

Article

An Action Research on Project-Based Science Inquiry Activities for Junior Class in Kindergarten

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Abstract: This study adopts action research to explore project-based science inquiry activities for kindergarten junior class. Based on constructivism, Piaget's cognitive development theory and Vygotsky's sociocultural theory, three rounds of "planning-implementation-observation-reflection" cycles were carried out in a Qingdao kindergarten around children's interest-driven themes: The Changing Moon, Ants, and Magical Rainwater. Research data were collected via classroom observation and interviews with teachers and the principal. The results indicate that project-based learning can boost young children's scientific inquiry motivation and develop their observation, expression, cooperation and preliminary reasoning skills. It also facilitates teachers' role transformation and promotes in-depth home-kindergarten collaboration. Nevertheless, several deficiencies remain in practice, including inappropriate material arrangement and inadequate differentiated support. Corresponding educational strategies are proposed. This research proves the feasibility of project-based learning in junior-class science activities and offers practical references for preschool science education.

Keywords: project-based learning; kindergarten junior class; scientific inquiry activities; action research

1. Problem Statement

In recent years, the focus of preschool education reform lies in cultivating core competencies. As a critical factor for children to understand the world, scientific inquiry competence exerts a direct influence on children's lifelong development and learning. The report to the 20th National Congress of the Communist Party of China clearly proposes to "strengthen the inclusive development of preschool education" and "accelerate the development of a high-quality education system". It regards preschool education as an important foundation for building an education powerhouse, and emphasizes the development of competency-oriented education and the cultivation of innovative spirit and practical capabilities, pointing out the direction for preschool education reform.

Project-based learning is theoretically rooted in constructivism, Piaget's theory of cognitive development, Vygotsky's sociocultural theory and other theories. It has the following characteristics: it is interest-oriented, focuses on research into a specific question, values hands-on operations, and adopts small-group cooperative learning. During this process, teachers need to document and reflect on children's learning, encourage children to present their outcomes in diverse forms and conduct multi-dimensional evaluation [1]. Project-based learning can be completed individually or in small groups, breaking the constraints of the traditional whole-class teaching model. It transforms teachers from knowledge transmitters into observers, instructors and partner-like learners. This teaching approach is practice-based; children acquire direct experience through personal practice and experience.

2. Process and Analysis of Action Research

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This study mainly adopts the action research method and introduces the philosophy of project-based learning into science inquiry activities for junior class in kindergarten. The research revolves around three themes generated from children's genuine interests: The Changing Moon, Ants, and Magical Rainwater. Each theme is designed following the basic logic of project-based learning: inquiry themes emerge from children's questions and prior experience; activities are carried out through group conversations, observational experiences, hands-on practices, game interactions and home-kindergarten cooperation. Reflections and adjustments are made after activities, forming a cyclical improvement process of "planning - implementation - observation - reflection".

2.1. Research Preparation

The research selects Class 4, Junior Grade of Kindergarten X as the research subject, including 11 boys and 13 girls. Located in Qingdao, Shandong Province, Kindergarten X is a municipal demonstration kindergarten with high-quality operation and abundant teaching staff. The kindergarten attaches great importance to science education and has established a science teaching research group to conduct activity teaching, classroom observation and curriculum discussion, fostering a harmonious research atmosphere. Four teachers are randomly selected from the junior classes of Kindergarten X in Qingdao as interviewees, namely one teacher from each junior class, forming a total of four teacher interviews. Meanwhile, an interview is conducted with the kindergarten principal regarding the implementation of project-based teaching in the kindergarten.

2.2. Research Implementation Stage

Preschool teachers should reflect on and explore in daily teaching practice, identify and solve problems through personal experience and perception [2]. Adopting the action research method, this study integrates project-based learning into science inquiry activities for junior class in kindergarten. Three inquiry themes, namely The Changing Moon, Ants, and Magical Rainwater, are developed based on children's real interests. Following the cyclical improvement model of "planning - implementation - observation - reflection", activities start from children's questions and prior experience and are promoted through group conversations, observational experiences, hands-on practices, game interactions and home-kindergarten cooperation to continuously optimize science inquiry activities.

