Science Learning Strategies In Early Childhood Education In The Digital Era: Preparing Early Childhood Kids To Face Global Challenges

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ABSTRACT

Early Childhood Education (PAUD) plays a crucial role in preparing the young generation to face global challenges in the digital era. This article explores effective science learning strategies in PAUD in the context of digital technology through a literature review from an assortment of sources; both books and scientific journals. Integrating interactive learning applications, videos and animations through an experience-based approach and collaborative projects, children are invited to comprehend science concepts in an excitement and in-depth way. Challenges such as limited access to technology, understanding abstract scientific concepts and the important role of digital literacy are discussed as part of efforts to prepare early childhood education to face an increasingly connected and multifarious world. Collaboration between educators, students and parents is identified as the main key in creating a learning environment that is empowering and relevant for children's futures. It is hoped that with this holistic approach, PAUD can effectively assist children construct a strong foundation in scientific and technological literacy, as well as the skills required to succeed in the digital era.

Keywords: Early Childhood Education, Science Learning, Digital Era, Technology Integration

I. Introduction

Science learning in Early Childhood Education (PAUD) is an essential step in constructing children's scientific foundations from an early age. In this digital era, learning methods and strategies have experienced significant changes with the introduction of technology into the learning process. Digital technology does not only influence the way children learn, but also opens up new opportunities for curriculum development and more interactive and engaging learning approaches.

In the last few decades, digital technology has changed the educational landscape in an unprecedented way (Izzuddin et al., 2019). The use of devices such as smart phones, computers and educational applications has made it feasible to

convey learning material that is more diverse and adaptive to the individual needs of each child (Papadakis et al., 2018). For instance, science-based educational applications can display interactive animations and simulations that assist children to comprehend abstract concepts more easily and have fun (Zaranis, 2015). In addition, technologies such as augmented reality (AR) and virtual reality (VR) can provide immersive learning experiences, allowing children to explore scientific environments and phenomena directly without leaving the classroom (Cheng & Tsai, 2013).

This interactive and engaging learning approach does not only increase children's interest and motivation in learning science, but can also increase information retention and understanding of complex concepts (Merchant et al., 2014). In addition, digital technology allows personalization of learning, children can learn according to their own pace and learning style, which is very crucial to congregate individual developmental needs in early childhood (Hirsh-Pasek et al., 2015). Research also shows that the use of digital technology in science learning can extend critical thinking and problem solving skills, which are very vital in preparing children to face global challenges in the future (Li & Ma, 2010). Thus, the integration of digital technology in science learning in PAUD does not only enrich children's learning experiences but also paves the way for the development of curricula that are more dynamic and responsive to the demands of the digital era.

Science education in PAUD has a crucial role in forming critical and logical thinking in children. Children who are exposed to science concepts from an early age tend to be better prepared to face future academic challenges (Bredekamp & Copple, 2009). In addition, science learning combined with digital technology can increase children's interest and involvement in the learning process (Haugland, 2000). Digital technology provides various tools and platforms that can make science learning more interactive and attractive. For example, the use of educational apps designed specifically for children allows them to explore science concepts throughout fun games and activities. Kids can learn about the principles of physics, biology and chemistry in an instinctive and immersive way through interactive simulations and engaging animations.

The use of technology such as augmented reality (AR) and virtual reality (VR) can also take the science learning experience to a higher level. With AR and VR, children can explore scientific environments that would be impossible for them to physically visit, such as exploring space, observing life on the ocean floor, or viewing molecular structures in three dimensions. This technology allows children to learn in a deeper and more immersive way, increasing their understanding of complex scientific concepts (Cheng & Tsai, 2013).

Digital technology allows more personalized and adaptive learning. Educational apps and software can be tailored to each child's ability level and learning pace, providing immediate feedback and adjusting the difficulty of the material based on progress. This is particularly important in early childhood education, as children's needs and abilities can vary greatly (Papadakis et al., 2018). In this way, each child can have a learning experience that suits their needs and interests; increasing their engagement and motivation to learn science.

