score 1 point; if there is an effort to make a movement but the movement (including language) cannot be discerned, score 2 points; if there is consideration and imagination of the situation and role, fine movements and description of language and expression, etc., score 5 points. The minimum is 1 point, and the maximum is 5 points. The higher the score, the higher the level of imagination.

2.3.2. SIT

The Scientific imagination is a combination of "science" and "imagination" and is the application of imagination in the scientific field (Wu, 2022). It is the ability to construct images in the mind, generate ideas, and materialize these mental processes in inventing or creating objects and products (Wang et al., 2014). Based on the essential connotation of the concept, a scientific imagination assessment task of "Animal and Plant Prototypes-Bionic Applied Imagination" was developed and simplified Scientific imagination Task (SIT). The measure's specific operation is as follows: firstly, to give 2 prototypes-examples of the application of imagination, confirm that children understand and then give test tasks, and objectively record children's reactions. For example, presenting prototypes-example 1, "Birds can fly particularly high through their spreading wings. People invented airplanes by imitating how birds fly." Prototypes-example 2, "This is a picture of a typical mushroom that we eat and see in daily life. People made pavilions, stools, lamps, etc. imitating the appearance of the mushroom." Then Show 5 pictures of animals and plants that are familiar to children (such as eggs, kittens, lotus pods, sunflowers, etc.), and ask them to choose one which they like the most. Then ask them: How can people learn from it? How to make beautiful or useful items by imitating it? Children can say whatever comes to mind, and the more they said, the better. [1 opportunity of changing and reimagining]

Scoring criteria: Objectively record what the children said. Referring to the TCAM scoring rules, 1 point is granted for no response; if the characteristics of the selected animal/plant was described, 2 points are granted; explanation of the uses of the animal/plant that does not involve bionic applications will be scored as 3 points; each reasonable bionic application name is worth 4 points (two are worth 8 points, and so on). The higher the score, the higher the level of scientific imagination.

The above tasks were administered one-on-one by the researchers in a quiet activity room. Keep paper and pencil records and process video throughout the entire process.

3. Results

3.1. Descriptive Analysis of First-Year Preschool Children's Imagination

The Torrance Motor Imagination Task was used to evaluate the imagination of 41 children. 3 children score 1 point (7.3%), one person scores 2 points (2.4%), and 36 children score 3 points (87.8%), and one person scores 4 points (2.4%). The scores are more concentrated in the 3-point area. The average score of children's motor imagination is 2.85 (the maximum score is 5 points), and the standard deviation is 0.57 (the minimum value is 1, the maximum value is 4). Among them, 25 boys have an average score of 2.76 (standard deviation 0.66), and 16 girls have an average score of 3.00 (standard deviation 0.37). The independent sample T-test shows that t (39) = 1.32, $p = 0.194 > 0.05$, and the gender difference is insignificant.

3.2. Longitudinal Changes of First-Year Preschool Children's Imagination

A pre-test comparison of children's motor imagination in different classes was conducted to provide a reference for whether there are differences in children's imagination at the starting points. Using the independent sample t test, we found that motor imagination pretest t (39) = 1.31, $p = 0.10 > 0.05$. It shows that there is no significant difference in children's imagination between STEAM bionic project practice class and the non-practice class in the pre-test. Then, a comparative analysis was conducted on the longitudinal changes in the motor imagination of children in practice class and non-practice class (see **Table 1**). Examine whether the imagination of children in different classes has changed and whether the change is significant. Thus, we can determine whether the implementation of the STEAM bionic project has an impact on the development of children's imagination.

Table 1. The changes of children's imagination in different classes.

