The Scientific Approach in Developing Scientific Attitudes in Early Childhood

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Abstract. This study aims to explore and understand the implementation of the scientific approach in developing scientific attitudes in early childhood amid resource limitations across ten Early Childhood Education (ECE) institutions (ECE). Using a qualitative method and case study approach, the research was conducted over three months, from January to March 2024. The subjects of the study included educators from various ECE institutions. Data were collected through interviews and observations based on planned activities. Data analysis followed the Miles and Huberman model, encompassing data collection, data condensation, data organization and display, as well as verification and conclusion drawing. The findings revealed that the scientific approach, despite resource challenges, was successfully integrated into teaching and learning activities and proved effective in enhancing scientific attitudes in early childhood. This research provides valuable insights into the strategies educators employ to overcome obstacles and support the development of Early Childhood Education.

Keywords: Attitudes, Early Childhood, Scientific.

1. Introduction

From an early age, it is crucial for children to develop a scientific attitude. This helps them understand the world around them critically and analytically. A scientific attitude includes high curiosity, logical thinking, and the ability to reason critically. By fostering a scientific attitude from an early age, children can build a strong foundation for lifelong learning. The scientific approach in Early Childhood Education (ECE) is a learning method that emphasizes observation, experimentation, and problem-solving [1]. Through this approach, children are encouraged to observe their environment, ask questions, and seek answers through experiments. They are also taught to think critically and analyze the information they encounter. The scientific approach in ECE provides a strong foundation for developing a scientific attitude.

In the era of globalization and rapid technological advancement, critical thinking, analytical skills, and problem-solving have become essential skills that must be developed from an early age. ECE plays a crucial role in building the foundation for lifelong learning. However, challenges in its implementation, such as limited resources and the need for innovative teaching methods, need attention. The objective of this research is to identify the challenges in implementing the scientific approach in ECE, particularly in the context of

ICEHHA 2024, December 13-14, Ruteng, Indonesia

DOI 10.4108/eai.13-12-2024.2355569

resource limitations that affect the development of children's scientific attitudes. These resources include experimental tools and materials, learning facilities that support the scientific approach (adequate classrooms, science laboratories, or open spaces for exploration), teacher competence, learning materials, a curriculum integrating the scientific approach, learning time, and budget. Additionally, this research also explores specific strategies and activities applied by educators to overcome these resource limitations. Research by Riatin et al. (2020) [2] explains that inadequate resources, such as limited access to materials and technology, can hinder the implementation of the scientific approach, thus affecting the quality of science education provided to children [2].

The scientific approach in early childhood education is recognized for its ability to improve scientific attitudes and children's overall development. This method includes various steps such as observing, questioning, experimenting, associating, and communicating, which play a crucial role in fostering creativity, imagination, and cognitive development. Additionally, this approach also supports critical thinking and problem-solving skills that are essential for young children. Experience-based learning methods in the scientific approach allow children to interact directly with real-world phenomena in a natural and engaging way. This not only enhances their cognitive abilities but also contributes to their effective and psychomotor development, making it a comprehensive educational strategy. The scientific approach encourages analytical thinking, reasoning, and cognitive skills, which are essential in children's intellectual development [3]. Children are encouraged to think critically through the process of asking questions, evaluating information rationally, and conducting in-depth analysis [4]. Through experience-based learning, this approach nurtures children's curiosity and creativity, allowing them to explore and understand natural phenomena more deeply [5]. The application of the STEAM (Science, Technology, Engineering, Art, and Mathematics) approach further strengthens scientific literacy and problem-solving skills, providing a significant improvement in children's understanding of scientific concepts [6]. Moreover, this method also emphasizes the development of communication and collaboration skills, which are essential for children's personal and social growth [3].

There are several key principles to consider when applying the scientific approach in ECE [7]. First, this approach should encourage curiosity and interest in science among children. They should be encouraged to ask questions and seek answers through experiments. Second, the scientific approach must foster critical and analytical thinking. Children need to be taught to observe carefully, analyze information, and draw conclusions based on available evidence. Third, this approach should involve interaction and collaboration. Children should be encouraged to work together with their peers, teachers, and parents in conducting experiments and solving problems. This helps them develop social and teamwork skills, which are important both in science and everyday life.

The application of the scientific approach in early childhood learning can be carried out in various ways [8]. First, teachers can create an environment that supports exploration and experimentation. The classroom should be equipped with tools and materials that allow children to observe and experiment. Second, teachers can use open-ended questions to stimulate children's curiosity. They can ask questions like "Why does water evaporate?" or "How do plants grow?" to encourage critical and analytical thinking. Additionally, teachers can invite children to conduct simple experiments. For example, they could observe how plants grow when given enough water and sunlight. Through this experiment, children can learn about the importance of water and sunlight for plant growth [9].

