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Understanding the Delivery of Science Education in Preschool Settings: A Qualitative Study of Domestic Kindergarten Teachers' Practices

Yuxi Zhao

Department of Education, DePaul University, Chicago, USA
Email: cindyt@capstone-research.com

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Abstract

This article primarily examines the delivery mode and implementation of science education in Chinese kindergartens. The study employs a qualitative research approach, utilizing in-depth interviews with two kindergarten teachers from China. The researcher meticulously recorded and transcribed each interview using a semi-structured format. The interview questions focused on the teachers' comprehension of science education, knowledge of science learning objectives, and their execution of science education within kindergartens. Through these interviews, this study aims to comprehend the current state of science education in kindergartens while exploring challenges and issues faced by kindergarten teachers in this field. Furthermore, this study specifically investigates whether imaginative play is included in the kindergarten science curriculum. Although limited by a small sample size and scope, the findings obtained from this study hold significant reference value for comprehending methods and strategies employed in Chinese kindergarten science education.

Keywords

Science Education, Kindergarten Teachers, Abstract Thinking, Curiosity, Teaching Modes, Exploratory Learning Model

1. Introduction

Preschool is a special time in a person's life, while science education is an essential component of preschool education that builds children's values and worldview, and impacts deeply on their future study and life. According to the "Guidelines for the Learning and Development of Children Aged 3 to 6" issued by the Ministry

of Education (Ministry of Education, 2012), kindergartens in China began to focus on the implementation of science education and shifted from focusing on the indoctrination of subject knowledge to cultivating children's curiosity and desire to explore. Although industry professionals have progressively realized the significance of science education to the lifelong development of preschoolers, there is still a paucity of research on the implementation strategies and practices of science education for kindergarten teachers in China.

Understanding the delivery of preschool scientific education is essential for creating a well-designed curriculum and enhancing young children's overall learning experience. In addition, the investigation of practice amid kindergarten teachers in China can provide valuable insights for preschool educators. It facilitates to study the challenges they face when introducing scientific concepts, and orients the development of preschool science education in the future. Consequently, the purpose of this qualitative study is to investigate how to conduct scientific education in domestic kindergartens through in-depth interviews with teachers and developmental evaluation.

The qualitative research methods are employed to interview two Chinese kindergarten teachers to determine the current status of the preschool science education delivery, including the development of scientific activities and children's ability to transfer scientific knowledge. Additionally, one of the most significant hypotheses of this research is that integrated imaginative play can facilitate the carry-out of early childhood scientific education. The interview, however, suggests that the integration model has not yet been utilized in the two kindergartens. Nevertheless, the interviewed teachers believe that this hypothesis is feasible and advantageous, and hold a positive attitude toward it. Insights from this study may contribute to the development of more effective teaching strategies and resources to promote the incorporation of age-appropriate and engaging integration tools in preschool science curricula, which will ultimately benefit both educators and students.

2. Literature Review

Early science education facilitates children's comprehension of the world and fosters the development of scientific reasoning skills. In the early stages of cognitive development, children acquire the capacity for abstract thinking. Therefore, the early introduction of scientific concepts to children exerts a positive influence on enhancing their cognitive development and future academic performance (Eshach & Fried, 2005). During the initial stages of development, young children exhibit an inherent curiosity and a strong inclination to explore, discover, and comprehend their surroundings. Hence, effective preschool science education plays a pivotal role in nurturing children's curiosity and establishing a solid foundation for future scientific inquiry.

It is significant to comprehend the teaching modes and methods employed by kindergarten educators in preschool science education as they play a significant role in shaping young minds and igniting their passion for the realm of science.

This part of the review examines the current preschool science teaching paradigm and practices of kindergarten teachers in order to gain a comprehensive understanding of the implementation of science education in kindergartens. The literature and research reviewed in this article not only focus on practical methods for preschool science education but also mention the issues arising from some teachers' lack of personal abilities and scientific knowledge reserves to some extent, which warrant further discussion. Additionally, it is crucial to evaluate the effectiveness of commonly used models and strategies in preschool science education while identifying potential areas for improvement, which also constitutes the primary objective of this review.

2.1. Teaching Models in Preschool Science Education

2.1.1. Exploratory Learning Model

The exploratory learning model is an educational approach that prioritizes active and self-directed learning through exploration, discovery, and hands-on experience. Analogous to a sailing boat navigating the sea of knowledge, students assume the role of captains, with their intrinsic motivation serving as the driving force propelling the vessel forward toward their desired learning destinations. Furthermore, students' cognitive abilities determine the extent to which they can traverse this vast expanse (Liu, 2020). This pedagogical model places significant emphasis on student engagement, curiosity formation, problem-solving aptitude, and critical thinking skills development. Within this framework, students are encouraged to actively investigate and manipulate materials, objects, or phenomena to construct their understanding of scientific concepts. It has gained widespread adoption across all levels of education including preschool. In the context of kindergarten science education, children's limited ability to comprehend exploration necessitates a crucial role for teachers. Consequently, educators must construct suitable scenarios that align with children's cognitive characteristics and provide conducive conditions for hands-on engagement. This enables children to embrace the stimulation offered by toys and learning tools, allowing them to independently manipulate and interact with these resources to perceive and experience explicit or relevant scientific knowledge embedded within them. Such experiential encounters serve as valuable building blocks for accumulating practical understanding. Simultaneously, throughout this process of experiential learning, teachers must offer appropriate guidance while encouraging communication and discussion among students following their exploratory activities. By doing so, teachers can facilitate the discovery of simple rules through active exploration on the part of students themselves, thereby fostering an understanding of various specific scientific phenomena (Xue, 2010). Ultimately, this play-based approach not only caters to children's unique learning characteristics but also significantly enhances their problem-solving abilities.

