Transforming Early Childhood Education: Technology, Sustainability, and Foundational Skills for the 21st Century

Editors
Prof. Dr. Bahattin Aydınlı • Assoc. Prof. Dr. Bahattin Deniz Altunoğlu

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Preface

The early 21st century has been a period of dramatic change, presenting new challenges and prospects in early childhood education. As our society becomes more interconnected and technologically sophisticated, educators must prepare children to live in a world where innovation, sustainability, and social change are the norms. This book, **"Transforming Early Childhood Education: Technology, Sustainability, and Foundational Skills for the 21st Century,"** confronts a number of principles and practices that lie at the heart of the education revolution—using technology as a tool, infusing practices and principles of sustainability into everything we do, and focusing on teaching the foundational skills that all children must master. The chapters in this volume offer a comprehensive exploration of contemporary themes in early childhood education, arranged into four interconnected sections. The first section provides insights into foundational topics such as school readiness, self-regulation, and leadership skills, setting the stage for a holistic understanding of early development. The second section delves into the transformative role of technology, showcasing how digital literacy, AI applications, and innovative learning environments can revolutionize early education. The third section highlights the growing importance of sustainability and environmental education, reflecting on nature-based learning, citizen science, and ecosystem mental models. The final section focuses on specialized research and topics that offer deeper academic insights into scientific process skills and biology education for preschoolers.

The work contained in this book is the effort of many people—old friends and new—who have committed themselves to advancing early childhood education. The writing is an expression of the innovative spirit and commitment to excellence that so many working in this field embody. We would like to express our deepest gratitude to **Atila ÇAĞLAR (PhD)**, whose unwavering support and thoughtful insights have been instrumental in shaping the vision and direction of this book. His contributions not only inspired this work but also provided invaluable guidance throughout the editorial process. We hope this book will be a resource and a change agent. We want it to be a vehicle for real, meaningful change in early childhood education. We want to embrace technology sustainably and let it guide us in a vehicle of change. We want to develop a basic set of skills upon which the youngest members of society can build in an ever-changing world.

We encourage you to delve into the concepts and ideals put forth in these pages and to work alongside us in envisioning what tomorrow will bring for early childhood education.

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Section 1:

Foundations of Early Childhood Education

Chapter 1

School Readiness in USA, Germany and Finland

Mehmet Akif Cingi[1]

Abstract

The concept of school readiness is a process that encompasses a child's journey of starting school and completing this journey easily and successfully. This concept is generally used for children who are about to start primary school, but it also applies to preschool education institutions attended by younger children. Since being ready for school requires a process, moving within a plan allows children to navigate this process more easily. The school level that children will start at is an important factor that also determines how this process will be planned. A child who is about to start kindergarten, preschool, or primary school needs to go through this process in different ways. Children's readiness for school requires a broader set of skills that is not limited to just academic competencies. Self-care skills such as eating and going to the bathroom independently, gross and fine motor skills to perform certain activities, cognitive skills like perception and attention, and social and emotional skills for social relationships are as important as academic skills in children's readiness for school. Different countries are conducting studies to identify children's readiness for school in various ways, so that they can navigate this process more comfortably.

1. Introduction

One morning during circle time, the teacher was counting the numbers and asking children to repeat. Jakalah suddenly turned his back to the circle and started working on his shoe. He was so engrossed in tying the untied shoelaces that he was neither counting with the class nor listening to what the teacher was saying. The teacher called to Jakalah and asked, "Which is more important?" "Numbers or shoes?" Jakalah answered without

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hesitation, "Shoes!" Seeing the teacher's skeptical look, Jakalah immediately changed his answer: "Numbers? The teacher confirmed Jakalah's answer: "Right, numbers. You need numbers in kindergarten!" (Parks, Bridges-Rhoads, 2010).

There are "musts" and "wants." The "wants" are academic skills, but the "musts" are knowing how to sit, listen, and be ready to learn. If they are ready to learn, we are fine with them, but if they are not, that is where we have a problem (A Primary School Principal in the United States, cited in Comprehensive Report, 2005).

"School readiness" is the state in which every child enters the classroom equipped with the knowledge and abilities necessary to succeed, learn, and gain benefits. Many early childhood educators think that children's preparedness for school goes much beyond their skill level (Vanover, 2017).

Although each country has its own perspective on the concept of school readiness; it can be seen that all perspectives are actually built on certain foundations. School readiness, which is considered necessary especially for starting primary school, was previously defined as children reaching a sufficient level of physical competence. With the increase in research on early childhood, it has become clear that school readiness should not be limited to physical competence. Although many definitions of school readiness are encountered in books, articles and search engines on the internet today, all definitions have certain common points. The common points of these definitions are that school readiness is not only about the child, but also that the family, the environment and the school have an important place in the school preparation process.

2. School Readiness in United States of America

The United States, by its very structure a multicultural state and governed by a system of states, presents school readiness in many different forms. It is possible to encounter school readiness and reading readiness from preschool education up to the sixth grade.

2.1. School Readiness in the Preschool Period

Preschool education in the United States emerged in 1856, and by the 1920s, some public schools had established kindergarten classes. Since 1986, when the state of Mississippi last recognized preschool education institutions as part of public schools, education has continued at least at the kindergarten level in public schools. After the establishment of kindergartens within state institutions in all states of the USA, topics of discussion have included whether preschool education should be mandatory, whether it should be half-day or full-day, at what age children should be admitted to these institutions, and how readiness for school should be determined (De Cos, 1997). In 2011, 45 states enacted laws requiring their local school districts to open kindergarten classes, and 19 of them made attending kindergarten mandatory (Bush, 2011).

The widening gap in school readiness between children from wealthy and poor families has prompted politicians to take action since 1990. At The National Education Goals Panel in 1990, it has been aimed that every child starting school by the year 2000 will be ready to learn. The National Center for Education Statistics has conducted a study regarding preschool teachers' thoughts on school readiness, in order to ensure that the concept of school readiness has a common meaning. As a result of this study conducted in 1993, teachers identified three prerequisites for children to start kindergarten: being healthy, being able to communicate, and having enthusiasm and curiosity (Joyner & Theodore, 2011). In the 1997 report of the National Education Goals Panel, the five components that a child should possess for school readiness are listed as follows (National Education Goals Report, 1997, p. 28):

1. Being physically healthy and to have appropriate motor development.
2. Being emotionally healthy and willing to trying new experiences.
3. To have age-appropriate social knowledge and competence.
4. To have age-appropriate language skills.
5. To have age-appropriate general knowledge and cognitive competence.

2.1.1. Components of School Readiness

Being physically healthy and having appropriate motor development: When we talk about being physically healthy, it should not just mean not having any major illnesses. It should be considered to have sufficient energy to participate in school activities and to be resistant to common infections. Frequent absenteeism at an early age makes it difficult to acquire fundamental knowledge and skills, which in turn creates challenges in gaining skills that require more academic knowledge (Doherty, 1997).

School readiness includes being physically healthy, as well as being able to do the tasks that must be done in preschool. Schools provide for five-year-olds to be able to perform tasks such as being able to hold and use a pencil correctly, and turning pages of books without wasting them. Children who have not reached these levels in motor development are unable to benefit effectively from activities, and as a result, they fall behind in many learning and practical duties (Doherty, 1997, p. 14).

Being emotionally ready and eager for new experiences: Readiness for school requires self-confidence. Thanks to self-confidence, children embark on new experiences without worrying about the fear of failure. To be emotionally mature, children are expected to try to fulfill the tasks assigned to them rather than seeking immediate gratification (Doherty, 1997, p. 15).

Having age-appropriate social knowledge and competence: Expectations for behavior among children in a specific age group include displaying generally accepted behaviors within society, being able to control own actions, and being able to collaborate with peers while working on a task (Doherty, 1997, p. 15).

Having age-appropriate language skills: For a child to be able to start school, they must be able to understand verbal instructions from adults and peers and be able to express their experiences, thoughts, wishes, and feelings in a way that others can understand (Doherty, 1997, p. 16).

Having general culture and cognitive competence appropriate for age: Just as communication skills are important, general cultural knowledge is equally significant. To fulfill academic duties, children must possess a basic general knowledge appropriate for their age. Being cognitively sufficient has been described as children's ability to receive, organize, and analyze stimuli from their environment. The cognitive competencies necessary for school readiness involve the ability to understand and identify similarities and differences among groups, as well as the ability to recall and convey a specific body of knowledge (Doherty, 1997, p. 17).

2.2. School Readiness for Primary School

Considering that approximately 80% of children in the U.S. attend preschool before starting first grade, there will be a large number of children coming to preschools from different cultures and experiences (Aud et all., 2013). The National Association for the Education of Young Children has argued that the programs implemented in preschool should be more suitable for children's ages and emphasized that more work needs to be done regarding the adaptation of children with individual differences in learning experiences to school (NAEYC Position Statement, 2009).

With the increasing importance of school readiness, determining whether children are prepared has also gained significance. The National

School Readiness Indicators Initiative has argued that being ready for school is not just about reaching certain developmental levels and completing chronological age. Accordingly, families, schools, and society must provide children with opportunities and experiences that support their physical, social, emotional, language, and cognitive development; otherwise, children cannot be ready for school. To determine readiness for school, measurable and easily trackable indicators known as core indicators have been established. According to the "School-Ready Child Equation":

Ready Family + Ready Community + Ready Services + Ready Schools = School-Ready Child (Rhode Island Kids Count, 2005).

2.3. School Readiness Equation for Children

The factors affecting children's readiness for school have been identified as physical health and motor development, social and emotional development, language development and literacy, cognitive development, general knowledge, and learning methods.

Physical Health and Motor Development: Early learning is the behavior that can be acquired through full-life experiences. In academic life, the acquisition of these early learnings is dependent on being physically healthy and having appropriate motor development (Getting a Good Start in School, 1997; Center for Child Health Research, 2004).

Social and Emotional Development: Receiving consistent care at an early age affects children's social and emotional development. It is expected that children with good social and emotional development will also be more academically successful in school (Nieer Special Report, 2003; Shonkoff & Phillips, 2000).

Language Development and Literacy: Language development and early literacy skills (vocabulary, letter recognition, understanding the relationship between sounds and letters) are crucial for starting school and for future academic life (National Education Goals Panel, 1994).

Cognitive Development and General Culture: Cognitive development helps in acquiring a series of skills in early childhood, which in turn aids in developing academic skills such as observation and identifying similarities and differences (Getting a Good Start in School, 1997).

Learning Methods: Children's success in school is not only dependent on academic skills but also on their habits and learning methods (Child Trends Research Brief, 2001).

2.4. Ready Family

The educational level of the family, the age of the mother at the time of having children, child neglect and abuse, and children cared for by others are factors that influence how prepared families are.

The Education Level of the Family: The education levels of parents play a significant role in the development of their children. It has been observed that children from families with higher education levels are healthier in early childhood, are more prepared for school, and have a greater desire to pursue higher education (Center for Child Health Research, 2004, p. 86).

The Age of Mothers Having Children: Individuals who become mothers at an early age tend to have low birth weight deliveries, experience difficulties in child care, and face financial and social challenges (Center for Child Health Research, 2004, p. 92).

Child Neglect and Abuse: Neglected children or those who have been physically or sexually abused are at a high risk of experiencing problems in cognitive and emotional development. Failure in school can lead to consequences such as frequent grade repetition and becoming a mother at an early age (Dicker, Gordon & Knitzer, 2002, p. 8; English, 1998).

Children Viewed by Others: In order for children's development and growth to be healthy, they must first feel safe. All children seek a safe, consistent care and lasting relationships at home in order to trust adults. Staying in homes outside their own for extended periods can lead to emotional and behavioral problems in children (Dicker, Gordon & Knitzer, 2002, p. 7).

2.5. Ready Society

Children in poverty, support programs for families with children, and the exposure of poor families to lead accumulation and poisoning are factors that affect the preparedness of society.

Children in Poverty: Poverty can negatively affect children's health and development. It is more difficult for these children to be ready for school compared to others. Economic difficulties, the impact of poverty on the social environment, and the lack of education among families are factors that negatively affect school readiness (Center for Child Health Research, 2004).

Support Programs for Families with Children: Programs designed for families and children living in poverty are those that provide support to both the families and the children (Schorr & Marchand, 2007; Shonkoff & Phillips, 2000).

Lead Accumulation and Poisoning: Children exposed to lead tend to have lower IQs and exhibit behavioral problems. This also leads to failure in academic life and the need for special educational requirements (Barton, 2003; Center for Child Health Research, 2004).

2.6. Ready Services

Health services (healthcare services, low birth weight infants) and educational services (children receiving early childhood education, preschool teacher qualifications, proper child care, access to government assistance for child care) are factors that influence school readiness.

Health Services: Due to the lack of a social state structure in the United States, individuals are forced to obtain private health insurance personally. Some states provide health insurance services for families in poverty. Families with health insurance can have their children's healthcare services provided in hospitals from birth. Families without health insurance are unable to benefit from the very expensive hospital services, leading to prolonged illnesses in children, difficulties in continuing their education, which in turn complicates the child's academic life in every sense (Center for Child Health Research, 2004; Schorr & Marchand, 2007).

Low Birth Weight: Babies born weighing less than 2.500 grams are likely to experience difficulties in their physical development compared to others. Babies born with low birth weight are more likely to have long-term illnesses or disabilities and a need for special education (Barton, 2003; Center for Child Health Research, 2004).

Children in Early Childhood Education: Children who receive preschool education one or two years before starting kindergarten have more advanced academic, social, and emotional development (Center for Child Health Research, 2001).

Early Childhood Teacher Qualifications: Having high-quality teachers in the early childhood period has a more positive impact on children's learning and development (Nieer Special Report, 2003).

Proper Child Care: Quality child care at an early age provides children with a safe and healthy learning experience. Children who receive quality care score better on cognitive and social tests during the preschool period than those who receive poor care (Center for Child Health Research, 2004; Kagan & Rigby, 2003).

Access to Government Assistance for Childcare: Especially low-income families are looking for places where they can safely leave their children in order to earn money and provide a good education for them. The state's assistance in this matter provides high-quality child care that meets their demands (Kagan & Rigby, 2003).

2.7. Ready School

The number of children per teacher and the number of children in the classroom are factors that affect reading skills in third grade (children who have not learned to read correctly by the time they reach third grade experience academic failures in later years), as well as the readiness of schools.

Number of Children per Teacher: If the number of children per teacher is low, it becomes easier for teachers to identify the individual needs of the children and to engage with them on a personal level (Barton, 2003).

Reading Skills in 4th Grade: The reading skills score in fourth grade is a reliable indicator of children's future academic success and school readiness, as well as a reflection of whether the child's needs have been adequately met by the time they reach fourth grade (Martinez, 2004).

2.8. School Readiness Assessment Tests

Due to the United States' system of governance by states and the authority of each state to make changes to its education system, the characteristics that children should possess before starting preschool education vary across different states in the U.S. Some states admit children who wish to attend preschool institutions without requiring any tests, while other states assess children's readiness for school through tests before enrollment (Stedron & Berger, 2010).

According to 2020 data, readiness tests for starting kindergarten are implemented in 31 states in the U.S. (https://nces.ed.gov). Readiness tests for school and the knowledge areas measured by these tests (such as reading only, reading and mathematics, etc.) vary from state to state. Dynamic Indicators of Basic Early Literacy Skills (DIBELS), Phonological Awareness Literacy Screening (PALS), Bracken, Denver Developmental Screening Test II (DENVER II), and Phonological Awareness Literacy (PALS-K) are readiness assessment tests recommended for use by states (www.phii.org). These tests are not specially designed for preschool, but rather one of the specific tests prepared for preschools, which is the Kindergarten Readiness Assessment-Literacy (KRA-L) test used in the state of Ohio. The KRAl-L test has also established early literacy as a criterion for starting preschool. In this test, children are subjected to a 15 minute assessment that includes answering who-what-when-why-how questions, repeating sentences, recognizing words and rhymes, finding rhyming words for a given word, recognizing letters, and listening to and identifying the initial letters of words.

