広島大学大学院人間社会科学研究科紀要「教育学研究」第５号　2024　337－346

Exploring the Quality of Teaching Materials and Methods during Planned Science Activities in Vietnamese Preschools

― A case study ―

Dinh Thi-Thu Hang

(Received. October 9, 2024)

Abstract: Planned science activity (PSA) is compulsory in Vietnamese preschools, where children learn about science under the guidance of teachers who have prepared the content, materials, and process in advance. This case study investigates materials usage during PSAs at a public preschool in Da Nang, Vietnam, focusing on the types and how science materials are used. This study's PSA-ECERS3 and PSA-SSTEW are adaptations of the original the Early Childhood Environment Rating Scale Third Edition (ECERS-3) and Sustain Shared Thinking and Emotional Well-being (SSTEW) scales. The results of these scales were presented as a qualitative report, complemented by illustrative instances of teaching methods from participant PSAs. The results showed that photos and slides on a computer about the objects of the PSA lesson were the most frequently used materials. Teachers used them to teach science concepts through on-site observation, question-and-answer sessions, and play. By contrast, teachers rarely used natural materials, experiments, or hands-on activities to help children learn about science. The results of ECERS-3 and SSTEW also indicated that PSAs with more interactive activities using the materials received higher scores than ones that did not include interaction.

Key words: planned science activity, science materials, a preschool classroom

Background of the study

Introducing children to science at an early age is crucial for their development. Through science activities, children can develop critical investigative skills such as reasoning, problem-solving, judgment, and classification (e.g., Adbo et al., 2020). In addition, early exposure to scientific experiences can help children develop positive attitudes toward science, which has been linked to scientific development (e.g., Patrick et al., 2008). Science activities also naturally foster children' social skills like cooperation, sharing, and teamwork (e.g., Adbo et al., 2020).

Furthermore, productive classroom science activities can capitalize on this inclination to make the activities highly motivating and consistently enjoyable for young children (Nayfeld et al., 2011). In Vietnamese Early Childhood Education (ECE), there is a planned science activity (PSA) (MOET, 2009). The current study focuses on the materials used in PSAs to extend our knowledge of how materials can impact the quality of these activities. The selection of appropriate materials and how they are

This paper, as a part of the author's doctoral dissertation, has been examined by the following reviewers.
Reviewers: Fuminori Nakatsubo (chief academic advisor). Atsushi Nanakida, Yashushi Maruyama, Yoshikazu Ogawa, and Chiaki Miwa

made accessible to students is crucial for effective science education (Worth, 2010).

Through this study, I explored the relationship between the process quality of PSA and materials, and discovered the significance of appropriate teaching materials and associated teaching methods.

Planned Science Activity and Process Quality

Currently, the most common evaluation methods used to assess PSA have several disadvantages and fail to reflect the reality of this activity. Firstly, evaluating PSAs is based on the observer's opinion and is subjective, which does not offer a good point of reference for comparisons between studies. This leads to the phenomenon in education called *bệnh thành tích* - "achievement obsession" (Nguyen, 2017), where the assessment score is always good or excellent, but the reality of quality is not. "Process quality" is a relatively objective evaluation and may help to pinpoint the reasons for low teaching and learning quality. Teaching quality is commonly divided into "structural quality" and "process quality." Structural quality refers to the features and characteristics of a program, such as the class size, teacher-child ratios, teacher qualifications and experiences (OECD, 2015). Process quality is described as the aspects of the classroom environment as experienced by children – their interactions with teachers and peers, and the materials and activities available to them that directly influence children's development (OECD, 2015). These studies showed that the good process quality of ECEC contributes to the persistence of positive teaching and learning outcomes (Anders et al., 2017).

Planned Science Activity and Teaching Materials

The literature has shown that materials have multiple benefits in supporting children's development across different domains (Tu, 2006). Exploring science typically require the use of various science materials (Ha, 2015). Although the significance of science materials in fostering children's scientific development is widely acknowledged, the existing research on this subject remains limited. Further investigation is warranted to elucidate how educators can proficiently select and integrate such materials within instructional contexts.