However, it is imperative to underscore that the exploratory learning mode encompasses both advantages and limitations. This pedagogical approach effectively fosters children's inquisitiveness and intrinsic motivation towards scientific

endeavors. The utilization of the exploratory learning mode in early childhood science education capitalizes on children's innate curiosity, nurturing their passion for scientific inquiry and genuine interest in understanding the world around them. Young learners actively engage in the educational process, thereby enhancing their retention and comprehension of scientific concepts while unconsciously promoting fundamental critical thinking skills and problem-solving abilities. Through hands-on exploration and experimentation, exploratory learning empowers children to cultivate rudimentary capacities for information analysis, integration, and evaluation. Moreover, this model encourages a certain degree of creativity and innovation as children autonomously discover diverse possibilities within objects or phenomena during their investigative pursuits.

Nevertheless, reality is always constrained by numerous factors hindering the realization of our desired outcomes. In many Chinese kindergartens, the time for daily science classes is limited, resulting in insufficient opportunities to explore and discover. Furthermore, the scarcity of material resources in inclusive kindergartens makes it less possible for all institutions to provide children with the necessary materials and equipment for effective science education. The reduced funds and limited channels due to economic downturn have even exacerbated this issue that many kindergartens face greater difficulties in procuring learning tools and materials than before. Nevertheless, a prevalent issue is the inadequate teaching abilities of many educators. Some lack fundamental scientific knowledge, while others struggle to provide meaningful guidance and support during exploratory activities. This hinders students' ability to make significant connections and understand key concepts.

The exploratory learning model in science education requires teachers to continuously enhance their own abilities and possess a correct understanding of preschool science education. However, educational research contradicts the notion that children solely "learn by doing" when it comes to self-directed exploration and scientific learning. Studies have revealed that preschoolers exhibit a limited comprehension of fundamental conceptual principles related to experimental design. For instance, while they can partially grasp covariant patterns and differentiate between true causation and spurious associations, children may encounter unexpected situations within real-world scientific contexts. Consequently, when there exists a disparity between the ideal scenario and reality, the relationship between children's actions and causal variables of interest becomes more intricate. During such instances, making a series of complex predictions and analyses as well as designing control intervention measures akin to those undertaken by older students become challenging (Cook et al., 2011). In general, devising a scientific experiment is often more arduous than selecting teaching content itself. Henceforth, integrating the exploratory learning model into preschool science instruction reasonably poses significant challenges for early childhood educators.

2.1.2. Inquiry-Based Learning Model

Inquiry-based learning is an educational approach that prioritizes students'

acquisition of new knowledge or skills through the processes of observation, questioning, exploration, and practice. This pedagogical method fosters self-driven student engagement and a proactive attitude while teachers assume the role of mentors or guides to facilitate the development of deep thinking and problem-solving abilities. It actively encourages students to explore scientific concepts by posing inquiries, designing experiments, gathering data, analyzing information, and drawing conclusions. Inquiry-based learning places significant emphasis on critical thinking, communication, collaboration, and reflection. Moreover, this model has also been extensively employed in *Science Education as Inquiry-Based Science Education* (IBSE). In early childhood education settings, particularly preschools or kindergartens, children's scientific inquiry encompasses various learning activities aimed at acquiring scientific knowledge, comprehending scientific concepts, and mastering research methodologies. As a form of science education currently implemented in kindergartens nationwide, it effectively nurtures both logical reasoning skills and practical operational capabilities. (Ma, 2010)

The IBSE model shares similarities with the exploratory learning model in terms of function; however, its distinctive feature lies in its ability to foster the integration of science, language, literature, mathematics, and other disciplines. Moreover, it exerts a positive influence on children's holistic development. Scientific inquiry is closely linked to the advancement of mathematical concepts such as comparison, classification, and categorization. For instance, when children collect and represent data while reasoning about their findings, they are effectively applying essential mathematical skills. Notably, researchers have observed that by cultivating an environment rich in scientific elements, the spirit of inquiry among children can be enhanced. This is evidenced by the frequent usage of scientific terminology like theory, hypothesis, and prediction among teachers and preschoolers (Hollingsworth & Vandermaas-Peeler, 2016). Consequently, IBSE offers a more enriched setting for children's growth across language acquisition, mathematics proficiency, and artistic expression.