3. School Readiness in Germany

In Germany, there is generally a compulsory education requirement. Accordingly, every child who has reached the age of six and resides in Germany is required to start school, regardless of their nationality (Aytaç 1979, cited in Kutluca Canbulat & Canbulat, 2012). Starting school refers to primary school, and attending kindergarten is not mandatory.

There is no obligation to attend preschool, nor is it necessary to take a school readiness test to start preschool. Some preschools determine whether children are ready for preschool by using checklists. Most of the time, families implement these checklists and work on the areas where their children are lacking before starting kindergarten.

When children reach the age of six they must start primary school. Every student starting primary school is required to take a school readiness examination which is called "Einschulungsuntersuchung" in German. School readiness is assessed not only by the children's ages but also by many other factors. These factors are: vision and hearing, height and weight, language, motor skills, drawing and writing, basic mathematics skills and behavior (www.wegweiser-bw.de).

The particular details of school entry health checks are determined by the municipality or city, which is in charge of organizing such examinations. School admission health tests are divided into two parts. In the first section, the doctors examine the kid's vaccination and preventive check-up booklet to determine whether the child has received all of the essential immunizations and check-ups. Doctors will also assess the child's weight and height. They assess whether the child can hear and see well enough to follow school lessons; if they find that the child is having difficulty, they may recommend glasses or hearing aids. The child's motor skills and mental development are also assessed by the doctors. In other words, they look at the following (www.handbook germany.de):

Social and emotional development: The doctors examine things like the kids' ability to focus, how they behave among new people and those they know, if they have any curiosity about school, and how confident they are.

Physical and motor skills development: The doctors check the kids' ability to work with a pen or scissors and to mimic movements, among other things.

Mental Development (Cognitive Skills): The doctors check, for example, if the kids can write their names, recognize colors and forms, speak German fluently, and can tell how old they are. Additionally, the doctors assess their ability to recall information and make connections.

"School medical examination" refers to the second portion of the exam. But this step isn't usually done; it's done in the following situations (www. handbook germany.de):

- The routine physical examination was skipped by the child.
- The preemptive medical examination revealed certain irregularities.
- The child did not go to kindergarten.
- The family is unsure if their child should begin school at this time.

Whether the kid has completed the first or both portions of the examination, the doctors will go over the test results with the family at the conclusion of the visit. The doctors will suggest any appropriate support options if any irregularities are found. A confirmation that the child participated in the school entry health testing will also be given to the family. For the family to register their child in school, these results are required. The child's future school will also receive the test results from the doctors. But they only provide broad details on the child, such as if they require assistance in a certain area. Information will only be provided to the school with parental permission (www.handbook germany.de).

4. School Readiness in Finland

The fundamental principle of education in Finland is that every person living in the country has the right to receive high-quality education, regardless of their ethnic background, age, economic status, or the region in which they live. In Finland, schools from preschool education to higher education are free of charge. Starting at the age of six, the state covers the costs of textbooks, school meals, and transportation expenses for students who commute to school during the non-compulsory preschool education and the basic education known as primary education, which spans ages 7 to 16 (Education in Finland, 2012; Taguma, Litjens & Makowiecki, 2012).

Before the mandatory education age of seven, families must send their children to preschool education institutions. The law requires that before starting compulsory school, kids must participate in pre-primary education or other comparable programs for a full year (www.infofinland.fi). Pre-primary instruction is provided without charge. The child will get free food during the day. The child will receive free transportation if they live far away (more than 5 km) or if the route is challenging. The child may attend early childhood education in addition to pre-primary schooling. The local authorities decide whether pre-primary education is held in a school, an early childhood education and care center, or another appropriate site. For example, pre-primary education may be outsourced by local government from a private early childhood education and care center. Pre-primary education may also be organized by public educational institutions and private basic education providers (www.okm.fi).

A pre-primary education group may have up to 13 students if there is just one teacher present, or up to 20 students if there is another properly educated adult in the group in addition to the teacher. If there are no students in the group enrolled in compulsory education, then pre-primary education can usually only be given by qualified kindergarten teachers and class instructors (www.okm.fi). Pre-primary schooling lasts for approximately four hours each day. Children enjoy playing and discovering new things. In the context of pre-primary education, parents play a crucial role. They encourage their child's education. Every child has a customized curriculum created by the teachers. When the instructors are creating the plan, parents can help (www.infofinland.fi).

According to the national core curriculum for pre-primary education, the learning areas have been divided into five entities (www.oph.fi):

Rich World of Languages: Enhancing children's language development and linguistic identities is the goal of early childhood education and care (ECEC). Children's interest in and curiosity about languages, literature, and cultures are strengthened by ECEC. Encouraging a child's language development is linked to their multiliteracy development. It is linked, among other things, to transversal competencies related to kids' intercultural communication and skill development. The children's growing language abilities give them new opportunities to influence and actively engage.

Diverse Forms of Expression: One of ECEC's responsibilities is to assist children in developing goal-oriented musical, visual, craft, verbal, and physical expression in addition to acquainting them with a variety of artistic mediums and cultural legacies. A child's culture has a big role in defining their identity. Children get the chance to view and interact with a variety of art forms and cultural experiences thanks to ECEC. Providing the kids with musical experiences and fostering their interest in and connection to music are the two main goals of musical expression. Developing children's relationships with visual arts, other visual cultures, and cultural history is the aim of visual expression. Children can take pleasure in drawing and using art to capture beautiful moments. They are also encouraged to express themselves verbally and physically, through play, dance, and drama, for instance. The exercises and games are meant to give kids the chance to express themselves verbally and physically as well as communicate in a variety of ways.

Me and Our Community: As they start receiving ECEC outside of their families, children's living environments grow. Children encounter a variety of thought and behavior patterns in addition to the customs, operating models, values, and worldviews of their homes. ECEC aims to enhance children's comprehension of the local community's variety and provide them with opportunities to participate in it. This subject is tackled from the viewpoints of worldviews, ethical reasoning, the media, the past, present, and future of the neighborhood.

Exploring and Interacting With My Environment: The ECEC's job is to give kids the ability to notice, evaluate, and comprehend what they are in. The kids are led to investigate and engage with the constructed and natural environments. ECEC fosters children's positive attitude toward maths and helps them develop their mathematical thinking. Technology and environmental education are also included in ECEC. Children learn about causal linkages and grow as thinkers and learners through firsthand observations and interactions with learning environments. Children become more multiliterate as their ability to name things and use several concepts grows.

I Grow, Move, and Develop: I Grow, Move, and Develop is a learning area that has objectives pertaining to health, safety, food education, and physical activity. All year round, it is advised for kids to play outside and be physically active. Children are guaranteed lots of opportunities for autonomous physical activity every day, both indoors and outdoors, in addition to supervised exercise. The purpose of food education is to encourage flexible and healthful eating practices as well as good attitudes toward food and eating. In ECEC, health and safety-related issues are taken into account alongside the children. The ability of children to take care of their personal hygiene and health is encouraged. Children are taught the importance of relaxation, exercise, and positive interpersonal interactions for their overall health and wellbeing.

5. Conclusion

School readiness is a multifaceted concept that extends beyond academic skills, encompassing physical, emotional, social, and cognitive dimensions. This chapter has highlighted the diverse approaches adopted by the United

States, Germany, and Finland, reflecting each country's unique educational philosophy and societal priorities.

In the United States, school readiness is strongly influenced by its multicultural and decentralized education system. Efforts such as readiness assessments and initiatives to reduce socio-economic disparities underline the emphasis on preparing children comprehensively for academic and social success. Germany's structured approach, with mandatory health and developmental screenings before primary school enrollment, underscores the importance of holistic development, ensuring children meet minimum physical, cognitive, and emotional thresholds. Meanwhile, Finland exemplifies an equitable and inclusive model, where pre-primary education is universally accessible and tailored to individual learning needs, fostering an environment of cooperation between families and schools.

Despite their differences, all three countries converge on the idea that school readiness is a shared responsibility among families, schools, and broader societal systems. These cases emphasize the importance of early interventions and a supportive educational ecosystem in preparing children for successful transitions to formal schooling. By understanding these varied frameworks, educators and policymakers can draw valuable insights to enhance school readiness strategies globally.

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Chapter 2

The Relationship Between Self-Regulation Skills and Anxiety Levels in Preschool-Aged Children[1]

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Abstract

Early childhood is a foundational period in life, during which developmental domains and skills begin to emerge. One of these skills is self-regulation. Self-regulation skills involve the ability of an individual to control their emotional, cognitive, and behavioral characteristics. This study was conducted to examine the relationship between self-regulation skills and anxiety levels in preschool children. To this end, the study focused on the relationship between children's self-regulation skills and anxiety levels, and whether this relationship showed significant differences based on demographic characteristics.

The research was carried out with the parents of 402 children aged 4-6 years who were attending preschool education institutions in the province of Samsun. To measure children's self-regulation skills, the Self-Regulation Skills Scale for 4-6-Year-Olds (Parent Form) was used. To assess the anxiety levels of preschool children, the Preschool Anxiety Scale adapted for 4-6-year-old children was utilized, along with a personal information form created by the researcher for families and children.

For the analysis of research data, statistical techniques such as Pearson Correlation Analysis, MANOVA, ANOVA, and t-tests were employed following a normality assessment. The results of the study revealed a low-level, negative correlation between children's self-regulation skills and anxiety levels. As children's self-regulation skills increased, their anxiety levels decreased, or conversely, as anxiety levels increased, self-regulation skills declined. It was concluded that, in terms of the impact of self-regulation skills on anxiety levels, the other hypotheses did not show a significant difference.

1 This study was derived from the master's thesis titled "The Relationship Between Self-Regulation Skills and Anxiety Levels in Children Aged 4-6," prepared by the first author.

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1. Introduction

Human development, beginning with the initial formation in the mother, continues to evolve throughout life, shaped by genetic, biological, psychological, and social processes. This developmental journey is complex, with interactions that contribute to individual differences by creating unique impacts on each person. Every developmental phase is influenced by prior experiences and, in turn, affects subsequent stages. Skills acquired early serve as a foundation for those required in later stages. Positive or negative experiences during infancy and early childhood significantly impact later life. As children prepare for elementary school, they develop physically, mentally, and emotionally, and they learn essential skills such as sharing, functioning individually within a group, socializing, and cooperating with others.

The preschool period is a crucial developmental phase, laying the foundation for all developmental domains and skills and setting the stage for later growth (Akbaş, 2007). In this period, children make choices, solve daily problems, and begin to develop conscious control over their actions—skills that are known as self-regulation. Self-regulation is fundamental to early childhood, influencing a range of behavioral domains (Shonkoff & Phillips, 2000). Terms like "self-control," "impulse control," and "self-management" are used interchangeably in psychology to describe aspects of self-regulation, reflecting the diversity of perspectives across different theoretical frameworks (Bronson, 2019). The rapid development of the brain during preschool years supports the maturation of cognitive, motor, language, social, and emotional skills, enabling children to thrive when their developmental needs are met. This solid foundation positions children to become productive individuals in the future (Myers, 2004). Consequently, the preschool period is often regarded as a critical stage of life.

The concept of self-regulation emerged in the 1980s with the rise of research in social psychology and personality development, spearheaded by Bandura's social learning theory. In the 1990s, the scope of self-regulation broadened to include dimensions such as "self-control," "self-management," and "self-directed learning" (Boekaerts, Zeidner, & Pintrich, 2000).

In his social learning theory, Bandura (1989) associated the regulation of motivation and performance with various self-regulation mechanisms, highlighting factors such as emotional regulation, self-efficacy, and goal-setting. Eisenberg et al. (2011) argued that self-regulation is best understood not as a single concept but in behavioral, emotional, and cognitive dimensions, each distinct yet interconnected. For instance, Ursache et al. (2012) emphasized differences between emotional and cognitive regulation, while Eisenberg et al. (2012) highlighted distinctions between intrinsic and extrinsic motivation within self-regulation processes (as cited in Ziv, Benita, & Sofri, 2017). Recognizing the importance of developing self-regulation skills in childhood underscores the significance of fostering individuals who can understand and manage themselves effectively, make sound decisions, and maintain self-control in challenging situations (Bauer & Baumeister, 2011; Posner & Rothbart, 2009).

Emerging as early as the prenatal period, self-regulation evolves with age into a complex skill. In infancy, it begins with meeting basic needs like nutrition, sleep, and care, eventually progressing into cognitive, emotional, and behavioral regulation shaped by environmental influences. The development of self-regulation is influenced by caregivers, peers, and all aspects of the child's environment (Sameroff, 2008).

Kopp (1982) divides self-regulation development into five stages: the neurophysiological stage (0-3 months), sensorimotor stage (4-9 months), control stage (9-18 months), self-control stage (24-36 months), and self-regulation stage (36 months and beyond). Achieving self-regulation skills allows children to manage their behaviors, enabling them to develop into unique individuals. Between ages 4 and 6, self-regulation skills tend to increase in parallel with brain development, making these skills more observable (Ertürk et al., 2018). During this period, self-regulation is primarily oriented towards controlling spontaneously initiated behaviors. Self-regulation emerges through the processes of "self-directed speech," "regulating others," and "internalizing rules." Over time, situational encounters and acquired experiences facilitate the internalization of these rules. Once children internalize rules, they realize the need to regulate their behavior not for others, but for themselves (Bodrova & Leong, 2010).

Self-regulation skills, which have a complex structure, are interpreted differently across various theories. In psychoanalytic theory, self-regulation develops as a result of emotional needs and impulses (Freud, 1933). Behavioral theory, however, defines self-regulation as a set of skills learned through external influences. Social learning theory posits that self-regulation skills develop through observation, self-management, and intrinsic motivation. According to social cognitive theory, self-regulation is the ability to direct one's own behavior through self-control. Among cognitive theorists, Piaget views self-regulation as the adaptation of mental processes to align optimally with the external environment, while Vygotsky suggests that self-regulation develops through language, which, guided by inherent curiosity, directs behavior and thought through self-talk (Bronson, 2019). Information processing theory defines self-regulation as a set of executive functions that utilize both innate and learned programs (Siegler, 1989). Summarizing previous research, Kopp describes self-regulation as a multifaceted, interactive structure encompassing the regulation of emotions, behavior, motivation, and attention (Kopp, 1982).

Researchers examining cognitive self-regulation skills have also studied children who succeed academically, identifying common traits among them: awareness of their learning processes, efforts to address problems when encountered, ability to organize their learning environment, and access to support from adults or peers (as cited in Berk, 2015). These studies suggest that fostering self-regulation skills in early childhood enables children to tackle future challenges more effectively, boosting their confidence as they find appropriate ways to cope with stress (Schunk & Zimmerman, 2001). Self-regulation skills are essential for helping children become aware of their emotions, plan responses and thoughts to various situations, control impulses, and use planning and organizational skills to achieve their goals.

The concept of anxiety can be defined as a state in which a person feels threatened and uneasy in relation to a situation, person, or object, with the exact cause often unknown. Although anxiety is generally perceived as a negative concept, it varies in duration and intensity, and can be classified as an emotional disorder depending on these factors (Foxman, 2004). Individuals experiencing normal levels of anxiety can achieve success and manage threatening situations effectively. For instance, if a student preparing for an exam experiences a normal level of anxiety, it may motivate them to study, and during the exam, this level of anxiety can enable them to recall information more easily.

On the other hand, abnormal levels of anxiety negatively impact a person's life. For example, a student with high anxiety might struggle to concentrate on studying, comprehend the material, or may forget what they know during the exam due to heightened anxiety, leading to confusion (Cüceloğlu, 1998).

Anxiety is often associated with various emotions, such as sadness, helplessness, uncertainty, and criticism. It arises when an individual perceives a neutral situation as threatening and reinforces this perception over time (Eren Gümüş, 2006). Terms like worry, stress, and depression frequently appear alongside anxiety, as these concepts involve negative attitudes towards past and future events, contributing to the formation of anxiety (Köknel, 2005). Anxiety, although its causes are not entirely clear, is a state of worry that can manifest at different times and in various situations (Le Gall, 2012).