2.3. Round 1 Action Research: The Changing Moon

2.3.1. Theme Rationale

The first theme is generated based on children's festive experience of the Mid-Autumn Festival and natural curiosity. The research is carried out around the Mid-Autumn Festival. Children have intuitive life experience of the moon, mooncakes and family reunion. Their experience of observing the moon at night and listening to moon-related stories arouses strong curiosity about lunar phase changes. This theme conforms to the concrete thinking characteristics of junior kindergarten children and effectively connects scientific inquiry with life experience.

From the perspective of project-based learning, the theme is highly open-ended. It not only covers the core scientific phenomenon of changes in the moon's appearance, but also extends to Mid-Autumn Festival culture, night observation, the relationship between the sun and the moon, home-kindergarten co-observation and other content. Instead of instilling knowledge directly, teachers guide children to raise questions based on their existing experience, making this theme an ideal starting point for the practice of project-based learning.

2.3.2. Activity Planning and Preparation

At the preliminary research stage, the design should take children as the main body, and responsibilities should be defined while work is carried out on the basis of teacher-child interaction. If teachers dominate activities, children's motivation for active exploration and hands-on operation cannot be stimulated [3]. Researchers and cooperating teachers jointly formulate the plan: understanding children's prior

knowledge of the moon through conversations; drawing a theme network centering on children's questions, including the Mid-Autumn Festival, changes of the moon, moon shapes, the sun and the moon, and The Moon in My Eyes; preparing lunar phase pictures, stickers, painting materials, night observation record sheets and other resources; designing home-kindergarten parent-child observation tasks to encourage parents to observe the moon with their children at night and keep records.

Three-dimensional activity objectives are set: first, to guide children to observe different shapes of the moon and perceive lunar phase changes; second, to stimulate children's curiosity about natural phenomena and encourage active questioning and expression; third, to develop children's observation, expression and hands-on abilities through observation, games and creation.

2.3.3. Activity Implementation

The activity starts with a conversational lead-in. The teacher asks, "Have you ever seen the moon? What does the moon look like?" Children share their life experience such as "the moon is round" and "the curved moon looks like a mooncake", and put forward core questions including "Why does the moon change?" and "What is on the moon?", which serve as key clues to promote the activity.

In the observation and inquiry session, the teacher presents pictures of full moon, crescent moon and half moon, and guides children to perceive differences with daily language, for instance, "The moon is round like a mooncake and curved like a small boat". Professional knowledge of lunar phases is not explained to match the cognitive level of junior class children.

In the game session, a physical imitation game Imitate the Changing Moon is organized. Children use body movements to show full moon and crescent moon with great enthusiasm. However, some children have weak awareness of rules, resulting in chaotic movements and poor classroom order.

In the creation session, night sky background boards, moon stickers and star stickers are provided for children to paste freely. Nevertheless, the excessive supply of full moon stickers and insufficient crescent stickers lead to limited diversity and monotonous expression in children's works.

A home-kindergarten observation task is assigned as activity extension, extending inquiry from kindergarten to family and helping children continuously observe natural phenomena in real scenarios.

2.3.4. Observation and Reflection

Children show strong interest in the theme and actively share experience in conversations, participating enthusiastically in games and creation. It proves that life-related themes can effectively stimulate children's learning motivation [4].

Deficiencies exist in the activity: first, rules are not explained clearly; children fail to understand requirements and classroom order is hard to maintain. Second, materials are imbalanced and single-type materials restrict creative expression. Third, peer communication is insufficient; the activity is dominated by teachers as collective participation, and children's interaction is superficial. Fourth, teachers respond rigidly, over-relying on preset plans and ignoring children's emergent questions.

Based on reflections, adjustments are proposed for subsequent activities: clarify and demonstrate rules before activities; enrich materials with hierarchical and optional choices; set up more sessions for children to share and communicate; pay attention to children's real questions and strengthen the emergent nature of activities.