Undoubtedly, inquiry-based science learning can significantly enhance children's comprehension of scientific concepts. By actively engaging in investigation and problem-solving activities, children develop a profound understanding of the breadth and depth of scientific principles. Moreover, this process facilitates the gradual construction of a comprehensive knowledge framework. Furthermore, IBSE often entails collaborative group work, fostering effective communication skills and teamwork abilities among students. This pedagogical approach mirrors authentic scientific practices.

While the advantages of IBSE are promising, it also presents certain drawbacks. Implementing IBSE necessitates additional time for students to explore, question, and investigate, as well as requiring teachers to provide relevant guidance and support to ensure meaningful and effective learning. This entails that teachers possess a solid understanding of scientific concepts and inquiry processes to effectively guide students through the inquiry learning process—a challenge that some preschools and teachers may face. Furthermore, the implementation of

inquiry learning requires sufficient teaching resources, including experimental materials and equipment, which may be limited in kindergartens with poor conditions. Additionally, the non-linear structure of IBSE demands flexibility and adaptability from teachers—qualities that can prove challenging for junior or inexperienced educators (Zudaire et al., 2021). Therefore, while IBSE offers numerous advantages, its successful implementation heavily relies on kindergarten support and teacher involvement. It is worth noting that assessment poses challenges for IBSE in kindergartens nationwide. Assessing individual learning outcomes in inquiry-based learning can be intricate due to the subjective nature involved in evaluating students' inquiry skills, problem-solving abilities, and critical thinking.

2.2. Teaching Strategies in Preschool Science Education

2.2.1. Hands-On Experiments and Activities

Practical experience is essential in science education for preschoolers, as it allows children to actively participate, explore, and gain a deeper understanding of scientific concepts through direct experiential learning. Hands-on experiments and activities enable children to observe and operate in person, promoting their comprehension of scientific principles. Kindergarten teachers carefully design age-appropriate activities aligned with children's learning goals to promote the development of important science skills and knowledge by providing opportunities for exploration and discovery. In one study by Pramling and Samuelsson (2001), a teacher encouraged a 3-year-old child to hypothesize whether an object would sink or float when placed in water; the child tested this hypothesis using hands-on strategies such as interaction and engagement while gradually building understanding. The results showed that even if the child did not fully comprehend these concepts, they could still carry out behavioral activities based on the concepts (Larsson, 2016).

Another study conducted by Kristina Andersson (2012) also focuses on hands-on experiments. The article depicts the implementation of a scientific activity on buoyancy by a kindergarten teacher named Molly. During this activity, children engaged in practical experiments using small plastic containers and documented their predictions and experimental outcomes. The teacher facilitated discussions among the children to explore the distinctions and similarities between various objects involved in the buoyancy experiment while introducing scientific concepts such as floating, sinking, heavy, and light. However, it was observed that teachers did not extensively delve into why certain objects float or sink during these activities, potentially hindering children from developing a comprehensive and accurate understanding of buoyancy. It is noteworthy that in this particular activity, however, teachers encouraged open-ended conclusions rather than fixed ones, thereby avoiding limitations solely focused on discussing density-buoyancy relationships (Andersson & Gullberg, 2012). This indicates that teachers involved in this activity possess an awareness of preschool science education goals distinct from those of primary and secondary school science education. Hands-on science activities necessitate the integration of both cognitive abilities and physical

engagement for children, fostering critical thinking skills and reflective practices. Simultaneously, such activities play a crucial role in enabling children to experience, comprehend, and establish scientific concepts as they embark upon their initial journey into the realm of science.

In addition to abstract scientific experiments such as buoyancy and gravity, planting is another hands-on science activity commonly implemented in kindergarten settings. In these activities, children are taking responsibility to plant their own seeds provided by educators. Through this process, children gain knowledge about the life cycle of plants and observe their transformation over time. They also develop essential skills by engaging in behaviors like watering and weeding that establish a connection between plant growth and development. These experiments not only impart an understanding of plant biology but also foster a sense of accountability and nurturing. To summarize, hands-on experiments and activities serve as effective teaching strategies within preschool science education. According to Vygotsky's perspective on early learning and development, constructing knowledge through play-based activities is both tangible and intuitive for young learners (Winsler, 2003). By actively participating in these activities, children consciously or unconsciously observe various characteristics of objects while adapting to different environments through shaping experiences. Vygotsky's dialectical perspective and contemporary applied development science posit that theory and practice are inseparable, intricately intertwined, and dynamically evolve together over time (Winsler, 2003). Consequently, by providing opportunities for children to actively explore and accumulate experiences, they can develop a profound comprehension of scientific concepts and principles. Hands-on experiments serve as a conduit between abstract scientific concepts and the real world, enabling children to comprehend science, and the world around them, and gain direct experiential knowledge. Kindergarten teachers play a pivotal role in facilitating this bridge-crossing process by uncovering and fully utilizing the potential of hands-on experiments to engage young children in high-quality scientific experimentation. This approach fosters their scientific thinking abilities, observational skills, as well as long-term interest in science.

2.2.2. Using Storytelling and Literature

The integration of storytelling and literature into science education yields a positive impact on augmenting students' comprehension and engagement with scientific concepts. When effectively employed, narratives and literary works can furnish a contextual framework for science education, promoting children's imagination and facilitating the cultivation of critical thinking skills.