Anxiety has been widely studied in conjunction with various other topics and has emerged as a factor that affects functionality when it reaches excessive levels. It can be asserted that it impacts the functionality of not only adults but also children in their lives. Anxiety is considered an emotional state that, when maintained at a certain level, can motivate individuals to take action, yet, when it surpasses a specific threshold, it leads to debilitating and challenging outcomes (Spielberger, 1972).

Although the concept of anxiety is perceived negatively, it is a natural part of our lives. However, when the intensity and frequency of anxiety increase to an unmanageable level, it is categorized among emotional disorders. Among these disorders, anxiety is the most commonly observed (Foxman, 2004).

Foxman (2004) describes anxiety as a feeling of fear and apprehension that can arise from various causes, the exact origins of which are often unknown. Spielberger (1966) categorized anxiety into two types: state anxiety and trait anxiety. State anxiety is a temporary response that occurs in dangerous situations, while trait anxiety arises when individuals frequently perceive events as threatening. It can be said that anxious children exhibit four fundamental issues: 1) difficulty calming themselves in stressful situations, 2) challenges in utilizing cognitive processes, 3) giving up on trying out their plans, and 4) an inability to recognize the feelings associated with their anxiety despite showing efforts to alleviate them (Dacey, Mack, & Fiore, 2017).

Alfred Adler, a proponent of individual psychology, defines the individual's purpose as adapting to society and expresses anxiety as a condition characterized by the display of inferiority and superiority complexes while attempting to fit into society. Adler posits that every individual begins with a sense of inferiority (inadequacy) and that this feeling is universal. A child experiencing feelings of inferiority spends a prolonged period reliant on an adult for survival. During this experience, the child compares themselves to strong, large adults in their environment and develops feelings of inferiority or superiority complexes when they aspire to be like them. This condition induces anxiety in individuals (Hazar, 2006). According to behavioral theory, anxiety is learned. Anxiety dissipates with the removal of conditioned stimuli.

In social learning theory, Bandura states that anxiety develops through observation and modeling of the child's family. According to the cognitive approach, anxiety is determined by the individual's perception and interpretation of events. Anxiety arises when there is a distortion in thought between perception and interpretation (Serin & Öztürk, 2007).

Anxiety disorders encompass subdimensions in both adults and children. These subdimensions include specific (simple) phobia, social phobia, separation anxiety, generalized anxiety disorder, panic disorder, agoraphobia, obsessive-compulsive disorder (OCD), and post-traumatic stress disorder (PTSD), consisting of a total of eight subdimensions (Spence, Rapee, McDonald, & Ingram, 2001; Dacey, Mack, & Fiore, 2017).

Despite the presence of numerous factors that contribute to anxiety, Foxman (2004) categorizes them into three main headings: personality, biological sensitivity, and stress. Biological sensitivity can be explained by genetic predisposition. Indicators of this may include hormonal imbalances and sensitive temperament. Anxiety emerges as a result of the child's experiences and biological sensitivity.

Anxiety is necessary to motivate various tasks in daily life; however, as its level increases, it transforms into a disorder. Anxiety disorders can be observed in children, adolescents, middle-aged individuals, and adults, meaning they can affect individuals of all ages.

A child's development comprises distinct stages, each bringing new learning opportunities. New situations and events in a child's life can lead to the emergence of anxiety. A child's personality is shaped by their experiences and biological factors, ultimately resulting in the development of an anxiety profile. Children with this profile tend to exhibit notable characteristics, such as a propensity for worry, a desire to please others, a heightened sense of responsibility, and the establishment of high standards for achievement. When faced with stress, these children often respond excessively due to their difficulty in effectively managing stress (Foxman, 2004).

Among the causes of anxiety in children aged 4 to 6, factors such as stranger anxiety, loud noises, animals, darkness, water, and separation from caregivers can be listed (Dacey, Mack, & Fiore, 2017). Because children in this age group may not express themselves as well as adults (Cebeci, 2009), it is essential for families to observe their children. Children who are overly restricted and less accepted by their families may exhibit elevated levels of anxiety. Spence et al. (2001) noted that anxieties arising in early childhood can impact future life outcomes. According to Foxman, there are specific characteristics that should be monitored to keep anxiety levels as low as possible in normally developing children: preschool-aged children should be provided with play environments and encouraged to engage in play, books should be read to them, curiosity should be supported, symptoms related to stress should be monitored, and environments that may induce stress should be structured appropriately (Foxman, 2004).

Just as adults display certain reactions when feeling anxious, children also show anxiety symptoms in similar situations. However, because children may struggle to articulate their feelings, their anxiety can go unnoticed. This has resulted in a delayed initiation of research on anxiety during childhood (Dacey, Mack, & Fiore, 2017).

It can be considered that the concepts of anxiety and self-regulation may be indirectly related to one another. Preschool children may attempt to solve problems encountered in daily life through steps such as monitoring, making predictions, and planning, based on the experiences they gain within their families and environments. These stages may contribute to the development of the children's self-regulation skills. As children acquire skills for self-control and regulation in their emotions and behaviors, their levels of anxiety may decrease. Therefore, it is thought that research should be conducted on the interactions between these two concepts in terms of managing and promoting positive levels of anxiety in children.

The early childhood period is foundational for life, and during this stage, various developmental domains and skills begin to emerge. One of these skills is self-regulation. Self-regulation skills can be described as emotional abilities such as being aware of emotions, controlling them, mitigating the effects of negative situations, and managing anger, as well as cognitive characteristics like maintaining attention, preventing distraction, and redirecting focus when necessary. The aim of supporting self-regulation skills in children is not to train them to comply with challenging rules, but rather to assist them in developing these skills by enabling them to conduct self-assessments using internal guidelines.

2. Methodology

2.1. Research Design, Population, and Sample

This study employed a correlational survey model to investigate the relationship between self-regulation skills and anxiety levels in children aged 4-6 years. The correlational survey model is used to determine the nature and strength of relationships among variables without any intervention by the researcher (Büyüköztürk, Çakmak, Akgün, Karadeniz, & Demirel, 2014). In line with this model, variables that may affect self-regulation skills and anxiety levels—such as the child's gender, age, and parental education level—were identified, and data were collected to analyze their relationship.

The population of this study consisted of parents with children aged 4-6 years attending official preschools and private educational institutions in the province of Samsun during the 2019-2020 academic year. The sample included 402 parents selected through purposeful sampling to ensure a heterogeneous distribution across official preschools and private educational institutions. Purposeful sampling is a method that selects samples based on predetermined criteria aligned with the research objectives (Büyüköztürk, Çakmak, Akgün, Karadeniz, & Demirel, 2014).

Table 1. The emergence of children according to their gender and experiences

Tables		n	%
Gender	Girl	181	45,0
	Boy	221	55,0
Age	4	120	29,9
	5	138	34,3
	6	144	35,8
	Total	402	100

Table 2. Distribution of parents according to educational status

Tables	Educational Status	n	%
	Primary School	82	20,4
	Secondary School	86	21,4
	High School	101	25,1
	Higher Education	133	33,1
	Total	402	100

2.2. Data Collection Tools

2.2.1. Personal Information Form

A personal information form was developed by the researcher to gather information on the gender, age, and parental educational background of children aged 4-6 years.

2.2.2. Self-Regulation Skills Scale for 4-6-Year-Old Children (Parent Form)

To measure self-regulation skills based on parental perspectives, the Self-Regulation Skills Scale for 4-6-Year-Old Children (Parent Form) developed by Erol and İvrendi (2018) was utilized. This scale is a 5-point Likert-type measure consisting of 20 items, with scores ranging from a minimum of 20 to a maximum of 100 points. Higher scores indicate stronger self-regulation skills. The scale includes four sub-dimensions: attention, working memory, inhibitory control-emotion, and inhibitory control-behavior. The internal consistency reliability coefficient (Cronbach's alpha) was found to be 0.90 for the entire scale, with sub-dimension reliability coefficients of 0.89 for attention, 0.89 for working memory, 0.82 for inhibitory control-emotion, and 0.77 for inhibitory control-behavior (Erol & İvrendi, 2018).

2.2.3. Revised Preschool Anxiety Scale for Children Aged 4-6

The Revised Preschool Anxiety Scale, adapted to Turkish by Güler (2016) based on the original scale by Edwards, Rapee, Kennedy, and Spence (2009), was used to measure the anxiety levels of 4-6-year-old children. This scale consists of 30 items rated on a 5-point Likert scale. The reliability analyses showed a Cronbach's alpha of .90 and a McDonald's omega of .92 for the overall scale. Test-retest reliability coefficients were .53 for social anxiety, .35 for generalized anxiety, .55 for separation anxiety, .59 for specific fears, and .53 for the total score (Güler, 2016).

2.3. Hypotheses

The following hypotheses were proposed:

1. There is a significant relationship between self-regulation skills and anxiety levels in children aged 4-6.
2. The relationship between self-regulation skills and anxiety levels differs significantly by gender.
3. The relationship between self-regulation skills and anxiety levels differs significantly by age.
4. The relationship between self-regulation skills and anxiety levels differs significantly by parental education level.
5. Self-regulation skills differ significantly by gender.
6. Self-regulation skills differ significantly by age.
7. Self-regulation skills differ significantly by parental education level.
8. Anxiety levels differ significantly by gender.
9. Anxiety levels differ significantly by age.
10. Anxiety levels differ significantly by parental education level.

2.4. Data Analysis

The data were analyzed using SPSS (Statistical Package for Social Sciences) version 22.0, a widely used tool in social sciences research. Before analysis, data accuracy, missing values, and outliers were checked. Descriptive statistics were used to summarize information on the children's age, gender, and parental education level.

The research data was examined for normal distribution. It was found that the skewness value of the self-regulation skills scale items in the mother form for children aged 4-6 years was -0.428, and the kurtosis value was -0.520. In the preschool anxiety scale, which was rearranged for preschool children aged 4-6, the skewness value of the items was observed to be 0.340, while the kurtosis value was -0.370. Tabachnick and Fidell (2013) stated that when the kurtosis and skewness values fall between -1.5 and +1.5, the data indicate normal distribution. George and Mallery (2012) indicated that when the kurtosis value is between -1.0 and +1.0, and in some specific applications, between -2.0 and +2.0, the data demonstrate normal distribution. Hair et al. (2013) also noted that when the skewness value is between -1.0 and +1.0, the data show normal distribution.

After determining that the data exhibited normal distribution, it was decided to use parametric tests. To examine the relationship between self-regulation skills and anxiety levels, Pearson Product-Moment Correlation Coefficient was calculated. Additionally, MANOVA was conducted to investigate whether self-regulation skills and anxiety levels showed significant differences based on gender, age, and parental education status (Büyüköztürk, 2018). Before applying the MANOVA test, the assumptions of MANOVA were checked, and the following steps were carried out: The equality of covariance for self-regulation skills and anxiety levels concerning gender, age, and parental education status was first examined. The covariance equality values were found to be 0.271 for the gender variable, 0.400 for the age variable, and 0.847 for the parental education status variable. Since these values were $p > 0.05$, it was concluded that the covariance values exhibited equal distribution. After assessing covariance equality, variance equality was examined using Levene's test. The variance equality for self-regulation skills and anxiety levels concerning the gender variable was found to be 0.137 and 0.718, respectively. For the age variable, the variance equality of self-regulation skills and anxiety levels was 0.876 and 0.149, respectively. For parental education status, the variance equality for self-regulation skills and anxiety levels was observed to be 0.014 and 0.879, respectively. The values for gender and age variables were $p > 0.05$, indicating equal distribution of variances. However, while parental education status showed equal distribution for anxiety levels, the $p < 0.05$ for self-regulation skills indicated that they did not exhibit equal variance distribution. Therefore, the results of the MANOVA test were interpreted according to Pillai's Trace statistic (Büyüköztürk, Çakmak, Akgün, Karadeniz, & Demirel, 2014). To examine whether there was a significant difference between self-regulation skills and the gender variable, a t-test was conducted. One-Way ANOVA was applied for self-regulation skills concerning age and parental education status. To investigate whether there was a significant difference between anxiety levels and the gender variable, a t-test was also conducted, and One-Way ANOVA was applied for anxiety levels concerning age and parental education variables. In all statistical analyses, a significance level of 0.05 was accepted as the upper limit.**3.**

3. Findings

3.1. The Relationship Between Self-Regulation Skills and Anxiety Levels

Table 3. Pearson Product-Moment Correlation Results Between Self-Regulation Skills and Anxiety Levels in Children Aged 4-6 Years

	Self-Regulation Skills	Anxiety Levels
Self-Regulation Skills	1	-,213**
Anxiety Levels	-,213**	1

N=402, **p < .001

Upon examining Table 3, it is observed that there is a low-level, negative relationship between self-regulation skills and anxiety levels in children aged 4-6 years. According to this finding, as self-regulation skills increase, anxiety levels decrease, or conversely, as anxiety levels increase, self-regulation skills decrease.

3.2. The Relationship Between Self-Regulation Skills and Anxiety Levels in Relation to Gender and Age Variables

Table 4. MANOVA Results for Self-Regulation Skills and Anxiety Levels in Children Aged 4-6 Years Concerning the Gender Variable

		Value	F	Hipotezdf	Hatadf	p	η^2
Gender	Pillai'sTrace	,011	2,211[b]	2,000	399,000	,111	,011
Age	Pillai'sTrace	,019	1,88	4,00	798,00	,111	,009

Upon examining the table, it was concluded that there was no significant difference in the relationship between self-regulation skills and anxiety levels among children aged 4-6 years based on the gender variable ($p > .05$). As a result of these findings, it can be seen that the relationship between self-regulation skills and anxiety levels in children aged 4-6 years is not influenced by the gender variable. According to the MANOVA results concerning the age variable, it was also concluded that there was no significant difference in the relationship between self-regulation skills and anxiety levels in children aged 4-6 years based on the age variable ($V = .019$, $F (4.00) = 1.88$, $p > .05$). Consequently, it can be seen that the relationship between self-regulation skills and anxiety levels in children aged 4-6 years is not influenced by the age variable.

3.3. The Relationship Between Self-Regulation Skills and Anxiety Levels in Relation to Parental Education

Table 5. MANOVA Results for Self-Regulation Skills and Anxiety Levels in Children Aged 4-6 Years Concerning Parental Education Status Variable

		Value	F	Hypothesis df	Hata df	p	η^2
Educational Status	Pillai'sTrace	,008	,528	6,000	796,000	,787	,004

Upon examining the table, it was concluded that there was no significant difference in the relationship between self-regulation skills and anxiety levels among children aged 4-6 years based on the parental education status variable ($V = .008$, $F (6.00) = .52$, $p > .05$). As a result of these findings, it can be seen that the relationship between self-regulation skills and anxiety levels in children aged 4-6 years is not influenced by the parental education variable.

3.4. The Relationship Between Self-Regulation Skills and Gender

Table 6. T-Test Results for Total Scores of Self-Regulation Skills Scale (Mother Form) for Children Aged 4-6 Years by Gender for Independent Samples

	$\bar{x}$	*S.s*	*sd*	*t*	*p*
Girl	82.11	7.84	400	1.52	.128
Boy	80.82	8.86			

The results of the independent samples t-test conducted in Table 6 indicated that there was no significant difference in the total scores of the self-regulation skills scale (mother form) for children aged 4-6 years based on gender ($t(400) = 1.52$, $p > .05$). These findings suggest that the levels of self-regulation skills in both girls and boys are similar.

3.5. The Relationship Between Anxiety Levels and Gender

Table 7. T-Test Results for Total Scores of the Revised Anxiety Scale for Children Aged 4-6 Years by Gender for Independent Samples

	$\bar{x}$	*S.s*	*sd*	*t*	*p*
Girl	66.93	17.35	400	1.08	.279
Boy	65.04	17.48			

The results of the independent samples t-test conducted in Table 7 indicated that there was no significant difference in the total scores of the revised anxiety scale for children aged 4-6 years based on gender ($t(400) = 1.08$, $p > .05$). These findings suggest that the anxiety levels of both girls and boys are similar.