The effectiveness of teaching materials is closely linked to how they are integrated into the teaching process. Teaching materials alone do not automatically improve learning outcomes; the methods employed by teachers—how they present, explain, and facilitate interactions with these materials—determine their impact. High-quality materials may not contribute to learning if used passively without encouraging exploration, discussion, or problem-solving. Studying materials, including their type, purpose, and relationship to process quality, can help improve quality. This is especially true for PSA, where teachers can choose the materials to teach children. Although the importance of teaching science to young children has been expressed in the literature, studies still need to discuss the materials that appear and help children discover science. My study define materials as objects children can directly interact with and learn about science with their senses in the PSA.

Study Motivation and Research Questions

The literature shows the research gaps related to teaching science. First, there is a lack of research regarding selecting and using materials to teach science to children. Second, most studies on PSA have mainly used quantitative methods through questionnaires, teacher interviews, and tests for children (e.g., Truong & Ngo, 2019), focusing on only a handful of measurable variables and giving a less detailed picture of the phenomenon (Creswell, 2022). A qualitative case study design was chosen for this study to get closer to real-life situations to enrich the understanding of the phenomenon and to become deeply immersed in the setting and among the participants (Creswell, 2022). Third, the existing assessment tools focus on children's *outcomes and learning goals* rather than the *teaching-learning process* (Dinh, 2019), which may lead to a one-sided view of the reasons for the low quality arising from teaching methods. My study used the two popular and highly recommended assessment tools for process quality - ECERS-3 and SSTEW. Applying two scales facilitated the assessment of process quality on each instructional facet in PSAs. This process-oriented analytical approach enabled the authors to discern specific teaching aspects warranting additional scrutiny and enhancement.

My study fills the gap in the literature by exploring the relationship between materials, including the type and purpose of their use, and the process quality of PSA to uncover the reality of teaching methods that help to improve quality. My investigation of *teacher-centered* PSAs via the *child-centered* process quality criteria may serve as a bridge between these two teaching philosophies. Bearing in mind the discussion thus far, here are my research questions (RQ):

RQ1: What materials have been used, and how were they used in the PSAs?

RQ2: How do science materials and teaching methods jointly impact PSA's process quality?

This study is part of a larger investigation of how teaching methods in Vietnamese classrooms can support children's scientific development, what teachers do to support children's learning about science through the discourse with children and create the interaction between children and materials. Although another paper has focused on teacher-child interaction, certain teaching materials are more conducive to better interactions, hence better process quality. A discussion of teaching materials cannot be separated from one of interaction, and vice versa. The findings contribute to teaching science to young children by providing recommendations on choosing the materials effectively in PSA.

Methodology

Study context

To achieve the study's aim, I conducted a case study with a public preschool in Da Nang City, Vietnam, a representative example of ECE, focusing on implementing PSA. According to the 2017-2018 statistics from the Viet Nam Ministry of Education and Training (MOET), almost 83% of preschools in Vietnam are public schools, which is the type of childcare most Vietnamese children attend. Previous studies have highlighted challenges regarding the imbalance in proficiency across teachers and schools and overwhelming class sizes (Hoang et al., 2018). My intention in selecting this preschool was to focus on a setting that exemplifies best practices in Vietnamese ECE, particularly in terms of meeting national quality standards. The aim was to study how teaching materials and methods were utilized in a context considered exemplary according to national benchmarks.

Participants and Data Collection

My study involved eight PSAs from four classrooms. The teachers in this public school are all female with 7 to 30 years of experience and a Bachelor's degree in kindergarten education. Classroom observations and video recordings were conducted over three consecutive months with 184 minutes. Almost all PSA sessions took place in the morning and were observed by two researchers.