Based on the sociocultural perspective, Susanne Walan (2019) and her research partner investigated the impact of integrating storytelling and drama in science education for children, recognizing that aesthetic activities play a crucial role in children's learning process. The research question posed was: What is the effect of utilizing a combination of storytelling and drama to explain complex scientific concepts to children? To address this question, Walan (2019) and his team

conducted their study by visiting two kindergartens and one primary school, where they invited 25 children aged 4 - 8 to participate. These participants were divided into groups, with each group listening to a story about Rhinovirus Rita. Notably, no visual aids were used during the storytelling session. Subsequently, both researchers and children engaged in enacting a play based on the story they had just heard. Additionally, the children were asked to create drawings related to the story. On a subsequent visit to the school, each child underwent individual interviews, and their previously created drawings were utilized as stimuli to elicit recollections. The findings revealed that a considerable number of children had acquired knowledge regarding the nomenclature and functioning of immune system cells during episodes of cold (the primary focus in the preceding narrative). Furthermore, they learned that viruses cause common colds. Despite a minority of children not exhibiting signs of assimilating this specific content, the study posits that employing storytelling and drama in combination constitutes an efficacious pedagogical strategy with promising implications for imparting scientific concepts to young learners (Walan & Enochsson, 2019).

Throughout history, adults have used storytelling to educate children. Narratives are a valuable teaching tool that helps children understand and learn by sharing the experiences and wisdom of past generations. Stories and children's literature epitomize the most direct and efficacious means of fostering imagination in young minds, which is an indispensable asset for effective knowledge acquisition. Consequently, it is imperative to advocate for enhanced integration and promotion of traditional storytelling practices within educational institutions.

All literary forms, including narratives, play a pivotal role in societal development by facilitating the transmission of established cultural traditions, tools, and norms. Furthermore, they enable individuals to subjectively and creatively engage with their surroundings. Storytelling also acts as a catalyst for enhancing scientific comprehension by fueling curiosity towards knowledge acquisition. For instance, the narrative structure of stories stimulates imagination and fosters an effective learning process. In early education settings like kindergarten, teachers can utilize storybooks to introduce science topics in an engaging and accessible manner while incorporating literature into science education through activities such as reading aloud children's literature or organizing class book clubs and literary circles that encourage interactive discussions. Additionally, writing exercises, role-playing scenarios or other visual representations based on stories or literature can be integrated to further enhance science education. The key lies in establishing connections between literary narratives and scientific concepts so that children perceive the relevance and practicality of science across various contexts.

Additionally, it is noteworthy that the incorporation of narrative literature can facilitate the amalgamation of imaginary play and science education. Despite limited research in this area and its infrequent implementation in kindergartens, it serves as a promising point of departure for discourse, inquiry, and further exploration into scientific subjects.

2.2.3. Use of Technology and Multimedia

In the context of today's era of intelligence, the integration of science, technology, and education emerges as an inevitable subject. Research has revealed that employing digital narratives can captivate children's attention and stimulate their profound interest, thereby enhancing their engagement in scientific activities and fostering comprehension and retention of scientific concepts (Yilmaz & Sığirtmaç, 2020). Exemplary digital narratives boast high-quality visual representation and effectively concretize abstract scientific notions to facilitate children's understanding of intricate scientific knowledge. Through digital narratives, educators can impart scientific knowledge that may not be feasible to teach through hands-on experiments due to safety concerns or economic constraints. This multimedia instructional model is applicable across various domains encompassing Earth and space sciences, life sciences, physical sciences, history, as well as natural sciences. The utilization of digital technology and multimedia as instructional materials for various concepts and contents offers a potent pedagogical tool for early childhood educators, facilitating the creation of a more captivating and interactive learning environment while providing an abundance of learning resources and opportunities for children. It can be asserted that employing scientific and technological resources to deliver interactive and immersive learning experiences to children can significantly enhance science education. In kindergarten settings, teachers should select suitable technological tools and multimedia based on student's age and developmental stage.

2.3. Summary

Understanding the methodologies employed by kindergarten teachers in science education is of paramount importance for several reasons. Firstly, it signifies whether educators have identified the most efficacious approaches to actively engage young children and enhance their comprehension and enjoyment of scientific concepts (Bulunuz, 2013). Furthermore, understanding these models and methods aids in identifying deficiencies and obstacles that currently hinder the implementation of science education in kindergartens. Lastly, analyzing teaching methodologies and practices can improve integration between science and other disciplines such as mathematics, language arts, literature, etc., thereby fostering continuous discourse and innovation within preschool science education on a more comprehensive interdisciplinary basis (Eshach & Fried, 2005).

