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Story-based Science Education: Framework of 5E Model in Preschool

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Hikâye Temelli Fen Eğitimi: Okul Öncesinde 5E Modeli Çerçevesi

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Abstract

This article aims to present a holistic framework for the story-based use of the 5E model, which supports inquiry-based education in preschool. Parents and teachers can support children's early literacy through picture books both at home and at school. Informative picture books, a sub-genre of children's picture books, for which the content is prepared considering the developmental characteristics of children, make important contributions to children's correct recognition and learning of science concepts, scientific vocabulary, and most importantly, their sense of curiosity. In this context, this research reveals the importance of using science-themed illustrated children's books, formulated on the story-based 5E model, and provides a sustainable framework to preschool teachers for using science-themed informational children's picture books.

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Hikâye Temelli Fen Eğitimi: Okul Öncesinde 5E Modeli Çerçevesi

Öz

Bu makale, okul öncesi eğitimde sorgulamaya dayalı eğitimi destekleyen 5E modelinin hikâye temelli kullanımına yönelik bütüncül bir çerçeve sunmayı amaçlamaktadır. Resimli çocuk kitapları, çocukların hayatlarında ilk karşılaştıkları kitap türü olmasına rağmen, ilerleyen yaşlarda erken okuryazarlık eğitimini desteklemek için sınıfta öğretmenler, evde ebeveynler tarafından yaygın olarak kullanılmaktadır. Resimli çocuk kitaplarının bir alt türü olan ve içeriği çocukların gelişim özellikleri dikkate alınarak hazırlanan bilgilendirici resimli kitaplar, çocukların fen kavramlarını, bilimsel kelimeleri ve en önemlisi merak duygularını doğru tanımalarına ve öğrenmelerine önemli katkılar sağlamaktadır. Bu bağlamda bu araştırma bilim temalı resimli çocuk kitaplarının kullanılmasının önemini ortaya koymakta, hikâye tabanlı 5E modeli üzerine formüle edilmiştir ve okul öncesi öğretmenlerine bilim temalı bilgilendirici resimli çocuk kitaplarını kullanma konusunda sürdürülebilir bir çerçeve sunmaktadır.

Makale Bilgisi

Anahtar Kelimeler: : hikâye temelli, bilim eğitimi, 5E model, sorgulayıcı temelli eğitim

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Introduction

Preschool education is one of the most important periods of life in which children make rapid progress. During this period, the opportunities offered by the environment and individuals support this development. In the preschool period, children constantly develop their natural learning, curiosity and motivation and continue to adapt to life. Moreover, children's endless curiosity is the result of their questioning. According to Hollingsworth and Vandermaas-Peeler (2016), almost everything we do involves questioning. Children born as scientists (Howitt, Lewis & Upson, 2011) and tend to have a natural inquiring disposition while exploring and learning about their environment. They wonder about the causes and consequences of events occurring around them, seek information, and try to comprehend them (Gopnik, 2012; Jirout & Klahr, 2012; Zimmerman, 2007). Therefore, they are developmentally ready to learn science (Hollingsworth & Vandermaas-Peeler, 2016). This period contains critical opportunities to support feelings of curiosity and reasoning skills (Morris, Croker, Masnick & Zimmerman, 2012). When these opportunities are evaluated, it is stated that children who are introduced to science and scientific research at an early age understand many scientific concepts better in fields such as science, mathematics, and technology in their future lives, and may have fewer misconceptions (Eshach & Fried, 2005; Hong & Diamond, 2012; Kuhn, Pease & Wirkala, 2009; Olcer, 2017; Zimmerman, 2007).

Inquiry-Based Science Learning in Preschool Period

The preschool period is the best and most productive time to engage children in inquiry-based scientific activities (Samarapungavan, Mantzicopoulos & Patrick, 2008; Pendergast, Lieberman-Betz & Vail, 2017; Gerde, Pierce, Lee & Egeren, 2018; Günsen, 2020). In the early years, children can think scientifically and learn through inquiry research (Günşen, 2020; National Research Council, 2007). The sense of curiosity and discovery, which is the basis of this approach, is at the highest level in the preschool period. Thus, children are volunteers and active participants in many educational activities (Budak-Bayır, 2008; Perry & Richardson, 2001). They plan, conduct, and evaluate their research in case of a problem (Berg, Bergendahl, Lundberg, & Tibell, 2003; Bianchini & Colburn, 2000; Brophy & Alleman, 2008). In this way, they understand science correctly and develop a positive understanding of it (Novak, 1964; Roth & Bowen, 1994).