Measurement

A combination of two highly recommended assessment tools was utilized to evaluate the process quality of PSA. The Early Childhood Environment Rating Scale (ERS) Third Edition (ECERS-3) (Harms et al., 2014) focuses on the type, number of materials, interaction, children's language, and how teachers manage the PSA. The Sustained Shared Thinking and Emotional Well-being (SSTEW) (Siraj et al., 2015) emphasizes children's cognitive development, such as problem-solving, higher-order thinking, and socio-emotional well-being. It also mentions how teachers support children in interacting. ECERS-3 is widely used globally to assess process quality (OECD, 2015). SSTEW is a highly recommended tool alongside ECERS, which yields efficient results in evaluating process quality (Siraj et al., 2015).

Combining the two scales help us understand in-depth how teachers create activities in which materials are used.

In PSA, teachers control the materials to teach children. I focus is on how teachers use this autonomy over both materials and methods in a Vietnamese *child-centered* curriculum. I considered five main sub-scales that affect the materials and methods of PSAs based on ECERS-3 and SSTEW, and I developed a rating scale appropriate for the Vietnamese context. They are (i). materials, (ii). interactions, (iii). cognitive development, (iv). socio-emotional well-being, and (v). activity management. The first sub-scale, "materials," answers the first half of RQ1 – "What materials have been used?" – while the other four help answer the second half – "How were they used in the PSAs?". I explored RQ2 while synthesizing findings in all five sub-scales. Besides, I eliminated several unrelated sub-scales and items such as "the meals," "the hygiene," etc.

The current version suitable for the Vietnamese PSA was termed "PSA-ECERS3" and "PSA-SSTEW". The scoring process involved the following steps:

(1) Observation and Recording: During each PSA, trained observers recorded detailed notes on the materials and teaching methods. These observations were complemented by video recordings, which were later transcribed and analyzed.

(2) Rating Process: Each session was then rated using the PSA-ECERS3 and PSA-SSTEW scales. Observers assigned scores on a 7-point scale, with 1 indicating "inadequate," 3 indicating "minimal," 5 indicating "good," and 7 indicating "excellent." The ratings were based on how well the session met the specific criteria for each sub-scale.

(3) Score Aggregation: The individual sub-scale scores were aggregated to produce an overall score for each PSA session on the PSA-ECERS3 and PSA-SSTEW scales.

(4) Cross-Referencing and Validation: The scores were cross-referenced between observers to ensure reliability. Any discrepancies were discussed and resolved to reach a consensus score.

Data Analysis

To answer RQ1, I created a coding form containing information about the materials and their purposes in the PSA. After obtaining the necessary information, the author checked the coding forms, observational records, and videos. Finally, I analyzed the coding form and used descriptive statistics to obtain a comprehensive overview of the science materials and their aims. To address RQ2, I used the two PSA-ECERS3 and PSA-SSTEW to identify PSA classes with varying process quality. The results of the two scales reflect the quality of teaching methods, how materials affect the quality, and whether some materials consistently contributed to better/worse quality.

To ensure the data's reliability, the researcher thoroughly cross-referenced the assessment sheets to guarantee the consistency of the data collection process. To establish credibility, the data was gathered through prolonged engagement, persistent observation, and the triangulation of sources and analysis (Creswell, 2022). I combined two data collections - direct observation and video recording - to approach the study of the same object and use two quantitative measurements - PSA-ECERS3 and PSA-SSTEW - of the same phenomenon in a study to build the triangulation sources of my research.

Findings

Finding 1: The commonly used materials and how they were used

The common materials used through PSAs are *photos, videos*, and *slides of objects on computers*. Teachers occasionally used living creatures like goldfish. These materials enabled on-site observation and encouraged children to ask questions about the objects. The children are guided by teachers, who provide step-by-step instructions. *Puzzles and plastic materials* were used to conduct games that helped children practice the scientific knowledge they had acquired. Most materials were not used during PSA sessions for hands-on activities or experiments, which have the potential to enhance scientific thinking, inquiry activity, discussion, and experimentation.