There are numerous approaches to implementing preschool science education; however, difficulties and challenges are encountered. Among these obstacles, many kindergartens in China face the harsh reality of limited resources, being reflected by the insufficient availability of essential materials and equipment required for immersive and experiential science teaching in some kindergartens. The quality of science education is limited by regional disparities, as inclusive kindergartens and lower-end private kindergartens lack the resources to procure sufficient scientific materials. Furthermore, in certain kindergartens, the curriculum planning lacks rationality, resulting in inadequate allocation of appropriate and

sufficient practice for the science section. Consequently, children's scientific exploration and experimental activities are relegated to a secondary position. Simultaneously, this issue represents one of the most prevalent challenges faced by preschool education—a general dearth of comprehensive science training for educators, coupled with insufficient professional knowledge, leads to evident shortcomings and hesitations in implementing science education practices. Thus, striking a delicate balance between the depth of scientific content and preschoolers' development becomes an intricate task that requires teachers to devise personalized and nuanced teaching methods.

The appropriate strategies are necessary to overcome these challenges. The unique nature of science education in preschool requires early childhood educators to possess the necessary pedagogical skills, proficiency, and confidence. They must also develop a continuous, development-oriented science education program for young children. To enhance teacher quality, kindergartens are advised to offer comprehensive science-related training or lectures to supplement teachers' scientific knowledge reservoirs and elevate their scientific literacy and teaching prowess. Additionally, as autonomous individuals, teachers can leverage abundant online resources to access relevant digital materials for science education. Simultaneously, establishing a sustainable and constructive network system within the realm of preschool science is crucial for fostering innovative educational strategies, consolidating teaching resources, and facilitating the exchange of pedagogical experiences among educators. For instance, creating dedicated sections on social media platforms would enable teachers to engage in fruitful exchanges and mutual learning.

By examining the pedagogical approaches employed in early childhood science classrooms, this review proposes viable science education programs aimed at providing enhanced support for the advancement of preschool science education. Drawing on relevant literature and research findings, this study conducted interviews with kindergarten teachers to gather their commonly used techniques for teaching science, aiming to derive insights from practical experience and identify areas that require improvement, thereby making a valuable contribution to the discourse on preschool science education. Furthermore, this study enables pertinent researchers, policymakers, and educators to gain a profound understanding of how to effectively engage and educate young learners.

3. Methodology

The primary aim of this qualitative research study is to examine the science education practices implemented in domestic kindergartens in China. Interviews have been chosen as the research methodology for this investigation. In order to obtain a thorough comprehension of the subject matter, two kindergarten teachers who possessed distinct origins were deliberately chosen to participate in the interviews. Kindergarten head teachers QQ and CC, both of whom are involved in traditional preschool education in Chengdu and Guangzhou, respectively, were selected to symbolize the two prevailing kindergarten models in China.

Two kindergarten teachers engaged in separate semi-structured interviews for the purpose of the study. The interview facilitated my understanding of their comprehension regarding science education for preschoolers and the implementation of their activities. I documented and transcribed the thirty to forty minutes that each interview lasted. All interviews were arranged at convenient times and locations for the participants (the teacher from Guangzhou and I engaged in online communication). Each interview guide contains a predetermined list of inquiries that shall be addressed. Nevertheless, these questions are subject to change throughout the interview process in response to the interviewees' answers. Participants can engage in a natural and flowing conversation due to the open-ended nature of the inquiries.

The interview commenced with inquiries regarding the participants' educational experiences, most recent scientific education projects, and workdays as a whole. This prior knowledge enhanced my comprehension of the two instructors' experiences instructing kindergarten science. In addition, I continue to inquire about teachers' perspectives on early childhood science education, their comprehension of the objectives of science learning for children, and their reactions to unforeseen circumstances involving students in the classroom through the use of open-ended questions. The reason for this is that instructors possess a subjective impact on the outcomes of students' acquisition of scientific knowledge.

The central inquiry that pervaded the interviews was "How is preschool science education in China developed?" Based on the responses to each of my follow-up inquiries, I endeavor to elicit more in-depth discussions from my interviewees regarding particular concepts. In addition, a particular research inquiry examined whether kindergarten science curricula include imaginary play. According to both educators, the incorporation of imaginary play into their science education methodologies is minimal.

A few limitations should be mentioned in this study: the sample size is quite small, and the research was limited to specific contexts. Nevertheless, the results obtained from this study will offer significant perspectives on the present methodologies and strategies employed in scientific instruction within domestic kindergartens across China.

4. Theory

4.1. Activity Theory

According to Jonassen and Rohrer-Murphy (1999), it is essential to analyze any activity within the context where it occurred. Activity theory elucidates the interplay between human actions, human consciousness, and the environments in which these actions take place. When examining human activities, it is necessary to consider not only "the kinds of activities that people engage in" but also "who is engaging in that activity, their goals and intentions, the resulting objects or products, the rules and norms governing the activity, and the broader community in which the activity happens" (Jonassen & Rohrer-Murphy, 1999). These

elements form the activity system crucial for understanding teachers' practices in the learning process. Engeström (2014) identifies six interrelated factors in an activity system that influence human activity: subject, object, tools and means, rules, community, and division of labor (**Figure 1**). Activity theory helps describe and analyze how cultural context shapes human activity within a system of practical activities (Bakhurst, 2009).

An activity involves "a subject, the object of the activity, the tools used, and the actions affecting the outcomes" (Jonassen & Rohrer-Murphy, 1999). The subject can be an individual or group performing the activity, while the object aligns with the subject's intent. The tools used can be any medium facilitating the subject's interaction with the object, and achieving the activity's goal requires a series of actions (Jonassen & Rohrer-Murphy, 1999).