Although the importance of this period is widely known Preschool inquiry-based science education studies is insufficient (Cabell, DeCoster, LoCasale-Crouch, Hamre, 2013; Whittaker, Kinzie, Williford, & DeCoster, 2016; Kuru & Akman, 2017; Mills & Sands, 2020; Nayfeld, Brenneman, & Gelman, 2011; Tu, 2006). It is concerning that even though preschool teachers conduct science activities in science learning centers where children can explore independently in their classrooms, only 13% of the activities (Tu, 2006) and 5% of the teachers actively use science in their education processes (Tu & Hsiao, 2008). This situation makes it difficult for children to meet scientific needs and support the development of their scientific thoughts (Park, Dimitrov, Patterson & Park, 2017; Li, Zhang, Yang, Song & Yuen, 2020). There is a lack on prechool teachers' science activities in the relevant literature.

Preschool teachers' views and attitudes towards science

There are studies stating that preschool teachers' knowledge, views, and attitudes towards science affect children (Aldemir & Kermani, 2017; Bozali & Camadan, 2018; Larimore, 2020; Olgan, 2015; Sackes, Akman, & Trundle, 2012). However, preschool teachers are generally inadequate, unwilling, or insecure about science education (Gelman & Brenneman, 2012; Hamlin & Wisneski, 2012; Kuru & Akman, 2017) and have failure anxiety due to low self-efficacy (Greenfield, Jirout, Dominguez, Greenberg, Maier & Fuccillo, 2009); they think that scientific concepts and education process are difficult (Günşen, 2020; Yoon & Onchwari, 2006), and perceive science as an abstract field, not knowing how to explain it to children (Metz, 2009). It is observed that their knowledge is insufficient (Appleton, 1995) and prejudiced against science due to their negative experiences of science learning in the past (Edward & Loveridge, 2011). As such, teachers' prejudices and negative attitudes cause various difficulties in planning, conducting, and evaluating science activities (Park, Dimitrov, Patterson & Park, 2017).

Some of the preschool teachers with positive attitudes do not know how to practice science education, which indicates deficiencies in science pedagogy (Erden & Sönmez, 2011; Fayez, Sabah & Oliemat, 2011; Günşen, 2020; Kıldan Pektaş, 2009; Timur, 2012). Through these studies, one can derive two main reasons why preschool teachers avoid or cannot perform science practices in their classrooms adequately: (1) they have a prejudice against science and low self-efficacy due to lack of knowledge, and (2) they do not know how to apply science activities in the education process. At this point, the importance of using illustrated children's books, which are easily accessible, effective, and one of the most basic educational materials frequently used by preschool teachers, in science education emerges.

Informational Children's Picture Books

The informational children's picture book is an answer to the question: 'How can we tolerate teachers' inadequacy, reluctance, and lack of confidence in science education when children are filled with curiosity and desire for exploration?' Children's picture books are a genre that teachers prefer and love in the classroom environment, which also contribute to their self-confidence as they feel competent in their use (Caswell & Duke, 1998; Enfield & Mathew, 2012; Günsen & Uyanık, 2021; Hansson, Leden & Thulin). , 2020; Yazıcı & Bolay, 2017). In this context, it is considered an effective tool in the field of science, where teachers have low self-efficacy and practice inadequacy. Similarly, it is considered one of the most basic resources for science practice in preschool classrooms, and it is recommended that it be used to change teachers' attitudes towards science in a positive manner (Günşen & Uyanık, 2022).

Moreover, literature offers a rich context for children to learn scientific concepts from. Associating it with a story, presenting it with a plot, establishing a cause-effect relationship, and concretizing it with pictures are the ways that make learning permanent (Avraamidou & Osborne, 2009; Butzow & Butzow, 2000). Children love stories; they are fascinated with the ambiguities of the stories, and they want to know/find out how they can solve the events. At this point, narrating scientific stories enables children to access information attractively and entertainingly (Loxley, Dawes, Nicholls & Dore, 2016). In most children's picture books, the subject is science and nature, and the characters are animals and plants. It includes science and nature subjects/events, such as humans, animals, plants, earth, sky, seas, machinery, and inventions. These books can also provide a child with context on many topics that cannot be brought into the classroom setting. For example, in a children's picture book about animals, which is scientifically correct, children can see close-up pictures and thus make observations. The pictures in the books freeze time and offer the opportunity to examine living things in motion, which are not easy to observe in real life. The child, who is afraid of a real spider, can make bold discoveries through spider pictures in books (Pringle & Lamme, 2005). In this way, children can learn science through their own life experiences in a familiar environment. Since they are likely to attract children's attention, these books provide natural participation in the education process based on reading comprehension and questioning (Ansberry & Morgan, 2007), and support children in discovering concepts, and developing scientific curiosity and thoughts (Daly & Blakeney, 2015). With an informational children's picture book, children can learn the function and structure of the language of science, recognize professions related to science, meet the image of a scientist, and gain the first mental representations of science (Andre, Whigham, Hendrickson & Chambers, 1999; Baker & Saul, 1994; Hadaway & Young, 1994).