3.6. The Relationship Between Self-Regulation Skills and Age

Table 8. One-Way ANOVA Results for Total Scores of the Self-Regulation Skills Scale (Mother Form) for Children Aged 4-6 Years by Age

	$\bar{x}$	*S.s*	sd_1, sd_2	*F*	*p*
4 yaş	80.31	8.63	2, 399	1.84	.154
5 yaş	82.33	8.18			
6 yaş	81.43	8.44			

The results of the one-way ANOVA conducted in Table 8 indicated that there was no significant difference in the total scores of the self-regulation skills scale for children aged 4-6 years based on age ($F(2, 399) = 1.84$, $p > .05$). These findings suggest that the self-regulation skills of 4, 5, and 6-year-old children are similar.

3.7. The Relationship Between Anxiety Levels and Age

Table 9. One-Way ANOVA Results for Total Scores of the Revised Anxiety Scale for Children Aged 4-6 Years by Age

	$\bar{x}$	S.s	sd_1, sd_2	F	p
4 years	64.37	16.37	2, 399	1.14	.320
5 years	67.59	18.56			
6 years	65.52	17.14			

In the one-way ANOVA conducted in Table 9, it was found that there was no significant difference in the total scores of the revised anxiety scale for children aged 4-6 years by age ($F(2, 399) = 1.14$, $p > .05$). These findings indicate that the anxiety levels of children aged 4, 5, and 6 are similar.

3.8. The Relationship Between Self-Regulation Skills and Parental Education Status

Table 10. One-Way ANOVA Results for Total Scores on the Self-Regulation Skills Scale (Mother Form) by Parental Education Status for Children Aged 4-6

Educational Status	$\bar{x}$	S.s	sd_1, sd_2	F	p
Primary School	81.65	7.98	3, 398	.746	.525
Secondary School	80.23	9.63			
High School	81.96	8.19			
Higher Education	81.59	8.05			

In Table 10, the results of the one-way ANOVA indicate that there is no significant difference in the total scores of the self-regulation skills scale for children aged 4-6 based on parental education status ($F(3, 398) = .746$, $p > .05$). These findings suggest that the self-regulation skills are similar regardless of the parents' educational background.

3.9. Relationship Between Anxiety Levels and Parental Education Status

Table 11. One-way ANOVA Results for Total Scores of the Anxiety Scale, Revised for 4-6 Years of Age, According to Parental Education Status

Educational Status	$\bar{x}$	S.s	sd_1, sd_2	F	p
Primary School	66.29	17.33	3, 398	.206	.892
Secondary School	65.17	17.99			
High School	65.16	17.46			
Higher Education	66.66	17.26			

In Table 11, the results of the one-way ANOVA indicate that there is no significant difference in the total scores of the revised anxiety scale for children aged 4-6 according to parental education status ($F(3, 398) = .206$, $p > .05$). These findings suggest that the anxiety levels are similar across different parental education statuses.

4. Discussion

According to the first hypothesis of the study, a negative low-level significant relationship was found between the self-regulation skills and anxiety levels of children aged 4 to 6 years. This finding suggests that as the self-regulation skills of children in this age group increase, their anxiety levels decrease, or conversely, as anxiety levels rise, their self-regulation skills decline. Based on this outcome, the first hypothesis of the study has been accepted.

Upon reviewing the existing literature, there are studies that have reached similar conclusions to those of this research. It has been found that students with high levels of social anxiety have lower expectations of achieving their goals and that these expectations are significantly negatively correlated with self-regulation skills (Kocovski & Endler, 2000). In the study by Asıcı and Uygur, a significant negative relationship was identified between the level of emotional regulation and the perceived level of stress (Asıcı & Uygur, 2017). Pritchard and Mezo found a negative correlation between self-regulation and optimism with anxiety (Pritchard & Mezo, 2017). Çiçek concluded that there is a positive relationship between self-regulation and motivation, and a negative relationship between self-regulation and anxiety (Çiçek, 2018). Another study indicated that individuals with a positive self-concept experience less chronic anxiety (Hamarta, Deniz, Arslan, & Dilmaç, 2012).

These findings, supported by the results from the literature, indicate a negative relationship between self-regulation—defined as the ability to control emotions, delay behaviors, suppress impulses, and maintain attention—and anxiety, which is characterized as an often undefined state in which an individual feels threatened, worried, and restless towards a situation, person, or object. Individuals with high anxiety levels may react with anger and aggression when faced with any stressful situation or obstacle, and they may struggle with regulating their emotions and behaviors.

The sub-dimensions of self-regulation, namely cognitive regulation and emotional regulation, are interrelated; a change in one affects the other. Therefore, a child who struggles to cope with anxiety, stress, or frustration may also have difficulty regulating their cognitive skills. For instance, a student with exam anxiety may find it challenging to concentrate while preparing for or during the exam, which can impair their comprehension of the material. Similarly, a child with social phobia may struggle to regulate their emotions and behaviors due to an intense preoccupation with thoughts such as, "What do people think of me?" Furthermore, since anxiety disorders are classified as emotional-behavioral disorders, it is expected that children with low self-regulation skills will experience heightened levels of anxiety.

According to the second hypothesis of the study, when examining the findings related to the comparison of the relationship between self-regulation and anxiety among children aged 4-6 in terms of the gender variable, it was concluded that there were no significant differences in the relationship between self-regulation and anxiety based on gender. Therefore, the second hypothesis of the study was not accepted. Similar findings can be found in the literature. In preschool children, the relationship between emotional regulation and anxiety levels has not been found to be significant based on gender (Cohen et al., 1993; Bosquet & Egeland, 2006; Else-Quest et al., 2006; Lavigne, LeBailly, Hopkins, Gouze, & Binns, 2009).

Research that yielded different results from this study has also been found. Seçer, Sarı, Çeliköz, and Üre concluded in their study that male children tend to exhibit more impulsive behaviors compared to female children (Seçer, Sarı, Çeliköz, & Üre, 2009). Male children who are unable to control their impulses may not be aware that not everything can be done immediately and that some desires need to be postponed. However, the better they can control, postpone, or substitute their impulses with other activities, the better they can cope with anxiety.

According to the third hypothesis of the study, when examining the findings related to the comparison of self-regulation and anxiety levels among children aged 4-6 in terms of the age variable, it was concluded that there were no significant differences between self-regulation and anxiety levels. Therefore, the third hypothesis of the study was not accepted. No studies have been found in the literature that specifically examine the relationship between self-regulation and anxiety in relation to the age variable. However, there are studies that investigate self-control and anxiety, as well as self-control and stress levels according to the age variable. In their study, Lavigne, LeBailly, Hopkins, Gouze, and Binns found no significant relationship between self-control and anxiety in terms of the age variable (Lavigne, LeBailly, Hopkins, Gouze, & Binns, 2009). Similarly, Doron and Sharbani did not find a significant relationship between self-control and stress in relation to age (Doron & Sharbani, 2013). The results in the literature parallel the findings of this study.

When examining the findings related to the fourth hypothesis of the study regarding the comparison of self-regulation and anxiety levels among children aged 4-6 in terms of parental education level, it was concluded that there were no significant differences between self-regulation and anxiety levels. Therefore, the fourth hypothesis of the study was not accepted. It was expected that as parental education levels increase, the quality of the relationship established with their child would develop in a more desirable direction. It was anticipated that parents with higher education levels would establish harmonious, balanced, and understanding relationships with their children, and that the development of self-regulation skills would be facilitated through more conscious interactions. Based on this reasoning, the hypothesis was formulated. However, the elevation of a parent's education level may not necessarily equip them with the skills needed to enhance the quality of their relationship with their child. Moreover, considering the fact that many multifaceted factors influence the establishment of quality relationships, parental education level may not be effective in this regard. In the literature, there are no studies found that specifically investigate the relationship between self-regulation skills and anxiety levels in relation to parental education status. However, studies on self-regulation and anxiety, as well as self-control and stress, have been identified. No significant relationship was found between self-regulation and anxiety concerning parental education level (Padilla-Walker, Coyne, Collier, & Nielson, 2015), nor was a significant relationship found between self-control and stress levels with respect to parental education status (Doron & Sharbani, 2013). The results emerging from these studies are similar to the findings of this research.

According to the fifth hypothesis of the study, which posits that there is a significant difference in self-regulation skills among children aged 4-6 based on gender, it was concluded that self-regulation skills did not show significant differences according to gender. Therefore, the fifth hypothesis of the study was not accepted. In the literature, however, studies indicate that self-regulation skills vary by gender, with girls demonstrating higher levels of self-regulation compared to boys (Kockansha, Murray & Coy, 1997; Ersoy, 2009; Tutkun, Şahin, Işıktekiner, 2017; Çiçek, 2018). The vocabulary of girls aged 4-5 is more developed than that of boys. This advantage in language development enables girls to express themselves better, adapt more easily to their surroundings, and think more quickly. Children with good language development can also better control their impulses. Expected behaviors from boys and girls in society also differ. While girls are expected to express their behaviors and emotions more controlled, negative behaviors are often normalized in boys. For instance, when a boy uses a rude word, adults may laugh it off, whereas the same reaction is not given to a girl. Therefore, it can be stated that girls are better able to regulate their behaviors, emotions, and attention compared to boys.

According to the sixth hypothesis of the study, which posits that there is a significant difference in self-regulation skills among children aged 4-6 based on age, it was concluded that no significant differences were found concerning the age variable. Thus, the sixth hypothesis of the study was also not accepted. A review of the literature shows that self-regulation varies with age (Moses, 2001; Akshoomoff, 2002; Carlson, 2005; Blair & Razza, 2007; Carlson & Wang, 2007; Liew et al., 2008; Taylor, 2011; Eggum et al., 2011; Tanrıbuyurdu, 2012; Tutkun, Şahin, Işıktekiner, 2017). As a child grows older, their experiences gained from the environment increase. In addition to experiences, the improvement in self-regulation skills also occurs with maturation, as maturation is a prerequisite for learning. Continuous progress is expected in self-regulation with the interaction between learning and mental, physical, and emotional maturation.

According to the seventh hypothesis of the study, which posits that there is a significant difference in self-regulation skills among children aged 4-6 based on parental education level, it was concluded that self-regulation skills did not show significant differences according to parental education status. Therefore, the seventh hypothesis of the study was not accepted. In their research, Tutkun, Şahin, and Işıktekiner (2017) found that parental education level did not affect self-regulation. Klenberg (2015) determined that as the educational level of the family increases, the attention dimensions of students also improve. In a study conducted by Bernier, Carlson, and

Whipple (2010), it was concluded that as mothers' educational levels rise, the self-efficacy of self-regulation in children also increases.

Parents with higher education levels are generally more conscious about how to regulate their emotions. Children learn emotional regulation strategies by observing their parents. The educational levels of families can impact their socioeconomic status, and it can be stated that parents with higher education levels tend to work in better professions and have a higher income. Therefore, a child's self-regulation skills may be influenced by the family's socioeconomic status, the professions they engage in, and their income level.

According to the eighth hypothesis of the study, which posits that there is a significant difference in anxiety levels among children aged 4-6 based on gender, it was concluded that anxiety levels did not show significant differences according to the gender variable. Therefore, the eighth hypothesis of the study was not accepted. Cohen et al. (1993), Bosquet and Egeland (2006), and Else-Quest et al. (2006) found no significant difference between anxiety levels and gender during the preschool period; however, Bouldin and Pratt (1998), Muris, Schmidt, and Merckelbach (2000), Essau, Muris, and Mederer (2002), Alisinanoğlu and Ulutaş (2003), Nauta et al. (2004), Wichstrøm et al. (2012), and Paulus et al. (2015) reported that girls exhibited higher anxiety levels than boys in school-aged children, indicating a significant difference based on gender.

Girls tend to experience daily life excitements more intensely and behave more meticulously compared to boys. Their intense emotional experiences and the ability to sustain them for extended periods can explain their higher anxiety levels. Meticulous behavior can be attributed to socially prescribed roles, which also reflect in the types of games children play. Girls are more likely to engage in role-playing and cleaning games. The intensity of cleaning-related games may predispose children to future obsessive-compulsive disorders. From a cultural perspective, boys tend to have more opportunities to express their thoughts freely compared to girls. Therefore, it can be argued that boys may be at a relative advantage concerning familial experiences that could lead to anxiety.

According to the ninth hypothesis of the study, which posits that there is a significant difference in anxiety levels among children aged 4-6 based on age, it was concluded that anxiety levels did not show significant differences according to the age variable. Therefore, the ninth hypothesis of the study was not accepted. In a study by Bora (2019) examining the relationship between the anxiety levels of preschool children and their parents, no significant results were found between the children's anxiety levels and their ages. This result supports the conclusion of the hypothesis. Küçüködek (2015) found that as children's ages increase, separation anxiety decreases, while Spence et al. (2001) reported that 3-year-old children have higher anxiety levels compared to 4- and 5-year-olds. This may be attributed to the separation anxiety experienced by 3-year-olds who are starting preschool. Güngör (2009) also observed that 6-year-old children had higher anxiety levels compared to 5-year-olds. As children grow older, their awareness increases, and the thought that 6-year-olds will start a new school in a year may cause anxiety.

According to the tenth hypothesis of the study, which posits that there is a significant difference in anxiety levels among children aged 4-6 based on parental education level, it was concluded that anxiety levels did not show significant differences according to parental education status. Therefore, the tenth hypothesis of the study was not accepted. A review of the available literature indicates that as parental education levels increase, children's anxiety levels tend to decrease (Hsu, 2004; Beesdo, Knappe & Pine, 2009; Güngör, 2009; Murray, Creswell & Cooper, 2009; Rapee, Schniering & Hudson, 2011; Bora, 2019). It is expected that as parents' educational levels rise, they will also be more conscious in parenting practices, avoiding attitudes such as judgment, criticism, punishment, or belittlement when their children fail. Parents are anticipated to be knowledgeable about their children's developmental characteristics and to set goals according to those characteristics to foster a sense of achievement in their children. Consequently, these attitudes are expected to help children avoid negative emotions that could lead to anxiety within the family environment.

5. Conclusion and Recommendations

5.1. Results

In the study conducted to determine the relationship between self-regulation skills and anxiety levels in preschool children, the following results were obtained:

When examining the relationship between self-regulation skills and anxiety levels, a negative, low-level significant relationship was found. Accordingly, it can be said that as self-regulation skills increase, anxiety levels decrease, or conversely, as anxiety levels increase, self-regulation skills decline.

When comparing the relationship between self-regulation skills and anxiety levels based on gender, no significant difference was found between girls and boys. Similarly, when examining the relationship between self-regulation skills and anxiety levels in terms of age, no significant difference was observed.

In terms of parental education status, the comparison of self-regulation skills and anxiety levels revealed no significant differences based on parental education. Additionally, when comparing self-regulation skills based on gender, no significant difference was found between the levels of self-regulation skills of girls and boys.

When examining the findings regarding the comparison of children's self-regulation skills based on age, no significant difference was found. This indicates that the self-regulation skills of 4-, 5-, and 6-year-old children are similar. Similarly, when the findings regarding the comparison of children's self-regulation skills based on parental education status were analyzed, no significant difference was found according to parental education levels.

In terms of anxiety levels, when comparing the findings based on gender, no significant difference was observed between the anxiety levels of girls and boys. Likewise, when the findings regarding the comparison of children's anxiety levels by age were examined, no significant difference was found. This suggests that the anxiety levels of 4-, 5-, and 6-year-old children are also similar. Additionally, when examining the comparison of children's anxiety levels based on parental education status, no significant differences were found.

In conclusion, it can be stated that this study provides concrete and significant information about the relationship between self-regulation skills and anxiety levels in 4- to 6-year-old children.