Furthermore, the integration of digital technology in science learning can also strengthen collaboration and communication between children. Digital tools allow kids to collaborate on science projects, share their findings and discuss the results of their experiments more easily. This helps them develop important social and collaborative skills, in addition to increase their understanding of science through discussion and teamwork (Resnick, 2007).

Digital technologies, such as educational applications, interactive videos and educational games, offer a variety of innovative ways to convey science concepts to children (Fleer, 2019). Nevertheless, the application of technology in learning in PAUD must be done wisely so as not to replace social interaction and direct experience which are also important for early childhood development (Plowman, McPake, & Stephen, 2010). Technology use should be balanced, ensuring that screen time does not detract from children's opportunities to engage in physical play, face-to-face interaction and exploration of their surroundings. Social interactions with peers and adults, as well as direct experiences with the physical world, are important components in children's cognitive, social and emotional development.

Early childhood children learn a lot through play and hands-on exploration. For example, manipulating physical objects, such as building with blocks or playing with sand, helps them understand basic science and mathematics concepts in a concrete way (Frost, Wortham, & Reifel, 2008). Additionally, face-to-face interactions with peers and educators are essential for developing social skills, such as cooperation, sharing and communication. When children play together, they learn to resolve conflict, work as a team and develop empathy. This experience cannot be completely replaced by digital technology (Charan et al., 2024).

In addition, the involvement of parents and educators in using technology with children can improve the quality of interaction and learning. Research shows that when adults engage in technology use with children, they can provide deeper context and explanations, helping children make connections between digital and real-world experiences (Takeuchi & Stevens, 2011). Consequently, the use of technology must be accompanied by educators or parents who are able to guide and enrich children's learning experiences.

It is also important to prefer quality digital content that is appropriate to the child's age. Well-designed content can enrich learning and support children's development, while inappropriate content can cause confusion or even have a negative impact on children's development (Guernsey, 2012). The use of technology should focus on applications and programs designed for educational purposes; taking into account the balance between education and entertainment.

Thus, the integration of technology in learning in PAUD must be designed by considering children's development needs holistically. The right combination of digital technology and physical activity, social interaction and hands-on experiences can produce a rich and balanced learning environment, supporting children's overall development and preparing them to face future challenges.

This research aims to explore science learning strategies in PAUD in the digital era, as well as identifying the challenges and opportunities faced in their implementation. In this way, it is hoped that it can supply useful recommendations for educators in preparing young children to face global challenges.

II. Research Methods

The methodology of this research is a literature review, which aims to investigate and analyze various relevant literature sources related to the topic under study. Literature reviews are carried out by collecting, evaluating and synthesizing information from various scientific journal articles, books, research reports and other related sources. This approach allows researchers to gain a deep understanding of theoretical developments, issues and the latest findings in the chosen field of study (Grant & Booth, 2009). In this research, we collect relevant sources related to Science Learning strategies in PAUD in the Digital Era. Data obtained from the literature review is used to support arguments, identify knowledge gaps and formulate a conceptual framework for further research. This method also allows researchers to carry out critical evaluations of existing research and develop a strong theoretical base as a basis for further research (Robinson & Lowe, 2015).

III. Discussion

This research explores various science learning strategies used in PAUD in the context of the digital era, challenges and recommendations. Effective science learning strategies in PAUD can be implemented through several approaches that have proven successful.

First, through experience-based learning, children can engage in simple experiments to observe natural phenomena directly, as well as use simple props to help them visualize abstract concepts (Morrison, 2020). Through experience-based learning, children can develop a deeper understanding of science through simple experiments they carry out themselves. The hands-on process of observing natural phenomena such as plant growth or weather changes not only increases their curiosity, but also helps them relate theoretical concepts to real practical

experiences. In addition, the use of simple props such as models, pictures or concrete objects helps children visualize abstract concepts such as gravity or the water cycle, hence they can understand them in a more concrete and fun way (Morrison, 2020). This approach does not only increase children's learning motivation but also supports the development of their critical thinking skills from an early age; an important preparation for facing future global challenges.