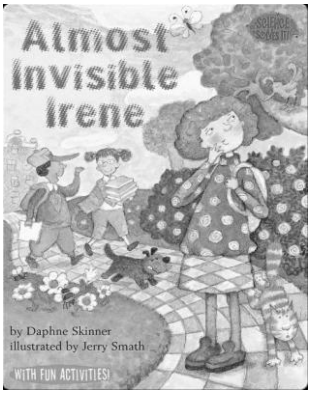

Figure 1. Almost Invisible Irene (Daphne Skinner)

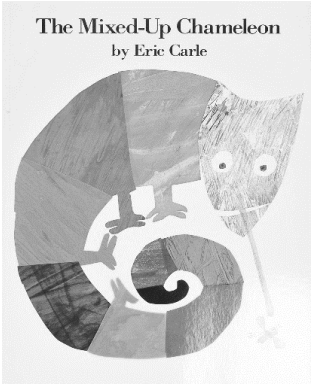

Figure 2. The Mixed-up Chameleon (Eric Carle)

Engaging children with informational children's picture books (for example, Figure 1 and Figure 2) provides holistic support for development as well as gaining skills such as knowledge, common sense, and critical thinking (Mantzipoulos & Patrick, 2011). During reading, children compare their previous knowledge with the information from the pictures and written texts of the book, analyze it using the information obtained during the process, and develop various strategic processes to predict the outcome (Mantzicopoulos & Patrick, 2011; Paris & Paris, 2003; Xoshimova, 2020). Therefore, informational children's picture books written according to the developmental levels of children support children's inquiry skills, scientific conceptual knowledge, scientific language acquisition, scientific thinking skills, and understanding of the nature of science (Akerson, Avsar Erumit & Elcan Kaynak, 2019; French, 2004; Gonzalez, Pollard-Duodola, Simmons, Taylor, Davis, Kim & Simmons, 2010; Günsen & Uyanık, 2021; Leung, 2008; Mantzicopoulos & Patrick, 2011; Saçkes, Flevares & Trundle, 2009; Songür Dağ, 2011; Valdez-Menchaca & Whitehurst, 1992). These benefits highlight the importance of considering not only the content of the books but also the interactive processes involved during their use, which further aligns with sociocultural perspectives on learning and development. In addition, sociocultural theorists do not consider cognition as a separate construct (Robbins, 2005), and reckon the pace of development and environmental impact in the early years to be pivotal (Bandura, 1971; Bronfenbrenner, 1977). In scaffolding concepts, the child gradually acquires skills to complete the task independently. This is sensitive to the child's developmental capacity (Wood, Bruner, & Ross, 1976). The role of the teacher in inquiry is to encourage real dialogue by asking questions (Lemke, 1990). The teacher tends to elicit, challenge, scaffolds student-thinking, and encourages wider responses from the class, instead of expounding clearly (Kawalkar and Vijapurkar, 2011). Talking about the book is the child's need for interaction and dialogue, which gives him pleasure (Clay, 2005). Contextual and out-of-context conversations are encouraged for a child's cognitive processes such as the child's vocabulary and comprehension skills (Dickinson & Smith, 1994).

Story-based 5E model in preschool education

One of the most effective teaching models in science education is the 5E model (Bybee et al, 2006). It has five steps: engage, explore, explain, elaborate, and evaluate. 'Engage' is the stage in which children's curiosity is aroused, their interest is drawn, their pre-knowledge is activated, mental imbalance is created, and they begin to question their existing knowledge. In the 'explore' step, the child begins research-exploration to eliminate the confusion experienced in the first step. In this step, it is important that children make observations by experiencing concrete objects and observable events, collect data, test their predictions, form hypotheses, and work in groups without direct instruction from their teachers. In the third step, i.e. 'explanation,' the teacher helps children understand the answers to the questions and the situations they observed during the research phase and allows them to present their experiences in written or oral formats, depending on the data collected during learning processes. An important consideration in this step is that the children's explanations of their observations and experiences be made before the teacher's explanation. The 'elaboration' step is an extension of the research stage of the 5E model. In this step, children are expected to expand the concepts they have learned in the previous steps and transfer them to new events and situations. 'Evaluation,' the last step of the model, is the stage in which the entire learning process of children is evaluated (Bass, Contant & Carin, 2009; Bybee, 2009).