There are many activities and strategies that can help children develop a scientific attitude. Active learning strategies support the development of science in early childhood by encouraging activity, critical thinking, and the development of various aspects of growth. The use of science literacy materials with the graphic organizers for science strategy can build students' scientific attitudes, although there are still challenges in fostering these attitudes [10]. These approaches can effectively help children develop a scientific attitude.

The implementation of the scientific approach in Early Childhood Education (ECE) faces several challenges that hinder effective implementation. One of the main challenges is the lack of teacher competence, as many ECE teachers do not have sufficient skills to optimally apply scientific learning, even after participating in training programs [11]. Peer coaching models have been suggested as a way to improve teacher competence, but consistent application remains a major challenge [11]. In addition, resource limitations also pose a significant problem, where many teachers struggle to access adequate learning resources. This hampers the effectiveness of the scientific approach, as resources such as audiovisual aids and other materials are essential for enriching children's learning experiences [12]. Without the right tools, scientific learning becomes limited and suboptimal.

Furthermore, challenges also arise in curriculum implementation, particularly in aligning teaching methods with the scientific approach. The ECE 2013 curriculum often makes it difficult for teachers to design lesson plans that not only meet educational standards but also align with the needs of their institutions [13]. However, some educators argue that children's natural curiosity could provide a strong foundation for scientific inquiry activities. With the right support, children can engage in scientific learning even without abundant resources or excessive teacher intervention. This perspective highlights children's potential to naturally engage in the learning process, even in limited conditions.

This study aims to explore and understand the implementation of the scientific approach in developing scientific attitudes in early childhood, especially amidst resource limitations. This research also identifies various challenges faced in its implementation, such as limited experimental tools, supporting facilities, teacher competence, curriculum, learning time, and available budgets. Additionally, this study analyzes the strategies used by educators to overcome these challenges to effectively implement the scientific approach in learning. Furthermore, this research evaluates the impact of the scientific approach on the development of scientific attitudes in early childhood, including increased curiosity, critical thinking, and problem-solving skills in the context of ECE education.

Based on this, this study seeks to explore how the scientific approach is implemented in ECE, the challenges faced, and the strategies used by educators to overcome them. Moreover, this study also analyzes the impact of the scientific approach on early childhood scientific attitudes and the role of teacher competence and curriculum in supporting effective scientific-based learning.

2. Method and Materials

This study employs a qualitative approach with a case study method. This approach was chosen because it allows for an in-depth investigation of how early childhood educators (ECE teachers) implement the scientific approach under limited resource conditions and how they overcome existing challenges. The case study method was selected as it provides detailed insights into the processes, challenges, and strategies applied in a specific context [14].

The subjects of this study were educators from 10 ECE institutions: ECE Hamba Maria, TKK Inviolata, TKK St. Fransiskus Asisi Karot, TKK Wejang Asih Mano, TK Sta. Maria Fatima Cewonikit, TK Brando, TKK Bunga Mawar, ECE Petra, ECE Sta. Anjela, and ECE Madre M. Ricci. The selection of these institutions was based on considerations of contextual diversity, institution types (TK and ECE), and representation from ECE institutions located in different areas. The selected institutions were expected to provide a comprehensive overview of the implementation of the scientific approach under various conditions. This study was conducted over a three-month period, from January to March 2024.

For sampling techniques, the researcher used purposive sampling with specific criteria, namely ECE institutions that have implemented or plan to implement the scientific approach in the learning process. Additionally, the teachers involved in this study were those with experience and knowledge related to the application of the scientific approach in the classroom. The total number of teachers involved was 20, consisting of educators teaching at various levels of ECE across the selected institutions.

The data collection techniques used include: 1) Interviews: Interviews were conducted with ECE educators to gain insights into their experiences in implementing the scientific approach, the challenges they faced, and the strategies they used to overcome them. The interview guidelines focused on practical aspects of scientific approach implementation and how teachers address resource limitations. 2) Observations: Observations were carried out in the ECE environment to directly witness the application of the scientific approach, interactions between educators and children, and the utilization of available resources. These observations focused on learning activities involving experiments, observations, and discussions related to science, conducted by teachers and children. 3) Document Analysis: Documents such as curricula, lesson plans, and teaching materials were analyzed to understand how the scientific approach is integrated into learning activities. This analysis aimed to determine whether these documents reflect the core principles of the scientific approach, such as observation, experimentation, and reflection.

The collected data were analyzed using the data analysis model from Miles and Huberman [14], which includes the following stages: 1) Data Collection: Data were gathered through interviews, observations, and document analysis. 2) Data Condensation: The collected data were selected, focused, simplified, and transformed to facilitate further analysis. 3) Data Organization and Display: Condensed data were structured to identify emerging patterns and relationships. 4) Verification and Conclusion Drawing: Conclusions were drawn and verified to ensure the validity of findings and confirm that the collected data accurately reflect real-world conditions.