Most of the PSAs in this study used *photos* relevant to the PSA's topic. It could be a single photo (e.g., *the face, the papaya, the orange* topic) or several, such as photos of the life cycle of a chicken, food (*the cat* topic), the clean and polluted water sources (*the importance of water in our life* topic), the parts of the orange or papaya (*the orange and papaya* topic) and the papaya's growth process (*the papaya* topic). Note that a PSA topic consisted of multiple sessions. These photos were often used to teach children new knowledge through observation, answer questions about objects, and practice after learning in individual practice sections or games.

The second most used material to teach children about science is *the slides on the computer*. The slides contained photos and videos of the objects. Teachers often used the slide to teach children about objects, including their names, colors, and some specific characteristics. The third material used in PSAs was *plastic models*, often used for the game to practice what children had learned. They were once used to teach children about objects. *Natural materials* (such as a real watermelon or a living goldfish) are the fourth most common, often used to introduce objects. In short, the materials used in the PSAs were not very interactive, even with the natural materials. Limited activities can hinder effective learning and engagement for young children.

Finding 2: Interactive activities with appropriate materials improved the process quality.

I found that PSAs with more interactive activities using the materials received higher scores than ones that did not include interaction, which I take as an indication of improved process quality. Interactive activities are defined as those activities where children actively engage with the materials through hands-on exploration, problem-solving, and peer collaboration. These activities require more than just observing or listening; they involve direct operation of materials, experimentation, and active participation, which are critical for developing children's scientific thinking and cognitive skills. The distinction was based on the degree and nature of interaction with the materials and whether the activities went beyond observation to include critical thinking, problem-solving, and collaborative learning. Other lessons with games and problem-solving elements were not considered "interactive" under my criteria if they lacked substantial hands-on engagement or opportunities for cognitive exploration. The process quality scores would only be high if teachers used effective, interactive teaching methods, even with suitable materials.

The first PSA -"*Our Face*"- achieved the highest scores in both PSA-ECERS3 and PSA-SSTEW, mainly due to its incorporation of interactive activities. This lesson stands out as the only one that truly exemplified interactive engagement, a significant factor in its elevated scores. "Our Face" lesson was selected as an example of "interactive activities" because it involved a series of thoughtfully designed tasks that actively engaged the children with the materials. For instance, children participated in individual practice activities using <u>puzzles</u>, which required them to actively reconstruct the image of a face, thereby directly interacting with the materials. The teacher enhanced interactivity by employing a quiz ("What is behind the curtain?") to spark the children's curiosity. This was followed by an observation exercise where children used <u>mirrors</u> to explore their faces as the mirror's reflection captivated them with its dynamic display of movements and emotions.

Additionally, the teacher introduced new scientific knowledge by guiding the children through observations of <u>face photos</u> and engaging them in a Q&A session. The subsequent individual puzzle activities reinforced the children's understanding, while a collaborative game encouraged teamwork and peer interaction. The organization of these interactive activities, combined with the teacher's support in introducing new vocabulary and facilitating hands-on exploration, significantly enhanced the children's scientific thinking skills. This direct, hands-on engagement with materials and the integration of problem-solving elements firmly establish "*Our Face*" as a lesson rich in interactive activities. Moreover, the teacher's tone of voice and emotional engagement further contributed to the high-quality outcomes. "*Our face*" was inadequate regarding the type of materials used and the explored activity. Regarding materials, if teachers incorporated books about faces, models of faces, or videos showing facial expressions (PSA-ECERS3) and planned activities that encourage children's problem-solving with the objects (PSA-SSTEW), it would have received a higher score.

In contrast, the "*Papaya*" lesson, while involving some level of interaction with the materials (e.g., handling the papaya), did not emphasize peer collaboration or hands-on problem-solving to the same extent. The interaction was primarily observational and did not engage the children in the same depth of cognitive processing as the "Our Face" lesson. As a result, it was not categorized under "interactive activities" in the same way.