2.4. Round 2 Action Research: Ants

2.4.1. Theme Rationale

The theme originates from children's spontaneous discovery during outdoor activities. Children accidentally spot ants in the grass, gather to observe and raise questions. The teacher captures this educational opportunity and transforms this temporary interest into a systematic inquiry theme.

The theme is inherently emergent and fits the core concept of project-based learning of "taking children's interest as the priority". Ants are common insects in daily life, easy for direct observation. Although children have perceptual impressions, they know little about ants' body structure, living habits and food sources. It is convenient to organize outdoor observation, group discussion, artistic expression and other inquiry activities, with strong practicability.

2.4.2. Activity Planning and Preparation

After determining the theme, the teacher sorts out children's prior experience through group conversations and draws a theme network covering ants' appearance, habitat, food, behaviors and companions around children's questions. Materials including ant observation boxes, high-definition pictures, picture books, colored pens, plasticine and stickers are prepared. Safety rules for observation are agreed with children: do not touch ants randomly and wash hands after observation.

Activity objectives for this round: help children recognize ants' body structure of head, thorax, abdomen and six legs; stimulate interest in insect inquiry and cultivate careful observation habits; develop scientific expression and hands-on abilities; support children to explore answers and experience the joy of inquiry.

2.4.3. Activity Implementation

The activity begins with a riddle: "Little bug, crawls around; two thin whiskers on its head; queues up to carry rice back home." Children quickly guess it is the ant. Afterwards, they share experiences of seeing ants on grass, at gateways and in flower beds. The teacher extracts inquiry questions: What do ants look like? What do ants eat? Where is the ant's home?

In the observation and inquiry session, observation boxes and high-definition pictures are used to guide children to identify ants' body parts. Simple language is adopted: "Ants have two antennae like small antennas to communicate with companions." Children are highly interested and can point out different body parts.

The game Ants Carrying Beans is designed. Children act as ants and imitate crawling, carrying food and queuing home to understand ants' behaviors through fun.

In the creation session, colored pens, plasticine and stickers are provided for children to draw, model or collage ants. However, excessive types of materials cause some children difficulty in selection and slow down the activity pace. Children's works vary greatly: some clearly show ant structure while others are free scribbles.

A home-kindergarten task is assigned for extension: parents accompany children to observe ants safely, record ants' food preferences and guide children to protect small creatures.

2.4.4. Observation and Reflection

Compared with the first round, the second round achieves remarkable progress. Rooted in children's real discovery, the theme enhances children's initiative for inquiry and natural participation. Children can carry out continuous inquiry on ants' appearance, food and habitat, achieving preliminary in-depth learning on the theme. Teachers respond more flexibly and are capable of converting children's questions into activity resources.

Existing problems: excessive creative materials distract children; differentiated guidance is insufficient for children with weak abilities; children's space for independent inquiry remains limited with obvious teacher dominance; feedback on home-kindergarten tasks is incomplete as some parents fail to keep complete records.

Subsequent adjustments: simplify operation materials to avoid distraction; provide differentiated support according to children's developmental levels; reduce direct lecturing by teachers and expand space for independent observation and expression; optimize home-kindergarten recording methods and improve parents' participation quality.

2.5. Round 3 Action Research: *Magical Rainwater*

2.5.1. Theme Rationale

The theme arises from a real rainy-day situation. It rains on the activity day. Children catch raindrops, observe puddles and discuss the causes of rain upon arrival at kindergarten. The teacher seizes this vivid educational opportunity and sets Magical Rainwater as the theme.

The rainwater theme is highly comprehensive, connecting natural phenomena, life experience, scientific experiments and environmental education. Junior class children have perceptual experience of rain, umbrellas and puddles, yet they have vague understanding of rain formation, whereabouts and functions. It is suitable to carry out observation, experiments and discussions in real contexts, matching the inquiry characteristics of junior kindergarten children.

2.5.2. Activity Planning and Preparation

The teacher sorts out children's core questions: Where does rain come from? Why does it rain? Where does rainwater go? Can rainwater be drunk? A theme network is built including the origin of rainwater, whereabouts, functions, protection on rainy days and water conservation. Rain sound audio, rain pictures, short videos of rain formation, small water tanks, plant models and watering cans are prepared. Simulated experiments of rain falling and watering plants are designed.