The 5E model contributes positively to children's pre-cognitive skills (Akerson et al., 2009; Aydın Ceran & Ateş, 2019;Namgyel & Bauraphan, 2017; Parveen, 2017; Zuiker & Whitaker, 2014), scientific process skills (Cheng et al., 2016; Devecioglu-Kaymakcı, 2016; Koyunlu Ünlü & Dökme, 2022; Song & Schwenz, 2013), problem-solving skills (Kalantarnia et al., 2020; Tezer & Cumhur, 2017), metacognition skills (Çetin-Dindar & Geban, 2017; Ramlee et al., 2019), creativity (Conradty et al., 2020; Kalantarnia et al., 2020), and collaboration and communication skills (Chen, 2021).

Informational children's picture books are an effective tool to implement the 5E model (Table 1), which can be explained by several elements that picture books contain or support, including embodied imagination, storyline, and conceptual knowledge.

Embodied imagination

Encourages children to imagine and embody how phenomena occur. The plot is implied to the child with pictures. For example, in the book 'Invisible Irene,' the camouflage phenomenon that occurs in nature is exemplified by Irene's shyness, so children are encouraged to imagine.

Storyline

There is a plot in picture books for children. The child identifies the characters and maintains curiosity. He establishes cause-and-effect relationships, creates meaning, solves problems, thinks critically, and questions. Empathizing with Irene's shyness and follows with interest the storyline of how Irene found a solution for this situation.

Conceptual knowledge
This exposes the child to complex language structures with a rich textual context. The child senses the meanings of unfamiliar concepts using both pictures and plots. Thus, new connections are established. As seen in the example of Almost Invisible Irene, the child is exposed to new words and concepts related to animals and nature with a longer and more complex language structure than a child can encounter in daily routine, along with the camouflage phenomenon. Similarly, this situation also refers to skills such as curiosity, inquiry-research, and cause-effect relationship.

These above three elements are at the focal point when using informational children's picture books in conjunction with the 5E model. The table we created demonstrates how the 5E model can be applied using picture books for children.

Table 1. Examples of story-based 5E model.

5E Steps	How do you use books?	Examples
Attention	With a book that arouses interest and curiosity, the child can provide motivation for the desired subject. By drawing attention to the cover of the book and asking questions, curiosity about the content can be aroused. Using a problem situation in the plot of the book and asking a question, defining the problem, showing a surprising event, a situation to the problem can be realized.	Before the children come to the classroom, the teacher hides different objects of various patterns and colors in various parts of the classroom. The important thing here is to hide the objects in places suitable for their pattern and color. The teacher prepares a graphic representation as to what the hidden objects are and hangs it on the wall.
Research	To better understand a problem situation, the child can make observations by looking at the pictures of the books. He can collect data on a topic from children's books. They can record the observation results by drawing and classify them with a mind map.	When the children come to the classroom, they ask them to find the objects hidden by the teacher by examining them on the graph. In this game called Camouflage Game, children search for objects hidden by the teacher in the classroom, accompanied by a song. In this process, children are expected to have difficulties.
Explanation	It gives the child the opportunity to ask questions 'according to the child.' The rich context presented by the picture and the content contributes to the child's questions. The child directs questions to the adult/teacher for new question marks. They can visualize the child's questions with picture cards, and the teacher can use video tapes and library research while answering them.	The teacher asks why the children find it difficult to find hidden objects and discusses the problems. Then, he gives the information that some animals in nature change color depending on the seasons. For example, an American rabbit turns white in winter and brown in spring. Teacher asks, 'What other examples could there be?' He asks them to picture their thoughts. Children present and explain their pictures. The teacher explains that this science event in nature is a camouflage event, and the book Almost Invisible Irene (Figure 1), which is about this event, is read together.
Refinement	Through many children's books written on one theme, the child can concentrate on new concepts and skills. The teacher presents visual materials upon which they can brainstorm by examining as a group.	The teacher and the children go to an outdoor area so they can observe nature. Children are asked to make observations that can be an example of camouflage in nature and to record their observations. When they go home in line with their observations, they are asked to prepare for a camouflage event they have planned. The next day, children come to class dressed appropriately and present their camouflage to their friends.

Evaluation	Whether the child applies new concepts and skills can be evaluated through another book on the same subject. When a new book creates a new context, questions asked can reveal children's current conceptual knowledge. It is also very practical to reflect these learnings to the child, the information learned in the context of the story is more permanent and easier to remember.	The process is evaluated by ensuring that the children present their camouflage to their friends. Afterwards, the whole educational process is evaluated by reading The Mixed-up Chameleon (Figure 2) book about the life of chameleons with children.