Second, by integrating digital technology, teachers can utilize interesting interactive learning applications to introduce science concepts in a fun way to children and also use videos and animations to explain complex concepts in a way that is easier to comprehend (Shiel, 2021). By integrating digital technology in science learning in PAUD, teachers can create a more interesting and interactive learning experience for children. Through the use of interactive learning applications, such as educational games or virtual simulations, children can learn science concepts in a way that is fun and captures their attention. This app does not only provide an interactive learning experience but also allows children to explore independently, strengthening their understanding of natural phenomena and basic science principles. Additionally, the use of videos and animations in teaching can help explain complex concepts, such as evolution or electrical circuits, in a way that is more visual and easy for children to comprehend. This approach does not only increase their absorption of the material, but also prepares them to face future global challenges with a solid understanding of science and technology.

Third, through project-based learning, children can engage in simple collaborative projects involving observations and experiments, which they then present to develop speaking skills and share knowledge (Larson & Buss, 2019). This approach does not only improve children's understanding of science but also helps them develop social and communication skills that are important in their development. Through project-based learning, children are given the opportunity to learn through hands-on experience and collaboration with their peers. They engage in simple projects that require them to carry out observations, experiments and analysis. For example, children can work together to create a mini garden or observe the life cycle of insects in their environment. This process does not only

increase their understanding of science concepts, but also develops social skills such as teamwork, communication and leadership (Larson & Buss, 2019). Additionally, when they present the results of their projects to classmates or parents, they gain experience in public speaking and sharing their knowledge, which are important skills for their future. Thus, a project-based learning approach does not only prepare children to comprehend the world of science, but also strengthens the skills necessary for success in their social and academic lives.

Science learning in PAUD in the digital era is not only about transferring knowledge, but also about building skills and positive attitudes towards science. Teachers need to adapt learning approaches that utilize digital technology to capture children's interest and ensure evocative learning. The integration of science in the PAUD curriculum must also be in line with children's development and accommodate their learning needs.

In the digital era, science learning strategies in PAUD face a number of complex challenges for both educators and students. One of the main challenges is limited access and use of technology, not all PAUD institutions have sufficient infrastructure to support digital-based learning (Kurniawati, 2018). In addition, young children often face difficulties in understanding abstract scientific concepts, requiring creative and fun approaches to be delivered with the intention that they can understand well (Dee & Garcia, 2020). The use of technology can also separate children from social interactions that are important for their development, thus requiring special attention in integrating science learning with balanced social-emotional aspects (Lau & Lee, 2020). Adapting the curriculum and teaching methods to suit the digital context is also a challenge, while ensuring that science learning is not only relevant but also touches aspects of children's holistic development (Pratiwi & Pratama, 2020). Hence, the development of digital literacy by children and educators is the crucial key in ensuring that technology is used productively and safely in the context of science learning in PAUD (Johansen & Steen-Utheim, 2021).

There are several recommendations that can be implemented by educators, students and parents to ensure the effectiveness and success of early childhood

learning. This approach is important to prepare them to face increasingly complex global challenges.

First, educators need to increase competence in the use of technology and its integration in science learning. This includes obtaining additional training in digital literacy development as well as utilizing interactive learning applications and other digital resources to increase children's engagement in learning (Johansen & Steen-Utheim, 2021).

Second, students need to be encouraged to actively participate in experiments and collaborative projects that support science learning. This does not only improve understanding of science concepts but also develops social, cooperative and problem-solving skills (Dee & Garcia, 2020).

Third, parents play an important role in supporting children's science learning at home. They can involve children in simple science activities around the house, such as growing plants or designing simple experiments, as well as supervising the positive and productive use of technology (Lau & Lee, 2020).

Collaboration between educators, students and parents; it is hoped that young children can construct a strong foundation in scientific and technological literacy, in order that they are ready to face global challenges in the future.

IV. Closing

Technological sophistication continues to grow; educators need to develop competence in using technology to support interactive and fun science learning. In the intervening time, children need to be encouraged to actively participate in experiments and collaborative projects that does not only improve their understanding of science concepts but also develops social skills and critical thinking abilities. The role of parents is also crucial in supporting children's learning at home and ensuring positive and productive use of technology. With good collaboration between educators, students and parents, it is hoped that young children can construct a strong foundation in scientific and technological literacy, which is necessary to face increasingly complex global challenges in the future.

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