Activity objectives: help children perceive rainfall as a natural phenomenon and preliminarily understand the origin and whereabouts of rainwater; stimulate interest in exploring natural phenomena and encourage active expression of discoveries; develop observation, expression and simple reasoning abilities; help children know rain nourishes plants and build initial awareness of water conservation.

2.5.3. Activity Implementation

The activity starts by playing rain sound audio to create a rainy scenario. The teacher asks: "What sound do you hear? What can you see when it rains?" Children share experiences of holding umbrellas, wet ground, wearing raincoats and plants getting wet. The teacher compiles a list of experience and introduces inquiry questions.

In the observation and inquiry session, pictures and short videos are used to explain rain formation in simple language: "Tiny water vapor gathers in the sky to form clouds. When water droplets grow heavier, they fall down as rain." Children intuitively perceive where rain comes from without mastering complicated meteorological knowledge.

In the experiment session, simulated rainfall is conducted: a water tank simulates the ground and a watering can simulates rain. Children observe water flowing to low-lying areas, watering plants and flowing into ditches, thus understanding the whereabouts of rainwater and establishing the cognition that rain nourishes flowers, grass and trees.

The game Raindrops Falling is designed. Children play raindrops and fall slowly with music onto grass, flowers and ditches, deepening their understanding of rainwater's whereabouts in the situational game.

In the discussion session, children are guided to think about the functions of rainwater. They mention rain can water flowers, trees and grass. The teacher further introduces the concept of water conservation, helping children form preliminary perception combined with life experience.

A home-kindergarten observation task is assigned as extension: parents observe rainy conditions and post-rain changes with children, record puddles and wet plants to continue inquiry experience.

2.5.4. Observation and Reflection

The third round of activities tends to be mature. Themes are generated naturally as teachers accurately capture life interests and transform them into curriculum resources. Activity scenarios are coherent with smooth transitions from lead-in, observation and experiments to games. Children express ideas actively and conduct simple reasoning around rainwater. Classroom order is improved and children's awareness of rules is greatly enhanced.

There is still room for improvement: too much verbal explanation about rain formation; more direct observation opportunities should be provided. Some children only watch in experiments and full participation needs to be guaranteed. Water conservation education is weakly connected with children's daily life, leading to insufficient personal experience. The completion quality of home-kindergarten tasks varies; requirements need to be clarified and guidance refined.

Overall, the three rounds of action research show progressive optimization. The first round focuses on theme introduction and preliminary attempts. The second round centers on children's real interests and operational experience. The third round achieves comprehensive maturity in situational creation, children's expression, activity organization and home-kindergarten cooperation. It verifies the high compatibility between project-based learning and junior class science inquiry activities.

3. Research Outcomes

3.1. Comprehensive Development of Children's Inquiry Competence

Project-based learning transforms children from passive knowledge receivers into active inquirers. Their abilities in observation, verbal expression and peer cooperation are significantly improved [5]. Children can observe the features of lunar phases, ants and rainwater attentively, clearly express discoveries and questions, and cooperate actively in games and creation. Meanwhile, simple reasoning ability develops initially. For example, they can infer "the ground becomes wet after rain" and "ants carry food back home", marking the transition from intuitive perception to preliminary thinking.

3.2. In-Depth Transformation of Teachers' Roles

Teachers change fundamentally from "knowledge lecturers" into observers, supporters, facilitators and curriculum constructors. They sensitively capture educational opportunities such as ants found outdoors and rainy days, and grasp children's interests accurately. Instead of providing ready-made answers, teachers support inquiry by offering materials and creating situations. They dynamically adjust activity pace, materials and questioning strategies according to children's responses and flexibly handle emergent questions, achieving continuous professional development.