Classes	Pre-test	Post-test	t	*p*
Practice class	2.72 ± 0.83	3.39 ± 0.61	2.38	0.029
Non-practice class	29.6 ± 0.21	3.26 ± 0.81	1.67	0.110

The paired sample T test shows that there is a significant difference between the pre- and post-test in motor imagination from practice class, t (17) = 2.38, $p = 0.029 < 0.05$. Combined with the mean M pretest = 2.72 and M posttest = 3.39, it shows that the posttest score is significantly higher than the pretest. That is to say, the motor imagination of first-year preschool children in the practice class has increased significantly. Then a pre- and post-test comparative analysis was conducted on the imagination of children in non-practice class. **Table 1** shows that the average score of the post-test on motor imagination is slightly higher than that of the pre-test, M pre-test = 2.96, M post-test = 3.26. The paired sample T test shows that there is no significant difference between the pre- and the post-test on children's motor imagination in non-practice class. T (22) = 1.67, $p = 0.110 > 0.05$. That is, there is no significant growth or change of children's imagination.

Further, analyze the changes in individual differences between the two classes from the standard deviation and full range description. Table 2 shows that in terms of motor imagination performance, the standard deviation and full range of children in practical class show a shrinking trend; the standard deviation and full range of children in non-practical class show an expanding trend.

Table 2. Descriptive statistical analysis of pre-and post-tests for children in two classes.

	Classes	Pre-test		Post-test	
		Range	SD	Range	SD
Motor	Practice class	3	0.83	2	0.61
Imagination	Non-practice class	1	0.21	3	0.81

3.3. Comparation of First-Year Preschool Children's Scientific Imagination

At the end of the project practice, the scientific imagination of the children from two classes was evaluated and compared. Table 3 shows that the average scientific imagination score of children in the practice class is 3.06, and the average scientific imagination score of children in the non-practical class is 3.81. The average score in the non-practical class is slightly higher than that of the practical class. The paired sample t-test showed that t (15) = 0.79, $p = 0.445 > 0.05$, indicating that there is no significant difference in scientific imagination performance between children in practical class and non-practical one.

Table 3. Comparison of post-test on scientific imagination of children from two classes.

Classes	N	Scientific Imagination					t	*p*
		Min	Max	M	SD	Range		
Practice class	16	1	9	3.06	2.84	8	0.79	0.445
Non-practice class	16	1	9	3.81	1.91	8		

4. Discussion

Many educators seem to agree that imagination is at the root of how human beings modify their material world (Yueh, Chang, & Liang, 2013). It is a force that opens possibilities. An individual's imagination begins to develop quietly from infancy (Fragkiadaki et al., 2021), and the preschool stage is the stage when children's imagination is the most abundant and active (Li, 2023). Understanding the development of children's imagination is an important prerequisite for the care and cultivation of their imagination. Current empirical research on the development of imagination in preschoolers is extremely limited. Research from China has found that the development of children's imagination shows an upward trend with age (Li, 2023; Lian, 2013); first-year preschool children have significantly lower imagination scores (Lian, 2013). This study also found that the average motor imagination score of children was 2.85, with the highest task score of 5 points, and the children's scores were close to the critical level. Children who scored 4 points or above were in single digits, and most children scored 3 points. Children who are at the beginning of their preschool life may be in the budding stage of imagination development. Once it begins to sprout, there may be a rapid development trend behind it. It is worth paying attention to the protect and cultivation of children's imagination during this period to avoid randomness or neglect in education.

Project inquiry is a process of inquiry into complex, real-life problems (Buck Institute of Education in the United States, 2008). The Reggio Emilia curriculum believes that project design can help children gain a comprehensive and in-depth understanding of things and phenomena worthy of their attention in their surrounding environment and experiences (Edwards et al., 2006). A good real-life problem can develop a good STEAM inquiry project (Peng, 2023c). Children live in nature, which is the source of human life and wisdom. How to get inspiration from nature's methods of adapting to the environment, overcoming numerous crises, and solving problems, and finding innovative solutions to the urgent and difficult real-life problems of human society deserves in-depth exploration. This study uses current real-life problems as a carrier to form a STEAM bionic project suitable for children's exploration—pointing to the real problem of "how do we learn from nature"; at the same time, the design of the project and its activities is based on early exploration as a theoretical basis; the project is implemented in practice Incorporating the experience and wisdom of kindergarten class teachers. The above efforts ensured the overall quality of the project to a certain extent.