The second PSA -*Goldfish* - received a relatively high score due to its use of interactive materials, particularly the aquarium, which allowed children to observe living goldfish. This hands-on interaction with the aquarium captivated the children's attention and provided a direct sensory experience, making it a key interactive activity. Despite the aquarium's potential as a rich science resource, the teacher missed opportunities to extend interactivity by not incorporating more individual practice activities or investigative tasks that would have allowed children to explore the fish in greater depth. Following the observation, the teacher used computer slides to discuss the fish's anatomy and diversity, complementing a Q&A session to deepen understanding. Additionally, the lesson included a puzzle game where children assembled images of fish, further reinforcing the knowledge they had acquired through direct engagement with the materials. The limited time allocated for interaction with the aquarium and goldfish meant the children had minimal hands-on engagement, which restricted their understanding of the subject. Much of the lesson involved passive listening, with few opportunities for the children to actively participate or express their thoughts. Additionally, the teacher's insufficient attention to the children's emotional and sensitive needs further detracted from the overall interactivity and effectiveness of the lesson.

For the *orange/papaya* topic, which scored more than 3 points on the PSA-SSTEW, teachers used natural orange/papaya, plastic orange/papaya, and photos of each part of the orange and papaya life cycle. The teacher expanded the children's vocabulary by providing new words relevant to the materials, such as the skin, seed, or juice sac. The teacher stimulated the children's interest by using a quiz at the beginning. Then, she organized an activity called "What is in the bag/box." During the activity, the children had to close their eyes, put their hands in the bag, and guess what fruit was inside. Both activities had individual practices where each child had their materials - the parts of an orange and the photos of the life cycle of a papaya. Children had time to interact with the provided materials. Although in both PSAs, the teachers had chosen various materials, the reasons that led to the relatively low score were the lack of conversation among children and teachers that supported the children's higher scientific thinking as problem-solving, curiosity, shared thinking in investigation and exploration.

The two lowest-scored PSAs - *The life cycle of a chicken and The importance of water in our live* were due to (1) too little time, (2) too many activities that were not fully explored, and (3) only using the photos and slides on the computer to teach the children about science. Moreover, these activities have the common trait that they include two sub-activities in PSAs, including observation and Q&A and games for children. The children did not have the opportunity to interact with the materials through their different senses. They simply looked at the photos or slides and answered the questions. Another PSA that received a relatively low score was the *watermelon* topic. Although it used both natural material (watermelon) and plastic fruits for children to discover about this fruit, the teacher designed the PSA with just observation, question and answer, and games. The poor experience resulted from the limited interactions the students were allowed to have. Teachers did not create an environment conducive to interaction and learning, even with the rich materials.

Discussion

This study shows that PSA's teaching materials are ineffective. The relationship between teaching materials and process quality was indirectly demonstrated through the findings that PSAs with higher ECERS-3 and SSTEW scores were those where teachers used materials in ways that actively involved children.

Various materials may improve process quality. The literature supported this finding: different materials can open up unique and divergent learning pathways for young children (Pacini-Ketchabaw et al., 2016). Rich material resources support imagination, discovery, creativity, problem-solving skills, and play as children discover the material (Penfold, 2019). Furthermore, science environments with diverse materials support brain development by providing numerous opportunities for social interaction, direct physical contact with the environment, and a changing set of objects for exploration (Darling-Hammond et al., 2019). The benefit of the variety of materials is apparent.

One telling example demonstrating the lack of variety was the overused information technology found in many PSAs. Preparing the PSA with slides is a good way to save time and money. Therefore, one-half of the activities in this study used laptops and television slideshows to teach children. Children seemed to use only one sense - the sense of sight - to look at objects and get information about them. There are many ways in which technology can be used in the classroom to engage children and provide exciting, engaging, and stimulating lessons, such as the video of the life cycle of animals or plants. Literature suggests that teachers should choose natural objects that allow children to use more senses to discover them, rather than virtual things on the screen (Prins et al., 2022).