3. Results

The following section presents the findings of the study:

3.1 Experimental Tools and Materials and Learning Facilities

The ten ECE institutions studied did not have dedicated laboratory spaces for experiments. This limitation resulted in experiments being conducted in a simplified manner, such as mixing colors or creating a rainbow effect with dyes and milk. However, teachers still utilized natural materials such as seeds, soil, and leaves as teaching aids.

The ECE institutions examined in this study made use of outdoor facilities such as school gardens and playgrounds as learning media. Additionally, classrooms with good natural lighting supported a comfortable learning environment for children.

3.2 Teacher Competence and Learning Materials

Interviews with 45 teachers indicated that they had a fairly good understanding of the scientific approach. However, implementation was inconsistent, and the scientific approach was often not followed sequentially. Most teachers had also never attended specialized training on the scientific approach.

Big books were the primary materials used in the ten ECE institutions studied. However, there were no specific activity guidelines for the scientific approach, and the use of online resources was still rare due to facility limitations.

3.3 Curriculum, Learning Time, Budget and Strategies for Overcoming Limitations

Although the ECE curriculum in these institutions had incorporated scientific learning objectives, implementation was not always optimal. One of the challenges found was the lack of integration between disciplines and the minimal number of exploration and experiment activities.

The ECE learning schedule lasted 3–4 hours per day, with 3–4 different activities. However, experiments and exploration were not conducted daily due to time constraints.

The main challenge identified was limited funding. Financial resources came from the School Operational Assistance (BOP) program and parental contributions, which were insufficient to improve facilities and provide teacher training.

Teachers utilized natural resources and recycled materials as alternative teaching tools. Some ECE institutions had also begun using the internet to display educational videos.

4. Discussion

The research findings indicate that the lack of experimental tools is one of the primary challenges in implementing the scientific approach. This aligns with research by Rahmah & Raihanah [15], which states that the availability of experimental tools and materials plays a crucial role in supporting early childhood scientific exploration. Experiment-based science learning media have been shown to effectively develop the cognitive abilities of 5–6-year-olds, with factors such as facility availability and teacher guidance playing a crucial role [16]. Additionally, the scientific approach has been proven to significantly enhance early childhood communication skills by providing meaningful contexts for interaction and expression [17].

Despite not having laboratories, the ECE institutions studied were able to utilize gardens and well-lit classrooms to support the learning process. Aragón, Sánchez & Enríquez (2021) [7] emphasize that children's interaction with nature is an effective strategy for fostering a scientific attitude.

The lack of specialized training has resulted in the suboptimal implementation of the scientific approach in ECE institutions. The effectiveness of the scientific approach in education largely depends on teacher training and competence. Teachers with inadequate training often struggle to apply this methodology effectively, leading to suboptimal educational outcomes.

On the other hand, teachers who lack adequate training tend to rely on traditional teaching methods that do not actively engage students in scientific inquiry [18]. Insufficient scientific knowledge can also lead to negative attitudes towards conducting experiments and explorations, ultimately reducing the quality of science education in the classroom [19]. These findings highlight the need for more systematic and continuous teacher training to ensure the effective implementation of the scientific approach in learning.

A rigid and inflexible curriculum can restrict teachers' creativity in applying the scientific approach. The prescriptive nature of such curricula often limits the flexibility needed for innovative teaching methods, ultimately hindering both teacher and student engagement in scientific inquiry. These constraints pose challenges in implementing exploration-based learning, which should support critical and innovative thinking in educational settings.

Rigid curricula often dictate specific content and teaching methods, leaving little room for teachers to tailor lessons to students' needs or interests [20]. Additionally, the pressure from standardized assessments frequently compels teachers to prioritize rote memorization over creative problem-solving, thereby inhibiting the development of divergent thinking skills in students [21].

However, there are various ways to foster creativity in science education. One approach is the use of heuristic curriculum materials, where learning materials are flexible and allow teachers the freedom to adjust teaching methods according to the context and needs of students. This approach has been proven to enhance both creativity and student engagement in learning. Additionally, pedagogical strategies such as project-based learning and collaborative activities have been shown to effectively promote scientific creativity among students by giving them opportunities to explore and discover solutions independently [22].

The study found challenges in implementing scientific approach. Limited funding hinders the procurement of experimental tools and teacher training. Zahro [23] emphasizes that financial constraints are one of the primary factors limiting the optimal implementation of the scientific approach in ECE institutions. Thus, the issue needs to be addressed by the policy makers and related stakeholders.

5. Conclusion

The scientific approach in early childhood education (ECE) has great potential in fostering children's scientific attitudes, including curiosity, critical thinking, and problem-solving skills. However, its implementation still faces various challenges, such as limited resources, lack of teacher training, and rigid curricula. Teachers strive to overcome these obstacles by utilizing simple materials, existing facilities, and innovative strategies. Additionally, teacher competence and a supportive learning environment play a crucial role in the successful application of this approach. Therefore, strengthening teacher training and developing a more flexible curriculum are essential to enhancing the effectiveness of the scientific approach in ECE.

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