3.3. Curriculum Organization Returns to the Authenticity of Life

Abandoning the drawbacks of traditional science activities which are divorced from life and filled with abstract indoctrination, project-based learning takes common things in daily life including the moon, ants and rainwater as carriers. Scientific inquiry is integrated into real observation, experience and expression, matching the cognitive characteristics of junior kindergarten children. Meanwhile, diversified activity forms are realized, combining conversations, observation, games, experiments and home-kindergarten cooperation to support children's development in multiple dimensions.

3.4. Home-Kindergarten Cooperation Achieves In-Depth Collaboration

Home-kindergarten cooperation upgrades from "routine coordination" to in-depth joint inquiry. Parents are no longer simple material preparers, but companions and co-learners of children's inquiry. Parents and children observe the moon, ants and rainwater together, record discoveries and answer questions. It not only expands the space for science education, but also enhances parent-child communication and forms a joint force for home-kindergarten education.

4. Educational Suggestions

4.1. Renew Educational Concepts and Focus on the Inquiry Process

The core of science education for junior kindergarten children is to protect curiosity and cultivate inquiry awareness rather than to teach concepts. Teachers should reduce didactic lecturing and increase opportunities for children to observe, operate and experience. Take children's questions as core inquiry resources [6]. Do not rush to give

answers. Guide children to discover independently and tolerate incomplete or wrong findings during inquiry, supporting children instead of preaching.

4.2. Improve Professional Competence and Optimize Activity Design

Kindergartens should strengthen training on project-based learning for teachers and enhance their abilities in observation, emergent curriculum development, activity organization and home-kindergarten communication. Five principles should be followed in activity design: themes are close to life and suit junior children's cognition; objectives emphasize process experience rather than knowledge mastery; content is open and adjustable; materials are hierarchical without causing distraction; evaluation focuses on participation process rather than final works [7].

4.3. Create Inquiry-Oriented Environment and Vitalize Space Resources

Make full use of classroom space to build nature corners, observation zones, material zones, recording zones and sharing zones, integrating inquiry into daily life. Provide life-oriented, safe and operable materials such as natural objects, recycled waste and observation tools. Update materials in a timely manner to avoid reduced interest caused by unchanged materials.

4.4. Deepen Home-Kindergarten Collaboration and Expand Educational Boundaries

Actively communicate project-based learning concepts to parents through parent meetings, online communication and task sheets, guiding parents to become inquiry companions. Assign specific and operable parent-child tasks and avoid formalized assignments. Give timely feedback on children's performance in kindergarten to enhance parents' sense of achievement and build a home-kindergarten collaborative system for science education.

4.5. Establish Reflection Mechanism for Continuous Optimization of Practice

Relying on teaching research activities, lesson case discussions and reflection exchanges, establish a regular reflection mechanism for teachers. Teachers should document children's performance, activity problems and adjustment strategies, and reflect on key questions: Is the theme generated from children's interests? Do children have sufficient space for inquiry? Are materials appropriate? Is teacher guidance excessive or inadequate? Is home-kindergarten cooperation effective? Continuous reflection promotes the improvement of activity quality.

5. Conclusion

Through three rounds of action research, this study integrates project-based learning into science inquiry activities for junior kindergarten class. The practice proves that project-based learning can effectively solve the pain points of traditional junior science activities and promote the development of children, teachers and home-kindergarten cooperation in all aspects.

For children, it stimulates interest in scientific inquiry and transforms passive learning into active observation, questioning and exploration. Their abilities in observation, expression, cooperation and reasoning receive initial cultivation. For teachers, it facilitates role transformation and improves capabilities in curriculum design, emergent teaching and reflection, realizing professional growth. For home-kindergarten cooperation, it breaks shallow coordination and builds an in-depth collaborative ecosystem for science education, making full use of resources from families and kindergartens.

Restricted by sample size and research duration, this study still has limitations. Nevertheless, it fully verifies the practical value of project-based learning: centered on children's interests, rooted in real situations, taking active inquiry as the path and supported by home-kindergarten cooperation. It conforms to the physical and mental development characteristics of junior kindergarten children and the reform direction of preschool science education. In future research, by expanding practice scope, improving plans and deepening collaboration, project-based learning will further improve the

quality of junior science inquiry activities and lay a solid foundation for young children's early scientific literacy.

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