Moreover, I found that the type and number of materials alone did not determine the quality. Instead, how teachers organized the activities to help children interact with the materials played a major role. Even with just the photo or slides, if teachers could create circumstances that help to stimulate children's scientific thinking and attract them to increase their concentration, the quality could likely be improved. However, there is no doubt that certain types have a natural advantage in stimulating children's concentration and willingness to participate and can help them gain more experience when interacting with these materials under the different activities in PSA. The inappropriate choices of materials result in a low score for the scale named "materials" of PSA-ECERS3, which will also result in a low overall score for PSA-ECERS3.

Interactive activities, such as hands-on or experimental or individual practice, often lead to higher-quality PSA. Experimental or investigative activities have a significant effect in helping children develop the necessary initial inquiry skills; these activities require children to coordinate their senses, pay attention to details, make predictions, and use problem-solving skills (Van Der Graaf et al., 2016). The literature shows that hands-on activities are an effective way for children to learn science concepts (Rukiyah et al., 2017). My findings show that teachers tend to let the children observe the objects and then let them explore with guiding questions. This step is necessary for children the first time they see the objects (Wynberg et al., 2022). However, teachers rarely organize experimental activities to help children explore the object well.

Furthermore, I found that teachers often used materials to help children practice what they had learned under the game for a group of children. Games have been shown to have numerous benefits for children, such as memorization, knowledge consolidation, and teamwork (Lego, 2017). However, some of the play activities with the materials took place mainly in the form of grouping games, and with limited class time, children were sometimes not ready to play and occasionally did not even fully understand the game's rules. I observed that children were utterly passive during some PSA sessions, regularly called by name by the teacher in a hurry and "forced" to play. The materials would have become more intuitive to the children if teachers had made them more interactive by creating group and individual activities where children could interact with materials themselves or their peers.

I found some possible reasons for the non-interactive materials. Firstly, because teachers had limited time, they tended to choose simple materials (e.g., photos and slides) which contributed to a poor score. This finding is consistent with OCED's (2015) research that indicates that limited teaching-learning time can lead to low effectiveness of learner development. Secondly, there is a need for more official training on how teachers can select and use effective teaching materials. During my observation, the teacher was the primary speaker, and the students were the primary listeners. The children needed more time to experience the materials. This approach has led to decreased student engagement and reduced interest in learning, and it is opposite to what OCED recommends for a children-centered curriculum (De Freitas & Palmer, 2015). I suggest a teachers' training course that focuses on effectively selecting and using materials in PSA, such as choosing suitable materials for the science topic and the benefits of each type of material for children's development. I also suggest the repeated use of materials both in PSA and free learning science, which can consolidate children's knowledge about science. Organizationally, I have to consider assigning more time and resources so that teachers can incorporate more engaging learning activities.

I consider ways to balance the child-centered philosophy in a teacher-led activity to improve the quality of PSA: a close combination of before, during, and after activities. In detail, teacher-centered approaches are clearly shown when teachers take an active role in setting the learning environment, which includes the materials. For instance, before doing the PSA about goldfish, I suggest that teachers set up an environment relevant to fish or sea animals with diverse materials such as books, aquariums, pictures, or a model. It is recommended that children have more time to interact freely with the materials without guidance and ask for help if they need it. This is where child-centeredness is introduced. In PSAs with limited time, teachers should prioritize activities they guide and supervise to help children develop their scientific thinking and skills, such as experimentation, hands-on, and multi-sensory. Under the teacher's control, children can freely explore the materials. After the PSA, teachers should ensure that children can practice and further develop the skills they learned during the activity. They allow each child to experiment again if they could only observe or work in groups during the PSA. Assigning more time can be the solution for balancing teacher-centered and child-centered teaching approaches.