While many informational children's picture books are only suitable for one stage of the 5E Teaching Model, sometimes the structure of a book allows it to be used in more than one 5E stages (Ansberry & Morgan, 2010; Forsythe, Jackson & Contreras, 2018; Pinnell & Fountas, 2011). When Table 1 is examined, it is observed that the book 'Almost Invisible Irene' (Daphne Skinner) (see Figure 1) can be used in this category. In this book, children embark on a journey of in-depth exploration by preparing graphics, making observations, playing games, and drawing pictures through each step of the 5E model to understand the phenomenon of 'camouflage,' one of the scientific concepts. In the evaluation phase, which is the last stage, a child is asked to expand upon and evaluate his learnings from the books, 'Almost Invisible Irene,' and 'The Mixed-up Chameleon' (Eric Carle) (see Figure 2).

It is undeniable that careful selection and use of informational children's picture books by teachers can build a strong foundation for the development of inquiry-based thinking skills. Preschool teachers can use informational children's picture books to initiate a lesson in science education or introduce a problem that structures research (Ansberry & Morgan, 2010). In addition, through these books, they can explain scientific events, introduce words, support the interpretation of observations, and establish a connection with the real world.

Learning occurs through interaction (Adrian, Clemente, Villanueva, & Rieffe, 2005). Further, interaction with adults plays a significant role in language development (Christakis, Lowry, Goldberg, Violette, & Garrison, 2019), as language and social interactions guide thoughts. Moreover, interactions between adults and children affect the child's learning from the book (Sénéchal, Cornell, & Broda, 1995). If we want to use books effectively as educational material, we must consider the elements of interaction. Therefore, a technique of reading books is a prerequisite. To add, asking questions that encourage thinking means encouraging thinking (Johnston, Halocha & Chater, 2007; Klein et al., 2000; Soysal, 2018; Storey, 2004) which helps children reach the information on their own (Goodwin et al., 1983). In this spirit, teachers can use techniques and strategies such as reading aloud, dialogic reading, and picture walking:

Reading aloud
It is defined as the adult or child's reading of texts by diversifying them with the tone, tempo, and volume levels (Johnston, 2016). Interaction elements, such as guessing, asking questions, and answering questions are included in this technique, making children active in the process (Lane & Wright, 2007).

Dialogic reading
This technique is designed for the child to gradually become a storyteller in the reading process. This feature encourages the child to use scientific concepts. This technique can be successfully applied in home and school settings. The child, who is exposed to open-ended questions with PEER strategies and CROWD instructions, becomes more competent in storytelling and uses more complex language structures (Whitehurst et al., 1994). 'When a word is voluntarily filled and adapted for its own purposes, it becomes part of the child's language' (Wertsch, 1991). The child, who actively uses language in the dialogic reading process, learns the scientific concepts more permanently.

Picture walking
This technique is a preview of the pictures in the book before reading the text, so that the child becomes accustomed to the story. The adult draws attention to the pictures/illustrations in the book, takes the children for a 'walk' inside the book and asks questions about the pictures, such as 'What do you see in the picture?' 'Who are the characters in this picture?' (Votteler, 2017).

Ethical Note: Research and publication ethics were followed. Ethics committee approval was not required as the review was an article.

Conclusion, Limitations and Suggestions

To conclude, preschool teachers cannot be expected to be equivalent to science experts and teach the knowledge to children. Moreover, due to changing understanding of education and the view of the child, the teacher is not an 'informed person' but a 'facilitator' for knowledge. Although the focus is more on information when it comes to science, cognitive skills, especially 'inquiry,' will facilitate children's access to information. In early years, children learn by using their scientific and inquisitive cognitive intelligence (Carin & Bass, 2001; Greenfield, Jirout, Dominguez, Greenberg, Maier & Fccillo, 2009; Günşen, 2020; Yoon, 2009). Therefore, knowing how to use effective materials and strategies will contribute preschool teachers eliminating negative attitudes, prejudices, and application concerns against science. The informative picture book is emphasized as an effective material in this article, and the use of these books is presented as a suggestion and exemplified by the 5E model. It is argued that this feature will contribute to the field. Furthermore, it is suggested for future studies to conduct experimental studies bt using this model, obtain opinions from teachers for practice, collect performance-based evaluations from children, and demonstrate the effectiveness of quantitative measurement tools in various aspects.

Contributions of the Researchers

All authors contributed to the manuscript equally.

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