5.2. Recommendations

Based on the findings from the research, the following recommendations can be made to assist future studies by experts in the field and practitioners:

1. This study utilized a cross-sectional approach within quantitative research methodologies. Conducting longitudinal studies could provide more detailed and long-term insights regarding the problem. Additionally, employing qualitative research methods would enhance the understanding of the topic. Qualitative studies can yield non-verbal data and allow participants to express their experiences in their own words, making their situations clearer and more comprehensible.
2. Other variables that may influence the relationship between self-regulation skills and anxiety levels in children aged 4-6 can also be

examined. For instance, variables such as self-esteem, play behaviors, stress levels, optimism, and attachment styles could be investigated for their impact on the relationship between self-regulation skills and anxiety levels.

3. This research found a relationship between self-regulation skills and anxiety levels in children aged 4-6. Future studies could focus on developing and implementing educational programs aimed at enhancing self-regulation skills and reducing anxiety levels.
4. In preschool education, there should be greater emphasis on practices that support the development of self-regulation skills, enabling children to manage their own learning processes.
5. Classroom practices should be chosen to enhance self-regulation, enabling children to manage their thoughts, emotions, and behaviors through increased self-awareness.
6. Preschool educational environments should be equipped with materials that support the development of self-regulation skills.
7. Self-regulation skills should be supported in both school and home environments. To achieve this, parents should be educated through home visits and seminars, teaching them activities that can support their children in the home setting.

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Chapter 3

Play Therapy, Its Types and Use in Early Childhood

Didem Semerci Arıkan[1]

Abstract

Play therapy, which constitutes one of the important areas of child therapy, is a field where a safe environment is provided for children to express their feelings and thoughts and to solve problems through play, and where the therapeutic power of play is used to help resolve issues. Play therapy, with a history of about a hundred years, has changed, developed, and diversified through the practices of researchers until today. The use of play for therapeutic purposes first began with Freud and has taken its current form through the work of many researchers such as Hug-Hellmuth, Winnicott, Rogers, and Axline on play therapy. Play therapy falls into two main categories: directive and non-directive play therapy. Play therapy can take different names and be applied differently depending on the theoretical framework on which the application is based, the application environment, the toys used in the application, and the practitioner's approach. The types of play therapy frequently studied in the literature are; psychoanalytic play therapy, release play therapy, experiential play therapy, Adlerian play therapy, Jungian analytic play therapy, structured play therapy, Gestalt play therapy, filial therapy, group play therapy, Theraplay, cognitive-behavioral play therapy, child-centered play therapy, Storyplay and sand therapy. Play therapy, mostly used in children between the ages of 3-12, can be applied in many areas such as ADHD, anxiety, developmental delays, behavioral problems, separation, and domestic violence. Literature reviews show that many types of play therapy are highly effective tools in solving various problems such as aggression, anxiety, and shyness in early childhood, especially covering the 0-8 age group.

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1. Introduction

Play therapy, a topic that has frequently come to the forefront in recent years and is extensively studied in the literature, constitutes one of the oldest and most popular areas of child therapy (Schaefer & Kaduson, 2006). The use of play for therapeutic purposes began and gained importance when mental health professionals recognized the role of play in child development (VanFleet, Sywulak & Caparosa Sniscak, 2018). The therapeutic power of play has been addressed under the headings of communication, emotional regulation, relationship development, moral judgment, coping with stress, strengthening the ego, preparing for life, and self-actualization, which has formed the basis for the therapeutic use of play (Blundon Nash & Schaefer, 2017).

The basic assumptions of therapists explaining the role of play in therapy about the therapeutic value of play are as follows (VanFleet, Sywulak & Caparosa Sniscak, 2018):

- Play contributes comprehensively to children's cognitive, emotional, social, motor, and moral development, and enhances their skills and competencies in these developmental areas.
- Play is a concept that expresses children's perceptions, emotions, inner worlds, wishes, and struggles.
- Play is a highly powerful source of motivation for children. Although play is an action seen in all age groups, it is more common in children.
- Play is a form of communication that children use to convey their emotions, thoughts, perceptions, and desires to their therapists, parents, and peers.
- Play, in addition to being effective in children's learning of traditions and social rules, also supports their ability to bond with their parents and peers.
- Play helps children express positive emotions like excitement and happiness while reducing negative emotions such as anxiety and distress.
- Play is a highly effective tool for children to overcome the problems they experience. In an environment where they feel emotionally safe without any punishment, it supports children's ability to reveal their inner worlds and find creative solutions to their problems.

- Play allows children to take risks, experience certain adversities, manage and regulate their impulses, providing them with opportunities to experience power and control.

The assumptions about the therapeutic value of play demonstrate the importance of using play for therapeutic purposes in children. Additionally, it shows that play therapy contributes to many areas such as children's development, ability to communicate, motivations, express their thoughts and feelings, bond with their peers and parents, and solve their problems.

2. Play Therapy

Play Therapy emerges as a concept defined in various ways by many researchers and organizations in the literature.

Axline (1981) defines play therapy as an opportunity for children to express their problems and emotions through play. According to Axline, just as adults can express themselves and their troubles through talking, children use play in play therapy as a natural way of expressing themselves.

According to another definition, play therapy is an approach that allows therapists to guide children using play, toys, art materials, and various play tools. Especially for children under twelve years old, their limited ability to come to counseling sessions in adult therapy, explain their problems to the therapist, and express themselves hinders the treatment they would receive. Play therapy, on the other hand, prevents this by enabling children to communicate comfortably with the therapist and express themselves (Kottman, 2011a).

According to Keppers (1981), play therapy is described as an important opportunity for children to express feelings such as loneliness, failure, inadequacy, fear, and hatred, and to solve their problems.

According to the Association for Play Therapy of America, play therapy can be described as the systematic use of the therapeutic power of play by trained play therapists to assist the client in promoting optimal development, preventing difficulties, and supporting problem-solving (United States Association for Play Therapy, n.d.).

According to the Canadian Association for Play Therapy, play therapy is a psychotherapeutic treatment developed to support children between the ages of three and twelve. This approach involves working with specially selected toys in an environment that encourages the child to express themselves safely and exhibit healthy behaviors. The therapist's goal is to use the therapeutic power of play to explore and solve the child's problems (Eugster, n.d.).

The British Association of Play Therapists defines play therapy as "A way of helping children express their feelings and cope with their emotional problems by using play as the primary means of communication." (British Association of Play Therapists, n.d.a).

The Australian Association of Play Therapists similarly defines play therapy as a way to help children express their feelings and cope with their emotional problems (Australian Play Therapists Association, 2021).

Based on all the aforementioned definitions, play therapy is an approach where the therapist and the child as the client work together, creating environments where children feel safe and are given the opportunity to freely express themselves through play, allowing children to safely reveal their emotions, aiming to solve various problems they experience, and utilizing the therapeutic aspect of play.

3. History of Play Therapy

Although play therapy is frequently used in recent therapeutic practices with children, it is not a new application. With a history of about a hundred years, play therapy has changed, developed, and diversified through the practices of researchers until today. When examining the entire historical flow of play therapy, we encounter the following names and their contributions to play therapy:

- **Sigmund Freud:** The use of play for therapeutic purposes first appears with Freud. Freud worked on the phobic symptoms shown by a child named Hans in his research titled "Analysis of a Phobia in a Five-Year-Old Boy" (Freud, 1909; Freud, 1955). Although Freud was primarily a psychoanalyst working with adults, he also worked with children in some exceptional cases, as in the mentioned book, to try to confirm the theory he developed. While this work is not exactly play therapy, it is considered the first application of using play during therapy (Winograd, 2016a).
- **Anna Freud:** She defined play as one of the ways for the therapist-child relationship to be positive and stated that it is an application that allows the therapist to access children's inner world and emotions (GoodTherapy, 2015).
- **Melanie Klein:** Klein, one of Freud's students, used play for therapeutic purposes by using various play materials and toys in her practices. In her work with children, she aimed to bring the unconscious feelings, thoughts, and desires of children to the level of

consciousness by using play instead of the free association technique (Pehrsson and Aguilera, 2007).

- **Hermine Hug-Hellmuth:** Considered the first psychoanalyst to specialize in the treatment of children, Hug-Hellmuth formally initiated the play therapy process by providing children with materials through which they could express themselves in her studies. She advocated the use of play in analyzing children (GoodTherapy, 2015).
- **Donald Winnicott:** He emphasized the role of play in the child's identity development and argued that the true self is discovered in play (Winograd, 2016b). He believed that the therapy process takes place in the play area created between the therapist and the client, and developed the "Squiggle Game". This game, which aims to allow children to freely express their feelings and thoughts, is also an ideal method for communicating with children who are too young to express their emotions and perceptions (Berger, 1980).
- **Joseph Solomon:** He developed a short and effective method by developing the "active play therapy" approach for solving children's emotional problems. In active play therapy, the therapist can obtain information about how the child reacts to their environment. The aim of this approach is to allow the child to experience emotions such as anger, fear, etc. during play, enabling them to move away from problematic behaviors in real life and acquire acceptable behaviors (Solomon, 1938).
- **David Levy:** He put forward a structured approach with the "release therapy" he developed in 1938. In this approach, the therapist follows these steps: encouraging the traumatized child to play freely, presenting materials related to the child's traumatic experience, and allowing the child to re-experience the event. The purpose of this application is to enable the child to re-experience their traumatic experience and thus release their unresolved emotions and actions (GoodTherapy, 2015).
- **Gove Hambridge:** He expanded David Levy's work and brought it together under the title of "structured play therapy". In Structured Play therapy, the therapist should follow a sequence of recreating the traumatic situation and then encouraging free play to solve problems related to the traumatic experiences children have had (Pehrsson and Aguilera, 2007).
- **Carl Rogers:** He created a new psychotherapy model called "Client-centered therapy" (Rogers, 1946; Rogers, 1951a; Rogers, 1951b;

Rogers, 1952). This model, which has reached today under the name of "person-centered therapy" or "non-directive therapy", drew attention to the need to establish a relationship based on acceptance and trust between the therapist and the client (British Association for Play Therapists, n.d.b).

- **Virginia Axline:** Axline (1947, 1964, 1981) adapted Rogers' approach to make it more suitable for children and developed child-centered play therapy. In her book where she describes the process of working with a 5-year-old child named Dibs (Dibs in Search of Self, 1964), Axline presented the child-centered play therapy application by detailing how she worked with Dibs and the therapy process she applied in his journey to health.

  Child-centered play therapy, founded by Axline, has been developed through numerous studies conducted by many researchers such as Moustakas, Schaefer, Landreth, Kottman until today, and has also led to the design of many different models such as "relational play therapy", "Adlerian play therapy", "systemic family therapy", "narrative therapy" and "solution-focused therapy" (Kot, Landreth and Giordano, 1998; Kottman, 1999; Kottman, 2001; Kottman and Johnson, 1993; Kottman and Warlick, 1989; Landreth, 1993; Moustakas, 1951; Moustakas, 1953; Moustakas, 1955; Moustakas, 1997; Moustakas and Schalock, 1955; Phillips and Landreth, 1998; Schaefer, 1993; Schaefer and Cangelosi, 2002; Schaefer and Carey, 1994).

- **Louise Gurney and Bernard Gurney:** In the 1960s, they developed filial therapy, which is closely related to child-centered play therapy. In this therapy, while the therapist applies child-centered play therapy to children on one hand, they also train and supervise parents, involving them in the therapeutic process (VanFleet, 2004).

4. Types of Play Therapy

Play therapy, which is one of the therapeutic methods, is fundamentally divided into two main approaches. These are; non-directive play therapy and directive play therapy.

Non-directive play therapy utilizes a less controlled environment that allows the child to freely explore and manage their own play (Joy, 2021; Ohwovoriole, 2021). In this approach, the therapist creates an environment of unconditional acceptance and trust for the child, allows the child to direct the play, uses reflective listening, and observes the child's behaviors (VandeCreek, Knapp and Jackson, 1992).

Directive play therapy, on the other hand, is a controlled approach where the therapist actively participates in the play therapy process. In this type of therapy, the therapist structures the child's activities by providing play materials and encouraging the child to use them (American Psychological Association, 2022).

Both methods begin with the therapist suggesting a general topic or activity, and both can be used to treat various conditions. However, directive play therapy is generally used with trauma victims, while non-directive play therapy is more often used to help those with behavioral problems. Still, there is no strict rule regarding this, and there are studies in the literature showing that both therapies are effective in many areas (Gierok, 2022).

Play therapy can take different names and be applied differently depending on the theoretical framework on which the application is based; the application environment, the toys used in the application, and the practitioner's approach. The types of play therapy frequently studied in the literature are; psychoanalytic play therapy, Jungian analytic play therapy, release play therapy, experiential play therapy, Adlerian play therapy, structured play therapy, Gestalt play therapy, filial therapy, group play therapy, Theraplay, cognitive behavioral play therapy, StoryPlay, sand therapy, and child-centered play therapy.

4.1. Psychoanalytic Play Therapy

Psychoanalytic play therapy accepts play as a reflection of the child's subconscious and takes into account the symbols present in the play. The main aim of this therapy is to explore the subconscious. In psychoanalytic play therapy, the therapist does not apply a specific technique. Instead, they maintain a professional stance by giving full attention to the child's play, anxieties, defenses, and verbal expressions (Punnett and Green, 2019).

4.2. Jungian Analytic Play Therapy

Jungian analytic play therapy argues that a person's healing and transformation come from within themselves rather than from any technique or person. In this therapy, the source of the healing and transformation experienced by the person is their own subconscious. In Jungian analytic play therapy, the emotions and problems that children cannot express verbally become noticeable and audible during the play process. Thus, the child is enabled to achieve a healthy transformation (Paul and Heiko, 2019).

4.3. Release Play Therapy

Release play therapy was developed by David Levy, adopting a structured approach. The process of this therapy begins with children playing freely. This process continues until the children feel comfortable in the playroom. After this, the therapist uses play to reenact the stressful situation or situations experienced by the child (Levy, 1938). The therapist's purpose in doing this is to allow children to release emotions (such as anxiety, grief, anger, etc.) that they cannot express due to the intensity of the trauma they experienced or due to their age and developmental skills. As this release process brings about a feeling of relaxation, it allows children to express their emotions freely (Gerard Kaduson, 2006).

4.4. Experiential Play Therapy

Experiential play therapy was developed by Byron Norton and Carol Norton and is among the non-directive play therapy types. In the therapy process developed by Norton and Norton (2015), there is a strong belief in children's perceptions of the challenges in their own lives. Therefore, in experiential play therapy, the child is allowed to manage their own play process. Throughout the play process, the aim is for children to regain their strength by using toys and their creativity. Throughout this therapy process, the role of therapists is to take on the roles that children want and participate in their quests.

4.5. Adlerian Play Therapy

Adlerian play therapy is a play therapy approach where Adlerian principles are applied through active and directive play interventions. At the same time, this play therapy uses the play process, which includes various toys, stories, puppets, art, drama, and role-playing, as a communication tool. Adlerian play therapy combines the theoretical structure of Alfred Adler's individual psychology and some therapeutic intervention strategies on the basis of play therapy. In this type of therapy, which argues that children are goal-oriented, subjective, and creative beings, the aim is to create positive change in children using fun ways for play therapists and children (Kottman, 2011b; Kottman and Ashby, 2019).

4.6. Structured Play Therapy

Structured play therapy is a play therapy approach that uses planned and structured activities in almost all sessions of the therapy process (Jones, Casado and Robinson, 2003). Structured play therapy, which is among the directive play therapy types, focuses on the developmental issues that children struggle with. In the therapy process, the therapist's task is to advance the planned process with their directions and provide a facilitating environment for children (Stone and Stark, 2013).

4.7. Gestalt Play Therapy

Gestalt play therapy, which is a humanistic, dynamic, present-centered, and process-oriented form of therapy, is an effective approach in treating most childhood disorders and disorders in the process of healthy emotional development (Carroll, 2009; Oaklander, 2001). The aim of Gestalt play therapy is to help children gain the missing aspects of their selves. In this process, while the therapist's task is to provide various experiences for the child, the child's responsibility is to develop by using the experiences offered to them (Oaklander, 2001).