Conclusion

In conclusion, the types of materials and the chance to interact with them are vital in increasing the quality of PSA. The more time and varied activities they spend discovering the materials, the higher the overall quality of the classes and, ultimately, the children's scientific development.

The findings can contribute to the broader early childhood education and care (ECEC) community. Firstly, it addresses the research gap related to teaching science, especially regarding using materials. Secondly, this study recommends enhancing quality by using the materials effectively: (1) Educators choose more interactive activities. (2) They should select materials more conducive to lively interactions. And (3) teacher training considers how to guide the teachers in using the materials effectively. My study identifies areas for improvement in teaching methods and paves the way for future research on similar topics. It opens up avenues for deeper exploration of the effective teaching methods, including teacher-child interaction and the learning environment.

It is acknowledged that the findings based on only one public preschool and eight PSAs cannot be generalized to all Vietnamese preschools. However, when such research aims to promote understanding, debate, and contribute to the improvement of educational practice, the relatability of a case study is more critical than its generalizability (Creswell, 2022). Moreover, this study used a child-centered scale (ECERS-3 & SSTEW) to assess the PSA. This mismatch between a child-centered evaluation metric and a teacher-centered activity may have led to a lower evaluation score. PSA is one of the compulsory subjects in the child-centered Vietnamese ECE curriculum. To achieve an educational program that better caters to children's needs, using a child-centered assessment tool is the necessary step forward.

References

Adbo, K., & Carulla, C. V. (2020). Learning about Science in Preschool: Play-Based activities to support children's understanding of chemistry concepts. *International Journal of Early Childhood*, **52**(1), 17–35. https://doi.org/10.1007/s13158-020-00259-3

Anders, Y., Hardy, I., Pauen, S., Ramseger, J., Sodian, B., & Steffensky, M. (2017). *Early Science Education – Goals and Process-Related Quality Criteria for Science Teaching*. Verlag Barbara Budrich. https://doi.org/10.2307/j.ctvbkjw1w

Creswell, J. W. (2022). *Research Design: Qualitative, Quantitative and Mixed Methods Approaches* (4th ed.). SAGE Publications, Inc.

Darling-Hammond, L., Flook, L., Cook-Harvey, C., Barron, B., & Osher, D. (2019). Implications for educational practice of the science of learning and development. *Applied Developmental Science*, **24**(2), 97–140. https://doi.org/10.1080/10888691.2018.1537791

De Freitas, E., & Palmer, A. (2015). How scientific concepts come to matter in early childhood curriculum: rethinking the concept of force. *Cultural Studies of Science Education*, **11**(4), 1201–1222. https://doi.org/10.1007/s11422-014-9652-6

Dinh, T.T.H. (2019). Quality Matters in Vietnamese Early Childhood Education: The Situation and the Challenge. *The Annual Research on Early Childhood*, **41**, 15–21. https://www.researchgate.net/publication/342840358_Quality_Matters_in_Vietnamese_Early_Childhood_Education_The_Situation_and_the_Challenge

Ha, T. H. (2015). *Hoạt Động Khám Phá Khoa Học Đối Với Sự Phát Triển Của Trẻ Mầm Non*. https://tapchigiaoduc.moet.gov.vn/vi/magazine/so-dac-biet-thang-6/23-hoat-dong-kham-pha-khoa-hoc-doi-voi-su-phat-trien-cua-tre-mam-non-3920.html

Harms, T., Clifford, R. M., & Cryer, D. (2014). *Early Childhood Environment Rating Scale (ECERS-3)* (3rd ed.). Teachers College Press.