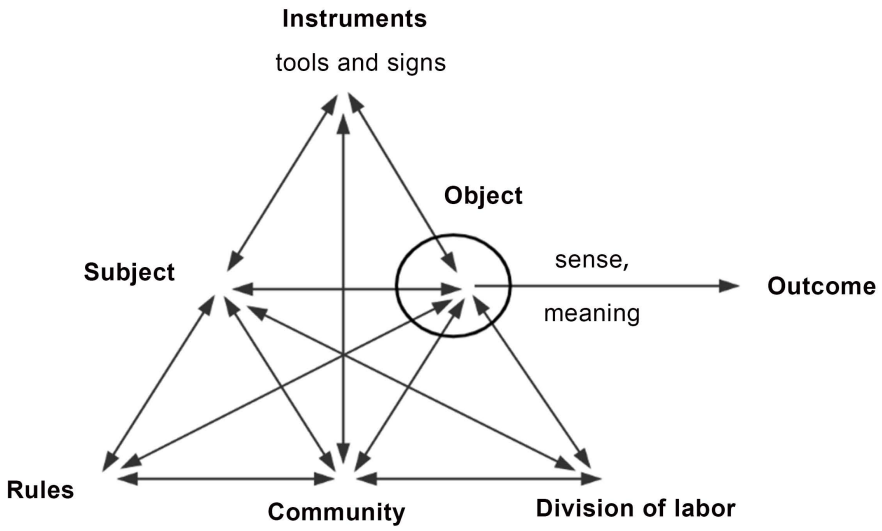

Figure 1. General model of an activity system (Engeström, 2004: p. 78).

4.2. Relevance and Application

Activity Theory supports the research by providing a comprehensive framework for analyzing preschool science education within the unique cultural and institutional contexts of different kindergartens in China. This theory emphasizes the need to consider the dynamic interactions between various elements such as teachers (subjects), educational goals (objects), teaching methods (tools), curriculum standards (rules), the school community, and the division of labor within educational settings. By examining these interconnected components, Activity Theory allows the researcher to explore how different teaching methodologies in Chengdu and Guangzhou are shaped by their specific contexts. For instance, the traditional, structured approach in Chengdu reflects broader Chinese educational practices, while the child-centered, exploratory learning model in Guangzhou's Montessori kindergarten highlights the influence of alternative educational philosophies.

The impact of Activity Theory on the research results is multifaceted. It elucidates

the effects of inconsistent curriculum standards on the quality of preschool science education across different regions, demonstrating how variations in curricula contribute to disparities in educational outcomes. Furthermore, the theory underscores the importance of teacher attitudes and continuous professional development in enhancing the effectiveness of science education. By focusing on the interaction between instructional methods and the educational environment, Activity Theory reveals how teachers' preparedness and adaptability influence children's ability to transfer and apply acquired knowledge in practical situations. This theoretical perspective not only provides a nuanced understanding of the current challenges and opportunities within preschool science education but also offers a robust foundation for proposing improvements in curriculum development, teacher training, and educational practices. Overall, Activity Theory enriches the research by framing it within a system of practical activities shaped by cultural context, thereby offering deeper insights into the dynamics of early childhood science education in China.

5. Results

The objective of this study is to investigate the current implementation status of preschool science education in China. Semi-structured interviews were conducted with a teacher from a traditional kindergarten in Chengdu (CC) and a teacher from a Montessori Kindergarten in Guangzhou (QQ). Each interview was audio-recorded, transcribed verbatim, and analyzed using thematic coding facilitated by MAXQDA. The analysis involved familiarization with the data, generating initial codes through open coding, and grouping these codes into broader themes such as teaching methodologies, curriculum challenges, children's engagement, and professional development. These themes were refined, defined, and incorporated into a comprehensive narrative that addressed the research objectives, illustrated with direct quotes from the interviews. This methodical approach ensured a rigorous examination of the diverse teaching practices and highlighted the influence of contextual factors on preschool science education in China.

These kindergartens were selected as representatives of the Chinese context, thus providing valuable insights into the present state of preschool science education in China. The interviewees primarily addressed aspects related to the format of science education, teaching activity processes, children's knowledge transfer abilities, and teachers' attitudes towards preschool science education.

5.1. Leading-In

The traditional approach to Preschool science education in this study primarily revolves around project-based activities, often employing experimental games and children's inquiries as introductory tools. Such activities are typically presented through a curriculum generation model, wherein educators continuously adjust the activities based on value judgments regarding children's interests and needs, aiming to enhance their learning outcomes more effectively. This dynamic process

fosters collaborative learning between teachers and students, making it a popular choice for science curricula among young children in China. The interviewee CC mentioned that she typically facilitates children in independently devising activity plans, encompassing problem introduction, result hypothesis or conjecture, self-sorting process, design plan, implementation plan, and outcome. This learning mode enhances the autonomy of children's education. In comparison to conventional kindergarten project activities, Montessori Kindergarten's science teaching approach is more streamlined. Interviewee QQ stated that science education in her kindergarten primarily revolves around teacher-led scientific observation courses. This is because, on one hand, Montessori Kindergartens emphasize sensory education; on the other hand, the Montessori Kindergarten is situated within a botanical garden and, in conjunction with its environmental characteristics, places greater emphasis on observing biodiversity in its science education curriculum. This abundant tropical natural ecological setting sets Montessori kindergarten apart in terms of implementing science education.