4.8. Filial Therapy

Filial therapy, developed by Louise Gurney and Bernard Gurney in the 1960s, is a type of play therapy that adopts an integrative approach combining cognitive, behavioral, psychodynamic, humanistic, family systems, and social learning theories (Glazer, 2010; VanFleet, 2004). In filial play therapy, the therapist works with both children and parents. During the therapy, while child-centered play therapy is applied to children, parents are also trained and supervised and included in the therapy process. This therapy aims for parents to establish a relationship with their children through a non-directive play process. The goals of filial therapy are; to provide opportunities for children to experience new things, to allow them to express themselves freely, to support their learning of social rules, to strengthen family bonds, and to create a safe environment that supports their sicil skill development (VanFleet, 2009).

4.9. Group Play Therapy

Group play therapy is an application that can be applied in situations where children make passive observations or actively participate, and in every situation, it provides the child with the opportunity to establish relationships with the group. Group play therapy can be used in many areas such as treating behavioral problems in children, correcting wrong habits, or treating behavioral disorders (Gibbs, 1945). In this technique, the therapist's task is to provide opportunities to support children's social and emotional development, communication skills, self-awareness, and coping skills when working with groups of children (Wonders, n.d.).

4.10. Theraplay

Theraplay, a child-family therapy, is defined by the Play Therapy Association as one of the innovative psychotherapies for children. Healthy attachment plays a crucial role in the development of children's good mental health, the development of their self-esteem and ability to establish secure relationships with others, and increasing their resilience in the face of difficulties. Therefore, Theraplay aims to support healthy attachment between the caregiver and the child (The Theraplay Institute, 2022). During the therapy process, the development of a healthy and natural interaction process between the child and the parent is supported. Theraplay is effective in solving various behavioral problems in children stemming from depressive behaviors, introversion, difficulty in socializing, temper tantrums, aggressive behaviors, phobias, developmental delays, learning difficulties, and pervasive developmental disorders (Jones and Gillogly, 2022).

4.11. Cognitive Behavioral Play Therapy

Cognitive behavioral play therapy, which includes structured and goal-oriented activities, is a type of play therapy that supports children in developing more appropriate and adaptive behaviors. In this type of therapy, the therapist focuses on children's emotions, perceptions, thoughts, and environment. In cognitive behavioral play therapy, puppets for role-playing and exposure, books containing bibliotherapy approaches, and traditional play therapy materials are used. Additionally, children are allowed to bring materials to the sessions. Cognitive behavioral play therapy is used to teach certain skills, create alternative behaviors, change cognitions, support coping skills, and generalize positive behaviors in specific environments. This type of therapy can be used for children with disorders such as anxiety and phobias, selective mutism, enuresis, encopresis, or those with traumatic experiences (Drewes and Cavett, 2019; Knell, 2009).

4.12. StoryPlay

StoryPlay is a multicultural, flexibility-based, and indirect play therapy model that utilizes each child's, adolescent's, or adult's own internal resources, skills, and strengths to create healing, problem-solving, self-improvement, professional development, growth, and change (Domsch, 2013; Mills, 2011). This approach fundamentally focuses on the power of play and therapeutic storytelling. The StoryPlay approach is a model that provides creative tools for working with difficult and/or traumatized clients while using the treatment methods or philosophy preferred by the clients (Courtney, 2017).

4.13. Sand Therapy

Sand therapy, also called sand play therapy or sandtray therapy, is based on the work of Carl Jung and Dora Kalff. Sand therapy is a method used to create significant changes in the subconscious of the person being worked with. The foundation of this type of therapy is the idea that when the right conditions are provided, the client can perform their own healing process. The therapist is the person who encourages the client's healing process and ensures that the therapy is safe and effective. While sand play therapy is largely used with children who have experienced various traumatic experiences, it can also be beneficial for young people and adults in some cases (Cunningham, 2013; Morin, 2021).

4.14. Child-Centered Play Therapy

Virginia Axline developed the technique she initially referred to as non-directive play therapy and which is now known as child-centered play therapy (Axline, 1947). The basis of this approach is formed by the idea that children are capable of solving their own problems and the assumption that they can show mature behaviors based on their inner desire to grow (Axline, 2019). Child-centered play therapy accepts play as the most natural way for a child to express themselves. In this way, the child can reveal many emotions such as tension, fear, aggression, insecurity, confusion, disappointment, and bewilderment, and learn to control these emotions by confronting them. As a result, experiencing emotional relief, the child progresses towards maturation, being themselves, thinking for themselves, and making their own decisions, thus structuring their personality.

After Axline, many researchers (Bratton, Ray, Edwards and Landreth, 2009; Moss and Hamlet, 2020; Glover and Landreth, 2016; Petruk, 2009; Ray and Landreth, 2015, Ray and Landreth, 2019) have also defined child-centered play therapy, conducted studies, and attempted to explain its scope.

5. Areas of Use for Play Therapy and Its Application in Early Childhood

While play therapy is generally an application that can benefit people of all age groups, it is mostly used with children between the ages of 3-12. Play therapy can be used in many areas such as attention deficit hyperactivity disorders in children, anxiety, fear, post-traumatic stress disorder, learning difficulties, problematic behaviors seen at school, anger control issues, developmental delays, adjustment and behavioral problems, autism spectrum disorder, issues like thumb sucking, nail biting, tics, eating, sleeping and toilet disorders, divorce, introversion, death of a close person, separation, attachment problems, domestic violence, neglect, and abuse (Pietrangelo, 2019; VanFleet, Sywulak and Caparosa Sniscak, 2018).

When conducting play therapy applications, the choice of therapy type (psychoanalytic play therapy, Jungian analytic play therapy, release play therapy, experiential play therapy, Adlerian play therapy, structured play therapy, Gestalt play therapy, filial therapy, group play therapy, Theraplay, cognitive behavioral play therapy, Storyplay, sand therapy, child-centered play therapy, etc.) can vary depending on the problem situation observed in the child, the child's age group, and the practitioner's approach.

Literature reviews show that many types of play therapy are highly effective tools in solving various problems of children in early childhood, covering the 0-8 age group. When examining the studies conducted; it is seen that child-centered play therapy is effective in reducing behavioral problems and increasing social skills of aggressive, anxious, inattentive, and hyperactive children in the 4-6 age group (Semerci, 2022), filial therapy is effective in improving parents' relationships with their 4-8 year old children and learning basic skills related to play therapy (Jang, 2020), play therapy has a significant effect on the shy behavior of a 6-year-old child showing shy behavior (Koçkaya and Siyez, 2017), Gestalt group play therapy is effective in treating behavioral problems of preschool children (Kafaki, Akerdi and Rezaei, 2014), Theraplay play therapy is effective in reducing emotional and behavioral problems of children aged 6-14 (Uysal, 2020), cognitive behavioral play therapy significantly reduces behavioral problems of children aged 7-10 with externalizing behavior problems (Ghodousi, Sajedi, Mirzaie and Rezasoltani, 2017), and Storyplay therapy is an effective approach in reducing anxiety in children aged 3-5 (Finarti, 2023).

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Chapter 4

Leadership Education and Leadership Skills in Early Childhood Education

Pınar Ayyıldız[1]

Abstract

This study aims to explore the individual and societal impacts of leadership education in early childhood. Leadership skills contribute to children's social, emotional, and cognitive development, strengthening critical competencies such as empathy, collaboration, and problem-solving. Through methods like play-based learning, storytelling, and group projects, children can experience leadership roles. This process fosters self-confidence, a sense of responsibility, and social awareness, promoting both individual growth and social solidarity. The study argues for the integration of leadership skills into educational policies and highlights the importance of teacher guidance and parental involvement. The incorporation of digital technologies into leadership education offers children opportunities to develop digital leadership skills. Additionally, culturally and socially sensitive leadership education can foster an inclusive leadership perspective in children. The findings suggest that leadership education can enhance individuals' personal and professional success and contribute to the development of a more harmonious society.

1. Introduction

Leadership is a pivotal concept at the core of societal structures and individual development. Throughout history, leadership skills have played a crucial role in shaping societies and advancing individual careers (Northouse, 2019). In this context, fostering leadership skills during early childhood establishes a foundational base for individuals to exhibit effective leadership later in life. Specifically, introducing leadership education in the preschool years can directly enhance children's social, emotional, and cognitive development. However, the impact of leadership education on this age group

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remains relatively underexplored in the educational literature (Hughes, 2018). Preschool period is indeed a critical phase for laying the groundwork for children's personality and social skills. According to Piaget's cognitive development theory, this stage is when children begin to develop problem-solving skills and make sense of their surroundings (Piaget, 1964). In a similar fashion, Vygotsky's sociocultural learning theory suggests that children can acquire complex skills like leadership through social interactions (Vygotsky, 1978). These theoretical perspectives support the idea that leadership skills can be cultivated during early childhood. In education, leadership should not only be viewed as the ability to guide a group or manage an organization but also as the capacity to develop self-management, decision-making, and empathy skills (Kouzes & Posner, 2017; Öztürk & Demiroğlu Çiçek, 2024). Leadership education in the preschool years empowers children to boost their self-confidence, enhance their communication with peers, and develop collaborative abilities (Muijs et al., 2006). Therefore, leadership education should be integrated into preschool curricula and nurtured at an early age.

1.1. The Importance of Leadership Education in Early Childhood

Preschool years are critical for learning and development. Education during this period significantly shapes individuals' lifelong learning abilities and personal growth (Heckman, 2006). Developing leadership skills at an early age not only contributes to individuals realizing their potential but also fosters social solidarity and collaboration (Smith et al., 2020). Hence, leadership education should be viewed as a developmental process beginning in childhood rather than a process exclusive to adults. Children naturally express leadership qualities through play and social interactions. Research shows that children exhibit leadership behaviors during play, and supporting these behaviors can help them form stronger social bonds (Whitebread & Basilio, 2013). For instance, when a child takes on a guiding role in group play, they demonstrate and enhance leadership traits such as empathy, communication, and problem-solving.

1.2. Leadership in Educational Programs

Current educational programs often address leadership education indirectly. Howbeit, a structured approach to fostering leadership skills in early childhood education is largely absent (Rodd, 2013). This indicates the need for more deliberate and systematic efforts to integrate leadership education into preschool settings. Educational policies and curricula must incorporate appropriate methods and content for leadership education.

Leadership education can be implemented in preschool settings through approaches such as play-based learning, storytelling, and group projects. These methods allow children to develop leadership skills organically. Furthermore, teachers play a vital role in encouraging leadership skills. By modeling and fostering leadership traits, teachers can help children internalize these skills and become role models for their peers (Hall et al., 2004).

1.3. Objective of the Study

This book chapter aims to explore how leadership skills can be developed in early childhood and examine the individual and societal impacts of this process. Specifically, it seeks to address the contributions of leadership education to social, emotional, and cognitive development in preschool children. Additionally, the chapter aims to fill gaps in the relevant line of literature by presenting effective teaching methods and practical applications for fostering leadership skills in this age group. In contemporary society, leadership skills are indispensable for individuals to succeed both personally and professionally. Leadership education in early childhood enables children to acquire these skills early in life, contributing significantly to their future achievements. In this regard, educational policies and practices need to be restructured to support the development of leadership skills. Equipping children with leadership skills not only enhances individual growth but also initiates a process that promotes social solidarity and collaboration.

2. Leadership and Leadership Skills

2.1. What is Leadership?

Leadership can be defined as the ability to influence, guide, and motivate individuals or groups toward achieving a common goal. This definition underscores that leadership is not merely a managerial tool but also an art of communication and relationship-building. Throughout history, leadership has been examined from diverse perspectives, ranging from an innate trait to a skill that can be cultivated (Northouse, 2021). Traditional leadership theories often focus on the influence of adults in business, politics, or society. That said, contemporary research provides significant insights into how leadership begins to emerge during early childhood (Rodd, 2013). Leadership in childhood primarily manifests through play, social interactions, and collaboration with peers. These activities provide a natural environment for children to experience leadership roles. Cultivating leadership skills early in life can enhance individuals' capacity to assume leadership roles throughout their lives.

Key Dimensions of Leadership

Leadership is generally understood through its core dimensions, which include vision development, interaction, power, and influence. In early childhood, these dimensions take simpler forms that children can experience and learn:

- **Vision Development:** Guiding children in setting goals and understanding the steps required to achieve them.
- **Interaction:** Sharing ideas during social play and group projects.
- **Power and Influence:** Organizing and guiding peer groups toward common objectives.

These dimensions provide a framework for understanding how children exhibit and develop leadership skills.

2.2. What are Leadership Skills?

Leadership skills refer to the core competencies that enable an individual to lead effectively. These skills are critical in both individual and group contexts, encompassing various sub-skills. During early childhood, fostering leadership skills contributes significantly to children's social, emotional, and cognitive development (Smith et al., 2020).

Core Leadership Skills

- **Communication Skills:** The ability of children to clearly express their emotions and thoughts is foundational to leadership. These skills are honed during group activities and classroom interactions.
- **Empathy:** A key element of leadership, empathy enables children to understand and respond to the feelings of others. Studies reveal that children with higher empathy levels demonstrate stronger leadership capabilities in group settings (Whitebread & Basilio, 2013).
- **Decision-Making:** The ability to evaluate multiple options and choose the best solution to a problem helps children take initiative in leadership roles.
- **Problem-Solving:** Effectively addressing challenges during group activities reflects the development of leadership skills.
- **Teamwork:** Collaborating with peers to achieve shared goals is a vital component of leadership (Muijs et al., 2006).

Benefits of Acquiring Leadership Skills

Children who develop leadership skills are better equipped to build healthy relationships, boost their self-confidence, and achieve academic and social success in later stages of life. For instance, a child with advanced problem-solving skills is more likely to overcome challenges both in school and in broader societal contexts (Heckman, 2006).

2.3. Leadership Development in Children

Leadership Through Play and Social Interaction

Play is one of the most effective mediums for leadership development in early childhood. During play, children naturally take on leadership roles and develop social, emotional, and cognitive skills. For example, a child guiding a group during play develops the ability to organize and motivate others while refining their communication and decision-making abilities (Vygotsky, 1978).

Peer Interaction and Leadership

Children reinforce their leadership skills through positive interactions with peers. Research indicates that children who engage in meaningful peer interactions are more successful in assuming leadership roles (Smith et al., 2020). Peer interactions also provide opportunities to cultivate empathy and communication skills.

Leadership Development in Educational Programs

Educational programs play a pivotal role in fostering leadership skills. Play-based and project-based approaches used in preschool education aim to develop leadership skills naturally. Teachers act as facilitators in this process, guiding children to recognize and nurture their leadership potential (Hall et al., 2004).

Confidence and Leadership

Developing leadership skills is an effective tool for building children's self-confidence. Confident children are more likely to assume leadership roles and establish healthier relationships with peers. Activities centered around play provide a significant avenue for nurturing confidence (Whitebread & Basilio, 2013).

2.4. Theoretical Framework: Models of Leadership Development

Piaget's Perspective on Leadership Development

According to Piaget's cognitive development theory, children acquire leadership and other complex skills through their exploration and understanding of the world (Piaget, 1964). For instance, when a child takes on a leadership role in group activities, the process enhances their cognitive and social development.

Vygotsky's Sociocultural Approach

Vygotsky's theory emphasizes the role of social interaction in the development of leadership skills. Peer groups and teacher guidance are crucial for children to develop these skills effectively (Vygotsky, 1978).

Contemporary Leadership Models

Modern leadership models view leadership as a developmental process and investigate how this process can begin in early childhood (Northouse, 2021). These models argue that leadership skills can be cultivated through environmental influences, structured education, and experiential learning.

The Significance of Early Leadership Development

The acquisition of leadership skills at an early age equips individuals to become effective leaders later in life. Play, social interaction, and structured educational programs provide critical opportunities for children to develop leadership competencies. This process not only fosters individual growth but also promotes social cohesion and collaboration, laying the foundation for a more resilient and adaptive society.