After nearly a semester of exploring and practicing the STEAM bionic project, the study found that the motor imagination of children in the practice class showed significant growth and changes before and after the implementation of the project; while the imagination of children in the class that did not implement the STEAM project did not show significant growth and changes. This result shows that quality STEAM bionic project practice has a certain positive effect on children's imagination. The results of this study are consistent with existing research in exploring the effects of STEAM education or STEAM project exploration on children's learning and development. For example, some studies have found that STEM activities significantly improve children's creativity and problem-solving abilities (Yalçın & Erden, 2021); implementing STEM project activities is conducive to cultivating children's problem-solving abilities (Gao, 2022); STEM project-based learning activities can promote children's creativity (Yang, 2022). These findings have important implications for the inquiry practice of preschool STEAM projects.

How to reduce early childhood gaps or academic gaps through support and intervention has always been a hot topic in international academic research and all sectors of society (Hindman et al., 2016). Some studies have found that individual differences in the development of children's early social abilities show great stability (Santos et al., 2014). How to find effective methods and strategies to avoid the continued widening of the gap in early development deserves unremitting exploration by the academic community. In this study, the individual differences in the development of motor imagination of all children are pronounced. However, the study found an interesting phenomenon, that is, the individual differences in motor imagination of children in classes that implement STEAM projects tend to be smaller than those in children in classes that do not practice. Individual differences in imagination are on the rise. The research reveals to a certain extent that quality or high-quality STEAM project inquiry practices may narrow the gap in early development. In theory, high-quality educational and teaching activities or environmental creation should help each child find space and development opportunities, instead of being ignored or left behind. However, how to truly make STEAM project exploration benefit every child, so that all children are interested in, participate in, and actively explore, etc. This is a challenge facing the practical field.

The study found that there is no significant difference in the scientific imagination between children in practical class and children in non-practical class. It reflects that there is a certain imbalance in the impact of STEAM project inquiry practice on the imagination of first-year preschool children. At the same time, the occurrence of this result may be related to the difficulty of the SIT developed. For example, in this study, the overall performance of first-year preschool children in scientific imagination is average, and less than half of the children (43.8%) tend to show scientific imagination. While the current research on scientific imagination is mainly aimed at elementary or middle school students or above, there is no assessment tools for preschool children's scientific imagination. This study initially developed a picture assessment task for children's scientific imagination. On the one hand, future research needs to further test the reliability and validity of the task; on the other hand, it can examine older children in preschool, and then explore the relationship between high-quality STEAM project exploration and the development of children's scientific imagination.

5. Limitations and Future Research

Several limitations may exist in the present study. First, the sample was small, and the analyses may have been underpowered at this level. In addition, though we have conducted pre-research to test the appropriate of scientific imagination task (SIT), the task which was developed in the study still need fully valid evidence in future. Thus, an important direction for future study is to examine and modify the measurement of SIT or to develop another assessment tool for young children's scientific imagination since there is lack of such kind of tools for very young children.

It has found that there is significant effect of STEAM project exploration on first-year preschool children. Whether this influence is more prominent and positive among children in the following two years in preschool deserves further exploration in future research. At the same time, future research can integrate daily situations to observe and collect evidence of the changes and development of children's imagination, and then re-test the findings of this study to truly discover possible patterns. It is worth mentioning that in addition to the kindergarten STEAM project exploration activities, children's imaginative behavior or imaginative performance is closely related to the classroom environment where children are immersed in daily activities and the daily small interactions between teachers and children. As some scholars have pointed out, Chinese children do not lack the potential for imagination, but lack the time, space and situation for the generation of imagination (Zhang & Chen, 2019). Therefore, in the exploration and practice of STEAM projects, updating teachers' original educational concepts, especially how to ensure that scientific and reasonable concepts are integrated into daily interactions, is also a focus that needs to be paid attention to in future research and practice.

6. Conclusion

Through this study, we have got to know that the imagination of first-year preschool children in the survey is generally close to the medium level; project-based STEAM exploration has a certain role in promoting children's imagination; that is, the impact is mainly on first-year preschool children's motor imagination but not scientific imagination. In summary, the main conclusion of this study is that the prepared high-quality STEAM project exploration activities have a significant impact on the imagination development of first-year preschool children.

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Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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