5.2. The Occurrence and Countermeasures of Distraction

In the process of implementing science education, teachers often encounter the challenge of children's distraction, which is difficult to avoid. According to respondent CC, young children can easily have their attention diverted in any educational setting related to science. There are multiple factors contributing to this distraction phenomenon. Based on the interview findings, two primary reasons for children's lack of focus include their ability and the level of teaching activity designed by teachers. Additionally, it should be noted that variations in real-life conditions may also impact children's concentration levels. For instance, in most traditional Chinese kindergartens, there tend to be larger class sizes for children. When activity materials are not distributed evenly among the students, some young learners may become distracted. However, this occurrence is less common in Montessori Kindergartens due to their low teacher-student ratio and sufficient teaching equipment that can cater to almost every child on average. Additionally, the smaller class size in Montessori kindergartens allows for greater attention towards cultivating children's focus.

When children's attention is diverted, teachers are often required to employ temporary coping strategies, which serve as a test of their immediate response capability, judgment skills, and organizational proficiency. Regarding effective approaches, both respondents emphasized the importance of establishing clear rules and highlighting classroom tasks to children prior to commencing science teaching activities. This proactive measure not only informs them about upcoming tasks but also helps mitigate potential distractions. Furthermore, it is crucial for teachers to promptly adapt the content and methods based on the actual situation when children's attention is diverted. Although the two respondents provided different responses, they both emphasized the significance of making informed judgments and adjustments accordingly. For instance, if a particular topic captivates

most children, teachers should swiftly assess its scientific validity and educational value to determine whether a modification in subsequent teaching content is necessary. Conversely, when only individual children become distracted, teachers can opt for personalized instruction without compromising overall teaching effectiveness. This study posits that the pedagogical proficiency and adaptability of teachers play pivotal roles in effectively communicating science education, yet some preschool educators exhibit deficiencies in these abilities. Although a comprehensive understanding of science is not imperative at the preschool level, there exist numerous intricate concepts, thereby necessitating a certain degree of knowledge reservoir for preschool teachers to adeptly respond to varying circumstances.

In addition, Montessori Kindergarten is characterized by mixed-age teaching. The interviewee QQ mentioned her aspiration to tailor science education based on children's aptitude as much as possible, while also incorporating group teaching activities that align with their age characteristics or ability differences. This approach not only enhances children's concentration but also mitigates distractions. Similarly, CC from the traditional Kindergarten considered group activities an effective strategy for reducing attention diversion, wherein peers within the group can also contribute significantly.

5.3. Knowledge Transfer Ability and Teachers' Attitude towards Preschool Science Education

Initially, we were concerned about the potential impact of children's attention diversion on teachers' instructional effectiveness and their ability to absorb scientific knowledge and transfer it. However, post-interview findings revealed that respondents exhibited a relatively open and inclusive attitude towards preschool science education. Interviewee CC emphasized that the primary focus of preschool science education lies in fostering children's interest in science and cultivating an exploratory spirit. While acquiring scientific knowledge is crucial, it should not be the sole objective of preschool science education, which distinguishes it from other stages of scientific education. Children's capacity to assimilate and transfer knowledge varies, making it unlikely for teachers to expect all children to fully grasp scientific concepts upon initial exposure. Therefore, educators should maintain a certain level of flexibility in facilitating children's acquisition of knowledge and employ tangible examples whenever possible to enhance their comprehension of abstract scientific principles. This approach can also facilitate the effective application of scientific knowledge by children.

6. Discussion

The findings of semi-structured interviews conducted with kindergarten teachers in Chengdu (CC) and Guangzhou (QQ) have shed light on several crucial aspects pertaining to the current state of preschool science education in China, thereby elucidating the challenges and opportunities that exist within this domain of education. This discourse aims to delineate the underlying thematic paradigms that

emerge from these interviews, critically reflect upon their implications, and propose potential avenues for future research and development in this field.

Firstly, a significant observation from the interviews is that the two different types of kindergartens employ distinct teaching methodologies. The traditional kindergarten in Chengdu appears to adhere to a more structured approach towards the routine curriculum, which is characteristic of many Chinese educational settings. If not appropriately adjusted by teachers, this style often emphasizes factual knowledge over practical exploration learning, which is crucial for early science education. In contrast, the Montessori kindergarten in Guangzhou adopts a child-centered learning approach that fosters an environment conducive to exploratory and inquisitive learning; however, it necessitates greater knowledge accumulation and personal adaptability on part of the teachers—a challenging pedagogical model. This disparity not only underscores variations in teaching methods across the mainland of China but also highlights how educational concepts can potentially influence preschool children's development of scientific thinking.