3. Leadership in Early Childhood Education

3.1. Leadership in Early Childhood Education Programs

Early childhood education is a critical period during which children develop fundamental cognitive, social, and emotional skills. Incorporating leadership education into this stage can help children navigate challenges they may encounter later in life. That being said, leadership skills are rarely explicitly targeted in existing early childhood education programs (Küçük-Demir, 2023; Rodd, 2013). Leadership education should be recognized as a core element that enhances lifelong learning competencies. Educational programs often address leadership skills indirectly. For example, group activities and creative tasks provide opportunities for children to explore leadership traits. Yet, these activities typically focus on general social skills rather than consciously fostering leadership abilities (Smith et al., 2020). Educational policies and curriculum content must include specific strategies and objectives for leadership development.

3.2. Approaches to Leadership Education

Various approaches can be employed to support leadership skills in early childhood, including play-based learning, storytelling, and project-based education. These methods create natural environments for children to develop leadership competencies.

Play-Based Learning: Play is one of the most organic tools through which children can exhibit leadership. In group games, children who assume leadership roles develop communication, collaboration, and problem-solving skills (Whitebread & Basilio, 2013). For example, activities like a "leadership game" allow children to guide their peers and experience leadership first-hand.

Storytelling: Storytelling is an effective tool for fostering leadership skills. Through stories, children learn empathy, problem-solving, and decision-making. Characters with leadership traits in stories serve as role models for children (Nicolopoulou, 2014).

Project-Based Education: Project-based learning offers a platform where children can take on leadership roles. As children collaborate to complete a project, they naturally exhibit leadership qualities. This approach allows children to discover their leadership potential within both individual and group dynamics (Bell, 2010).

3.3. The Role of Teachers

Teachers play a pivotal role in fostering leadership skills. They act as facilitators who guide and encourage children to explore their leadership potential. Research shows that when teachers create an environment conducive to leadership development, children are more likely to exhibit leadership traits (Muijs et al., 2006; Yılmaz, Uysal & Nacar, 2024).

Teachers must carefully observe and support children's natural leadership tendencies. Furthermore, diversifying classroom activities and employing various strategies to encourage leadership are essential. For instance, a teacher can rotate leadership roles among children during group activities, ensuring that each child has the opportunity to lead.

4. The Gains of Leadership Education

4.1. Effects on Socio-Emotional Development

The acquisition of leadership skills during early childhood plays a crucial role in children's socio-emotional development. Research indicates that leadership education enhances children's abilities such as empathy, self-regulation, and self-confidence (Elias & Arnold, 2006). Socio-emotional development forms the foundation of leadership and enables children to establish healthy social relationships. In particular, empathy and emotional awareness are critical for effective leadership processes.

Leadership education helps children communicate more effectively and collaborate within peer groups. Through this process, children learn to understand diverse perspectives and manage conflicts. For instance, a child who assumes a leadership role during group play learns to both advocate for their ideas and respect the ideas of others (Goleman, 2000). These skills contribute to forming healthier social bonds in later life.

4.2. Teamwork and Collaboration Skills

Leadership education contributes to the development of teamwork and collaboration skills in children. Children who take on leadership roles in group activities gain the ability to identify the strengths of others and organize these strengths toward achieving a common goal. Research demonstrates that the acquisition of collaboration skills in early childhood correlates with success in professional life later on (Johnson & Johnson, 2009; Yılmaz, Şahin-Atılgan & Güzel-Sekecek, 2024).

4.3. Decision-Making and Problem-Solving Abilities

The development of leadership skills positively influences children's decision-making and problem-solving abilities. These skills help children cope with challenges and produce effective solutions in complex situations. For instance, when a child leads a group project, they evaluate the ideas of others and make decisions to find the most suitable solution (Ayyıldız & Yılmaz, 2023a; Dweck, 2006; Öztürk, 2023). This process is essential for both cognitive and social development.

4.4. Boosting Self-Confidence

Children who acquire leadership skills tend to have higher self-confidence. Self-confidence is a critical factor for children to embrace leadership roles and succeed in them. Leadership education provides children with experiences that bolster their confidence. For example, when a child leads a classroom activity, this experience can enhance their belief in their abilities (Bandura, 1997).

4.5. Academic and Social Success

Leadership education significantly enhances children's academic and social achievements by fostering essential skills that contribute to success in various settings. Academically, children who acquire leadership skills demonstrate higher levels of engagement in classroom activities and are more likely to take initiative in collaborative and individual tasks. This proactive attitude stems from the confidence and problem-solving abilities cultivated through leadership education. Such children are often better equipped to tackle academic challenges, approach complex tasks with resilience, and seek innovative solutions to problems (Marzano et al., 2005).

Socially, leadership education prepares children to navigate interpersonal relationships with empathy, effective communication, and teamwork. These skills not only help them build stronger bonds with peers but also enable them to mediate conflicts and foster a sense of community within group settings. For instance, a child who has developed leadership skills may naturally assume the role of a mediator during a disagreement, promoting harmony and collaboration. This proactive social engagement often translates into greater participation in extracurricular activities, where children can further hone their leadership abilities (Johnson & Johnson, 2009).

Furthermore, leadership education instills a sense of responsibility and purpose in children, encouraging them to actively contribute to their classroom and social environments. This active engagement not only enhances their immediate social interactions but also lays the foundation for lifelong skills in civic responsibility and community involvement. By fostering a balance between individual confidence and collective collaboration, leadership education equips children with the tools to excel both academically and socially, setting them up for success in future endeavors.

5. Practical Examples

5.1. The Role of Classroom Activities in Developing Leadership Skills

Classroom activities provide a fundamental platform for children to acquire and develop leadership skills. These activities offer children hands-on opportunities to practice problem-solving, collaboration, communication, and decision-making. Research highlights that structured activities are effective in fostering leadership qualities and that the classroom environment plays a crucial role in supporting this process (Ayyıldız & Yılmaz, 2021; Rimm-Kaufman & Hulleman, 2015).

Group Games and Interactive Leadership Activities: Play-based learning serves as a powerful tool for children to experience and learn leadership skills. For example, the activity "Who's the Team Leader?" allows each child to assume a leadership role in a group project, enhancing their responsibility and team management skills. During group games, children learn to coordinate peers, make decisions, and work collaboratively. Such activities also boost children's confidence (Fisher, 2013).

Problem-Solving and Creative Thinking Exercises: Classroom activities can present children with real-world scenarios where they are required to devise solutions. For instance, teachers can create a classroom scenario and ask children to propose a solution. A child in a leadership role may evaluate the ideas of peers and choose the most effective solution. This process reinforces both analytical thinking and leadership skills (Pellegrini & Smith, 2005).

Storytelling and Role-Playing: Storytelling is an ideal method for instilling leadership traits such as empathy, problem-solving, and decision-making. Leadership-themed stories provide children with opportunities to analyze the behaviors of leader characters and draw lessons from them. For example, children can role-play as the leader from a story, critically examine the leader's decisions, and suggest alternative solutions. This activity strengthens children's critical thinking and leadership potential (Nicolopoulou, 2014).

5.2. The Role of Families and Parents in Leadership Education

Parents play a fundamental role in developing children's leadership skills. Reinforcing what children learn at school in the home environment contributes to the natural growth of leadership abilities. Research shows that parental involvement strengthens the leadership education process and positively impacts children's socio-emotional development (Epstein, 2011; Yılmaz, 2021).

Leadership Practices at Home: Parents can provide opportunities for children to practice leadership at home by assigning responsibilities. For instance, planning a family meal allows a child to develop organizational skills. Similarly, children can act as mediators during family discussions, enhancing their empathy and communication abilities (Sanders & Epstein, 2005).

Parent-Teacher Collaboration: Collaboration between parents and teachers ensures that leadership skills are developed consistently in both school and home settings. For example, teachers can share details of leadership-themed activities conducted in the classroom and provide guidance to parents on how to reinforce these activities at home. This collaboration enhances the effectiveness of the learning process (Hornby & Lafaele, 2011).

5.3. Teachers' Role in Supporting Leadership Development

Teachers are pivotal actors in leadership education. For leadership education to be effectively implemented, teachers need the right tools and strategies. Accumulated research points to that teachers who create environments conducive to leadership development significantly impact children's ability to develop these skills (Ayyıldız & Yılmaz, 2023b; Leithwood & Jantzi, 2005).

Classroom Management and Leadership Opportunities: It is essential for teachers to offer every child the opportunity to take on leadership roles in the classroom. For example, teachers can organize weekly classroom duties, ensuring that each child takes on a leadership position. These duties provide a platform for children to develop responsibility and leadership skills.

Differentiated Instruction Strategies: Every child develops leadership skills at a different pace and in unique ways. Thus, it is crucial for teachers to adopt differentiated instruction methods. For instance, one child may excel in individual leadership, while another may thrive in group leadership. Teachers can enhance the effectiveness of leadership education by recognizing these differences and tailoring their strategies accordingly (Tomlinson, 2001).

Feedback Processes in Leadership Development: Teachers' observations and feedback on children's leadership experiences are critical. For instance, after a leadership activity, teachers can provide constructive feedback on what children did well and areas for improvement. This process helps children develop their leadership skills more consciously.

6. Future Contributions of Leadership Education to Society and Individuals

6.1. Impact of Leadership Education on Individual Development

Leadership education profoundly influences individuals' personal development. Acquiring leadership skills at an early age enhances self-confidence, self-awareness, and emotional resilience. These skills play a critical role not only in academic and professional success but also in equipping individuals to navigate social and personal challenges throughout life (Day et al., 2014).

Self-Management and Emotional Intelligence Development: Leadership education contributes to the development of individuals' emotional intelligence (EQ). Emotional intelligence encompasses skills such as empathy, conflict resolution, self-awareness, and understanding others, which are essential for effective leadership at both individual and group levels (Goleman, et al., 2013; Yılmaz, 2023).

Strengthening Critical and Analytical Thinking Skills: Individuals who receive leadership education early in life tend to think more analytically and creatively when solving problems. For instance, the ability to evaluate diverse perspectives during group work helps children become more effective leaders in both academic and social contexts (Seibert et al., 2017; Yılmaz, 2024).

Personal Responsibility and Self-Efficacy: Leadership education strengthens individuals' sense of responsibility. Through leadership experiences, children gain the confidence that comes with completing tasks or projects, which in turn enhances their belief in their own abilities. This sense of self-efficacy encourages individuals to embrace leadership roles with greater courage (Bandura, 1997).

6.2. Contributions of Leadership Education to Social Solidarity and Collaboration

Leadership education enhances individuals' contributions to society. Those who receive leadership education at an early age play active roles not only in their personal achievements but also in projects that promote social solidarity.

Fostering a Sense of Social Responsibility: Leadership education increases individuals' awareness of societal responsibilities. Individuals who are sensitive to social issues often take active roles in addressing challenges such as environmental problems, inequality, and human rights. When instilled at a young age, this awareness leads to lifelong social engagement (Heifetz et al., 2009).

Empowering Community Leadership: Leadership skills enable individuals to become more effective leaders within their communities. For instance, individuals who lead local community projects motivate others to unite and achieve common goals. This process strengthens social cohesion (Komives et al., 2013).

Sensitivity to Cultural and Social Diversity: Leadership education promotes sensitivity to cultural and social diversity. The ability to respect diversity and integrate different perspectives makes leaders more inclusive and effective. Such leaders play a significant role in fostering societal harmony and peace (Northouse, 2021).

6.3. Leadership Education for Future Societies

Leadership education plays a critical role in shaping the societies of the future. In a rapidly changing technological and social environment, leadership skills help individuals adapt to these transformations. Thus, it is essential to emphasize the future importance of leadership education.

Supporting 21st Century Skills: Leadership education today is a vital tool for developing skills such as critical thinking, creativity, communication, and collaboration, which are essential in the 21st century. These skills enable individuals to become more effective leaders in a globalized world (Sevgi, Ayyıldız & Yılmaz, 2023; Trilling & Fadel, 2009).

Technology and Digital Leadership: In the digital age, leadership education equips individuals to effectively use digital tools and lead in virtual environments. Skills such as managing virtual teams, analyzing data, and communicating online will become fundamental for future leadership (Avolio et al., 2009).

Sustainability and Environmental Leadership: Leadership education encourages individuals to take initiative in sustainability and environmental awareness. Environmentally conscious leaders can develop solutions to environmental challenges at both individual and societal levels (Kemp, 2011).

7. Conclusion and Recommendations

7.1. Conclusion

This study comprehensively explored the individual and societal benefits of fostering leadership education in early childhood. Leadership skills not only support individual confidence and responsibility but also strengthen social and emotional abilities such as empathy, collaboration, and problem-solving. Related studies indicate that leadership skills acquired in early childhood contribute significantly to individuals' lifelong success and societal contributions (Kouzes & Posner, 2017; Heckman, 2006).

Integrating leadership skills into education enables individuals to better navigate the social, academic, and professional challenges they will face throughout their lives. Play-based learning, storytelling, and group projects have proven to be effective tools for developing children's leadership potential. With that being said, the active involvement of both teachers and parents is crucial for the successful implementation of leadership education (Leithwood & Jantzi, 2005).

This study underscores that leadership education is not merely a tool for personal gain but also a mechanism to strengthen societal solidarity. Leadership skills encourage individuals to take on social responsibilities, embrace diversity, and collaborate effectively. Therefore, leadership education contributes not only to individual development but also to the formation of a more equitable, sustainable, and harmonious society (Komives et al., 2013).

7.2. Recommendations

To effectively implement leadership education, the following recommendations are proposed:

7.2.1. Integration of Leadership Education into Curricula

Leadership skills should be systematically integrated into preschool curricula. This enables children to develop their leadership potential at an early age and lays the foundation for future success. Educational programs should include play-based and project-based learning strategies that support leadership skills (Smith et al., 2020).

Practical Example: Activities such as "weekly leadership roles" can be incorporated into the preschool curriculum. Each child can take turns assuming a specific responsibility in the classroom to gain leadership experience.

7.2.2. Investment in Teacher Training

In-service training programs should be organized to ensure that teachers are competent in fostering leadership skills. These training sessions should educate teachers on the principles of leadership education and practical methods for implementation (Rodd, 2013; Sevgi & Yılmaz, 2023).

Practical Example: Workshops on leadership education can be held for teachers, providing them with skills to design activities that promote leadership in the classroom.

7.2.3. Strengthening Parental Involvement

Parents should be encouraged to actively participate in the leadership education process. Activities and guidance programs that enhance school-home collaboration should be developed. Parents can support their children by providing daily activities that allow them to practice leadership skills at home (Epstein, 2011).

Practical Example: Parents can assign small tasks to their children to support leadership development at home. For example, a child can be allowed to set an agenda item during a family meeting.

7.2.4. Use of Digital Tools

Incorporating technological advancements into leadership education processes is essential. Digital games and leadership-themed mobile applications can provide children with enjoyable ways to develop their leadership skills (Avolio et al., 2020; Ayyıldız, Yılmaz & Baltacı, 2021).

Practical Example: Leadership-focused digital games can be used to develop children's teamwork, decision-making, and problem-solving skills. For instance, an application like "Virtual Leadership Simulation" can allow children to experience leadership roles in a digital environment.

7.2.5. Sensitivity to Diversity and Inclusivity

Leadership education should be designed with sensitivity to cultural and social diversity. Themes of diversity and inclusivity should be central to leadership education, encouraging children to respect different perspectives (Northouse, 2021).

Practical Example: Classroom activities can include stories and leadership examples from different cultures, enhancing children's cultural awareness.

7.2.6. Research and Evaluation

Longitudinal research should be conducted to measure the impact of leadership education, and educational programs should be adjusted based on these findings. Standardized assessment tools should be developed to evaluate the effectiveness of educational practices (Komives et al., 2013).

Practical Example: Observation forms and surveys assessing children's leadership skills can be utilized. These tools can guide teachers in understanding children's developmental processes.