Hoang, N., Holopainen, L., & Siekkinen, M. (2018). Quality of teacher–child interactions and its relations to children's classroom engagement and disaffection in Vietnamese kindergartens. *International Journal of Early Years Education*, **26**(4), 387–402. https://doi.org/10.1080/09669760.2018.1478281

Lego Foundation. (2017). *Learning through play: a review of the evidence*. https://www.unicef.org/sites/default/files/2018-12/UNICEF-Lego-Foundation-Learning-through-Play.pdf

Nayfeld, I., Brenneman, K., & Gelman, R. (2011). Science in the Classroom: Finding a Balance Between Autonomous Exploration and Teacher-Led Instruction in Preschool Settings. *Early Education & Development*, **22**(6), 970–988. https://doi.org/10.1080/10409289.2010.507496

Nguyen, K. D. (2017). *Please Wait. Cloudflare*. https://www.researchgate.net/publication/313987448_Giao_vien_day_gioi_-_Cai_nghiep_hu_danh_va_benh_thanh_tich_Good_teacher_-_The_fate_karmaexpletive_the_fake_fame_and_achievement_ obsession

OECD. (2015). *Starting Strong IV Monitoring Quality in Early Childhood Education and Care.*

Pacini-Ketchabaw, V., Kind, S., & Kocher, L. L. M. (2016). Encounters with Materials in Early Childhood Education. In *Routledge eBooks*. https://doi.org/10.4324/9781315743257

Patrick, H., Mantzicopoulos, P., Samarapungavan, A., & French, B. (2008). Patterns of Young Children's Motivation for Science and Teacher-Child Relationships. *The Journal of Experimental Education*, **76**(2), 121–144. https://doi.org/10.3200/jexe.76.2.121-144

Penfold, L. (2019, February 19). *Material matters in children's creative learning*. Journal of Design and Science. https://jods.mitpress.mit.edu/pub/bwp6cysy

Prins, J., Van Der Wilt, F., Van Der Veen, C., & Hovinga, D. (2022). Nature play in early childhood education: A systematic review and meta ethnography of qualitative research. *Frontiers in Psychology*, **13**. https://doi.org/10.3389/fpsyg.2022.995164

Rukiyah, Marlina, & Kanedi, M. (2017). Child Science Skill Improvement through Hands-On Learning Activities in Kindergarten with Limited Human Resources and Facilities. *American Journal of Educational Research*, **5**(5), 540–545. https://doi.org/10.12691/education-5-5-10

Siraj, I., Kingston, D., & Melhuish, E. (2015). *Assessing Quality in Early Childhood Education and Care: Sustained Shared Thinking and Emotional Well-being (SSTEW) Scale for 2-5 Year-olds Provision* (Spi). Trentham Books.

Truong, T. T., Ngo, M. D. (2019). Sử dụng tác phẩm văn học trong hoạt động hướng dẫn trẻ mẫu giáo 5-6 tuổi khám phá khoa học. *Tạp Chí Giáo Dục,* **2**(Special Issue), 132–137.

Tu, T. (2006). Preschool Science Environment: What Is Available in a Preschool Classroom? *Early Childhood Education Journal*, **33**(4), 245–251. https://doi.org/10.1007/s10643-005-0049-8

Van Der Graaf, J., Segers, E., & Verhoeven, L. (2016). Scientific reasoning in kindergarten: Cognitive factors in experimentation and evidence evaluation. *Learning and Individual Differences*, **49**, 190–200. https://doi.org/10.1016/j.lindif.2016.06.006

Vu, T. T. (2021). Early childhood education in Vietnam, history, and development. *International Journal of Child Care and Education Policy/International Journal of Child Care and Education*, **15**(1). https://doi.org/10.1186/s40723-020-00080-4

Worth, K. (2010). Science in Early Childhood Classrooms: Content and Process. *SEED: Collected Paper*, https://ecrp.illinois.edu/beyond/seed/worth.html. https://kerd.ku.ac.ke/handle/123456789/1096

Wynberg, E. R., Van Der Wilt, F., Boland, A., Raijmakers, M. E. J., & Van Der Veen, C. (2022). How young children explore, follow and impose rules during object-oriented play: a multiple case study. *International Journal of Early Years Education*, **30**(3), 577–594. https://doi.org/10.1080/09669760.2022.2091981