In addition, discussions among educators regarding the structure of science education and instructional practices highlight a broader concern surrounding curriculum standards for early childhood science education. Currently, there seems to be a lack of consistency in curricula, leading to disparities in the quality of science education across regions and educational institutions. While each kindergarten may possess its own unique characteristics, the implementation of a standardized yet adaptable curriculum model could offer valuable guidance to teachers striving for high-quality science education.

Another crucial aspect that has emerged from the interviews pertains to the children's capacity for knowledge transfer. The ability of young learners to effectively apply acquired concepts in practical situations serves as the cornerstone of early childhood science education. The cultivation of this skill is significantly influenced by instructional methods and educational environments. The discourse implies that there exists variation in the emphasis placed on fostering these skills across different kindergarten settings, thereby highlighting a potential need for targeted teacher training programs aimed at equipping educators with enhanced abilities to facilitate knowledge transfer among preschoolers.

Ultimately, the interview revealed a predominantly positive attitude of teachers towards preschool science education. This optimistic outlook, coupled with children's genuine interest in science, has the potential to significantly enhance the efficacy of teaching preschool science. Consequently, teacher preparation courses and continuous professional development programs focusing on science education for preschool educators can play a pivotal role in fortifying this crucial aspect.

In conclusion, despite significant variations in the approach to teaching science across different preschool settings in China, the challenges and successes identified by interviewed educators offer promising opportunities for future innovation in curriculum development, teacher training, and research. Incorporating these

insights into practical applications is essential for enhancing the quality and effectiveness of early childhood science education in China.

Inspiration for Practice

The findings from this study have significant implications for educational practice, policy, and further research in preschool science education. In practical terms, there is a pressing need to integrate more exploratory and inquiry-based learning approaches, akin to the Montessori model observed in Guangzhou, into traditional settings to foster critical thinking and facilitate a deeper comprehension of scientific concepts among preschool children. This objective can be accomplished by equipping teachers with the skills to strike a balance between structured teaching methods and hands-on, child-centered learning experiences while incorporating additional science labs and interactive tools. Furthermore, the development of a standardized yet adaptable science curriculum can promote consistency in educational quality while allowing for local customization. Policymakers should collaborate closely with educators to create and pilot such curricula that not only meet core competencies but also encourage innovative practices. Continuous professional development programs focusing on contemporary science education techniques and child psychology are also indispensable; these necessitate investment in regular workshops and training sessions supported by partnerships with universities and experts.

In terms of educational policy, it is imperative to develop coherent policies that standardize science education objectives while allowing flexibility in pedagogical approaches. While achieving absolute fairness in resource distribution may be unattainable, efforts should be directed towards attaining relative fairness by ensuring equitable allocation of training materials and technological tools across diverse regions to support science education. Additionally, policies should offer comprehensive support and incentives for teachers, including financial rewards, opportunities for career advancement, and recognition programs aimed at motivating and retaining effective educators. Further research is warranted to optimize preschool science education through longitudinal studies assessing the long-term impact of teaching methodologies, comparative analyses across regions to identify best practices, and investigations into the effectiveness of various professional development models. By directly linking these findings with specific recommendations, this study provides a comprehensive roadmap for enhancing the quality and effectiveness of preschool science education in China.

7. Significance

In China, there is a growing recognition of the significance of science education among the populace. Kindergartens are abundant in the country, each offering distinct approaches to science education. This study selected two representative kindergartens: a traditional public kindergarten and a private Montessori kindergarten.

Both institutions incorporate science education into their daily curriculum; however, they differ in their methodologies. Traditional public kindergartens in China typically follow a structured curriculum that integrates science education seamlessly. These establishments prioritize project-based learning, encouraging children to inquire, predict, experiment, and deepen their comprehension of scientific concepts. Such an approach not only cultivates investigative skills but also establishes a strong foundation in scientific principles for young learners.

On the other hand, private Montessori kindergartens adopt a holistic and child-centered approach to science education inspired by Maria Montessori's educational philosophy. These institutions emphasize sensory development and biodiversity education with the aim of fostering children's appreciation for the natural world. The unique garden-like environment provided by the Montessori Kindergartens offers ample exposure to nature and opportunities for observing the surrounding world, nurturing innate curiosity towards scientific phenomena. Moreover, Montessori preschools frequently integrate scientific concepts into daily activities such as incorporating mathematical principles into art projects or exploring botany through gardening.

The methods employed by these two kinds of kindergartens exhibit both similarities and differences which can serve as valuable inspiration for future research on preschool science education in China.

8. Limitations

Although this study has some limitations in sample selection, it can still provide a partial reflection of the current state of preschool science education in China. Furthermore, the interview questions included aspects related to imaginative play and its integration into preschool science education, aiming to gather insights on practical cases. Regrettably, such integration is not commonly observed in the kindergartens where the two interviewees work. Consequently, this study did not obtain substantial information regarding the incorporation of imaginative play into preschool science education. It is anticipated that this research will assist future scholars in comprehending the present status of science education in kindergartens more comprehensively, bridging existing research gaps and fostering advancements and enhancements within preschool science education.

Conflicts of Interest

The author declares no conflicts of interest regarding the publication of this paper.

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