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Chapter 5

Development of 21st Century Skills in the Preschool Period

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Abstract

Today, the importance given to preschool education is increasing, and many studies support that acquiring knowledge and skills at an early age positively affects children's academic success in later stages. It is known that the foundations of many skills are laid during the preschool period, which plays a significant role in children's cognitive development. Skills such as scientific thinking, establishing cause-effect relationships, and problem-solving begin to be instilled at this stage. Research has shown that children are ready to acquire these skills in the early years of their lives and start school with a broad knowledge base (Clements & Sarama, 2011). The concepts and knowledge gained through preschool education are comprehensive and form the foundation of their future academic achievements (Ginsburg, 2006). Furthermore, rapid technological and social changes require individuals to continually renew themselves. The importance of acquiring competencies defined as 21st-century skills—such as collaboration, critical thinking, problem-solving, and digital literacy—at an early age is increasingly emphasized (OECD, 2018). In this context, supporting children's social, emotional, and cognitive development is seen as critical for them to grow into well-rounded individuals. Instilling these skills early not only increases the likelihood of success in social and professional life but also emphasizes the importance of laying the foundation for 21st-century skills during the preschool period (Robinson, 2015). While preschool education plays a critical role in preparing individuals for society, it is important to adopt student-centered and creative approaches as well as traditional methods in education.

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1. Introduction

Technology is advancing rapidly, occupying an increasing space in our lives. Developments in information and communication technologies, alongside economic and political changes, are also transforming social structures. In the 21st century, individuals are expected to adapt to changes, use knowledge and skills effectively, be productive, and play responsible roles as citizens in society (Maviş, 2014; Yenice & Ceren-Atmaca, 2017). The skills specific to this century are defined as a synthesis of competencies from various disciplines that meet the needs of the era. According to OECD studies, 21st-century skills are examined under categories like knowledge, communication, ethics, and social impact, including sub-skills such as critical thinking, responsibility, and media literacy. Additionally, Wagner (2008) categorizes 21st-century skills into areas like critical thinking, problem-solving, collaboration, and leadership. Curriculums are being adjusted in schools to instill these skills, utilizing technology-supported teaching methods. Research emphasizes the need to nurture generations that inquire, investigate, and are supported by technology rather than relying solely on rote learning (Ananiadou & Claro, 2009). During this period, preschool education plays a critical role in preparing individuals for society. Besides traditional methods, adopting student-centered and creative approaches in education is essential.

21st-century skills encompass the core competencies necessary for individuals to thrive in today's fast-paced and constantly changing world. These skills empower individuals in areas like accessing information, critically evaluating knowledge, problem-solving, creativity, collaboration, communication, and digital literacy (Trilling & Fadel, 2009). Although access to information has become easier in the digital age, skills like analyzing information accurately, critical thinking, and generating innovative solutions have become more valuable than ever for societies.

The "Turkey Century Education Model" aims not only to educate individuals but also to equip them with skills based on knowledge and the potential to contribute to societal development. In this context, 21st-century skills allow students to go beyond merely accessing information to analyze it, think creatively, and develop problem-solving competencies. These skills support individuals in succeeding in the global competitive environment in the future and contribute to societal progress. For example, strengthening creative thinking and critical analysis skills through new educational programs enables individuals to make knowledge-based decisions and produce innovative solutions to problems, thereby contributing to social transformation (Gürsan et al., 2021).

Figure 1: Skills associated with 21st Century Skills for Preschool Education

2. Integration of 21st Century Skills into Education

The integration of 21st-century skills into education supports students' analytical thinking and collaboration skills. Acquiring competencies like digital literacy, communication, and collaboration is essential for students to succeed in the information technology age. Education is emphasized not only to support students' academic success but also to foster lifelong learning and self-development skills (Partnership for 21st Century Skills, 2009). In this regard, incorporating innovative approaches in the Turkey Century Education Model aims to ensure that education programs enable individuals not just to access information but to use it effectively. 21st-century skills are essential for success in both academic and professional life. The Turkey Century Education Model targets early acquisition of these skills, aiming to equip individuals with competencies like critical thinking, problem-solving, and communication, thus enabling children to contribute to both individual and societal development. Emphasizing these skills in education is a strong step toward supporting Turkey's future competitive strength and societal progress. This section addresses ten 21st-century skills considered to be particularly important for preschool education.

2.1. Critical Thinking

Critical thinking is one of the fundamental elements of 21st-century skills, enabling individuals to analyze and evaluate the information and situations they encounter, understand different perspectives, and make informed decisions (Elder & Paul, 2013). It is generally defined as the process of reaching a judgment based on certain criteria (Elder & Paul, 2013) or evaluating an event by considering its pros and cons (Alkın & Gözütok, 2013). Critical thinking helps individuals reflect, think deeply, and reason logically about what they do or believe (Rudd, 2007). This process, involving steps such as organizing, analyzing, and evaluating, requires high-level thinking skills and is therefore also regarded as synthesis (Moore, 2001). Individuals who successfully engage in the critical thinking process are expected to have comprehensive behavior (Akınoğlu, 2003; Çokluk-Bökeoğlu & Yılmaz, 2005; Elder & Paul, 2013; Ennis, 1989; Halpern, 2013). Critically thinking individuals are skilled in questioning information, distinguishing between right and wrong, and developing an objective viewpoint on events. In today's information-dense world, this skill enables individuals to access accurate information and base their own thoughts on solid foundations. According to Pascarella and Terenzini (1992), it is necessary to approach information critically and inquisitively rather than accepting it as it is. Trilling and Fadel (2009) place problem-solving and critical thinking skills at the foundation of the 21st-century learning framework taxonomy.

2.1.1. The Importance of Critical Thinking in the Preschool Period

The preschool period is a time when children explore their surroundings, learn about the relationships between objects, and develop their initial thinking skills. Laying the foundations of critical thinking at this stage contributes to the development of an inquisitive mind in children. Critical thinking plays an important role in helping children understand different perspectives, express themselves, and view events from multiple angles. For example, when a child listens to a story and questions the characters' actions or tries to understand cause-and-effect relationships, they are employing critical thinking skills.

2.1.1.1. The Necessity of Critical Thinking from the Perspective of the Turkey Century Education Model

The Turkey Century Education Model emphasizes a thinking, analyzing, and informed decision-making approach in education. In this model, critical thinking is an essential tool for nurturing individuals who not only access information but also interpret and evaluate it. Developing critical thinking skills at an early age will contribute to children becoming independent, inquisitive individuals throughout their educational journey and in their later lives. Structuring educational programs to encourage critical thinking paves the way for cultivating conscious and intellectually capable individuals, aligning with the goals of the Turkey Century.

2.1.1.1.1. Recommendations for Developing Critical Thinking in Children

Various methods and activities can be used to support the development of critical thinking skills in children during the preschool period. Some strategies to foster critical thinking at this age include:

- **Encouraging Curiosity and Questioning:** Encouraging children to question the events and objects around them can enhance their thinking processes. Asking them questions like "Why do you think this is so?" can help them explore different ways of thinking.
- **Problem-Solving Games:** Presenting children with simple problems and encouraging them to find their own solutions can develop their critical thinking skills. For example, when completing a puzzle, children learn to analyze pieces.
- **Understanding and Respecting Alternative Thoughts:** Teaching children different perspectives and fostering respect for others' thoughts support their empathy and critical thinking skills.
- **Providing Opportunities for Comparison and Evaluation:** Giving children the chance to compare two objects, stories, or solutions helps them deepen their thinking and make choices.

2.2. Creativity

Lipman (2003) define creativity as one of the 21st-century skills, referring to individuals' capacity for original thinking, problem-solving, and generating new ideas. In a world that is constantly changing and evolving toward becoming an information society, individuals are increasingly directed toward creative thinking. Creative thinking is essential for finding new solutions to problems encountered during the developmental process or for developing new products. Creativity, which plays a crucial role in raising active and productive individuals, is a complex skill that allows individuals to generate unique, innovative, and alternative ideas (Ayyıldız & Yılmaz, 2023; Gokalp, 2016). In the literature, the concepts of creative thinking and creativity are often confused. While creativity encompasses both mental and performance-based activities and is broader, creative thinking focuses more on cognitive processes (Özkale, Kılıç & Yelken, 2020; Yılmaz & Yiğit, 2024).

Individuals with creative thinking skills are noted for their sensitivity to problems, their ability to produce unusual and functional ideas, their capacity to transition easily between different thoughts, and their ability to manage and evaluate complex relationships (Uçak & Erdem, 2020). In the 21st century, especially emphasized by the WEF (2017), the development of creative thinking skills requires attention to creative approaches and applications. Creative individuals are capable of developing new solutions and offering alternative perspectives by thinking outside the box.

Figure 2: Stages of Creativity

According to Bacanlı, et all. (2011), creative thinking includes both cognitive and affective aspects in the learning process and this way of thinking includes elements such as imagination, flexible thinking, analysis, questioning, originality and efficiency. Although creativity has traditionally been considered an innate characteristic and a talent specific to the arts, Lipman (2003) included creativity in the field of education. Today's standards see creativity and innovation as important not only in the arts but in a wide range of fields such as environmental issues, biotechnology, nanotechnology and renewable energy. According to Trilling and Fadel (2009, pp. 56-59), imagination is related to the richness of an individual's experience and should be supported through education.

2.2.1. The Importance of Creativity in the Preschool Period

The preschool period is when the foundations of children's cognitive, emotional, and social skills are laid. Developing creative thinking during this period enhances children's interest in learning and exploring, strengthens their self-expression, sharing of thoughts, and self-confidence. Additionally, the development of creative thinking skills supports children's problem-solving abilities. For example, when a child wonders how a toy works and tries to discover it through trial and error, they are using both cognitive and creative skills.

2.2.1.1. The Necessity of Creativity from the Perspective of the Turkey Century Education Model

The Turkey Century Education Model values the development of individual talents, emphasizing skills required by the era. Raising creative individuals is an important goal for the social and economic development of the country. Supporting creativity skills from an early age in educational programs structured to provide children with creative thinking opportunities is seen as effective in helping them reach their full potential.

2.2.1.1.1.Recommendations for Developing Creativity in Children

Several activities and teaching methods can be used to foster creativity in preschool-aged children. Here are some suggestions:

- **Play and Art Activities:** Providing environments where children can freely play, paint, mold clay, and explore various materials supports their creativity.
- **Encouraging Questioning and Exploration:** Keeping children's curiosity alive helps develop their creative thinking skills. It is essential to ask open-ended questions and encourage them to discover new things.
- **Presenting Problem-Solving Opportunities:** Giving children small problems to solve independently strengthens their thinking skills and encourages them to look for creative solutions.
- **Providing an Environment for Free Thinking:** Offering children an environment where they can freely express themselves, make mistakes, and try new things helps develop their imagination and creative capacity.

2.3. Communication

Communication is the process through which individuals express emotions, thoughts, information, and experiences through verbal or nonverbal means. People constantly communicate with each other in different contexts and forms in their daily lives. As social beings, humans must constantly use this skill. Communication is generally defined as the exchange of messages between two parties (Cüceloğlu, 1997; Demirel & Yağcı, 2012). From another perspective, communication is explained as a process that aims to create behavioral changes by sharing thoughts, knowledge, attitudes, emotions, and skills (Koçak et al., 2014). The communication process gives individuals the opportunity to express themselves and understand others, providing them with an essential power (Gülbahar & Sıvacı, 2018). The communication process consists of five basic components: source, message, channel, receiver, and feedback (Cüceloğlu, 1997; Ergin, 2014).

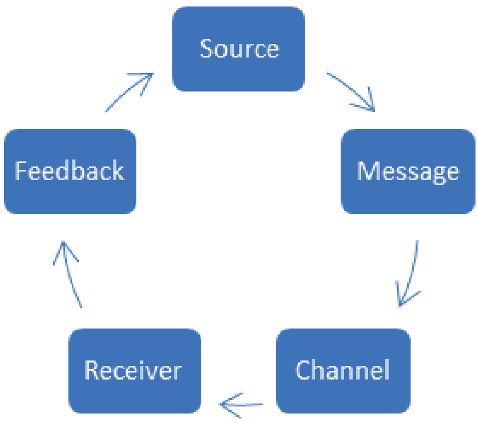

Figure 3: Key components of the communication process

The source is the person who initiates communication and aims to create a behavioral change in the receiver (Ergin, 2012). The message conveys the thoughts, feelings or information that the source wants to convey to the receiver through symbols (Memduhoğlu et al., 2014). The channel is the method or means by which the message is transmitted. The receiver is the person or group that receives the message (Demirel & Yağcı, 2012), and the feedback is the recipient's response to the message. Communication is effective only when these components function in a complete way. Effective communication enables understanding the feelings and thoughts of others, cooperating in harmony and establishing social bonds. In the 21st century, communication skills are one of the cornerstones of success not only in daily life but also in professional life and social environment. According to Johnson and Johnson (2010), the rapid increase in globalization with the 21st century has brought important challenges for countries, and one of the most important of these challenges is the need for communication that arises with the increase in local diversity and global differences. According to Trilling and Fadel (2009), the development of communication tools with the advancement of technology increases interpersonal communication. In today's world, it has become increasingly important for individuals to be able to express themselves and to express their feelings and thoughts clearly. This skill is necessary for individuals to establish healthy relationships, solve problems and achieve social cohesion

2.3.1. The Importance of Communication Skills in the Preschool Period

The preschool period is when children lay the foundations for communication skills and learn social interaction. At this stage, children learn to express emotions and thoughts, listen to others, and engage in mutual understanding. Communication skills help children establish healthy relationships with friends and adults while increasing their self-confidence. Communication skills acquired early on enable children to grow into more successful and happier individuals later in life. Communication abilities also support children in expressing themselves in school, respecting others' rights, and participating in group activities.

2.3.1.1.The Necessity of Communication Skills from the Perspective of the Turkey Century Education Model

The Turkey Century Education Model offers an educational approach aimed at developing students into effective individuals in a global world. In this context, communication is seen as an essential skill for individuals to contribute to society, collaborate effectively, and live in harmony with diverse cultural structures. The Model's curricula support activities to develop children's abilities to express themselves, recognize their emotions, and understand others' feelings. Communication is regarded as a crucial skill in this model for fostering social cohesion, understanding cultural diversity, and developing empathy. Therefore, supporting communication skills in children during the preschool period contributes to Turkey's educational vision and aids in raising individuals who are compatible, respectful, and responsible.

2.3.1.1.1. Recommendations for Developing Communication Skills in Children

To support the development of communication skills in children during the preschool period, teachers and parents can implement various strategies. Here are some suggestions:

- **Supporting Expressive Skills Through Games and Activities:** Games, drama activities, and role-playing exercises are effective tools to help children express themselves. In these activities, children find opportunities to express themselves in various ways by taking on different roles.
- **Developing Listening Skills:** Good communication is built on listening. Teaching children the importance of listening to others fosters empathy. Organizing activities like storytelling and story time helps children learn active listening.
- **Expanding Vocabulary and Language Skills:** Enriching children's vocabulary allows them to express themselves better. Songs, rhymes, and reading activities can develop children's language skills. Teaching children words to describe emotions also strengthens their emotional communication.

2.4. Collaboration

Collaboration, which holds a significant place among 21st-century skills, refers to individuals' capacity to come together and work effectively toward a common goal. A team is defined as a small group of individuals who focus on a shared objective, share responsibilities, and complement each other (Straub, 2002). Teamwork, on the other hand, is a process where individuals who are willing to solve problems together act collaboratively, sharing responsibility within an environment of trust (Avan, Gülgün, Yılmaz & Doğanay, 2019; Kaldırım, 2003). According to the Turkish Language Association (TDK), collaboration is a working partnership established in line with shared goals. When examining teamwork and collaboration, it is observed that these two concepts carry similar meanings. Both teamwork and collaboration are essential in 21st-century skills and play a critical role in advancing modern sciences. Therefore, it is crucial to use methods and techniques in education that offer students opportunities for teamwork and collaboration. These approaches give students both teamwork experience and help them develop their collaboration skills (Bozan & Anagün, 2019; Öztürk & Altun-Yalçın, 2020; Sari & Wardhani, 2020)). Individuals capable of collaborating work harmoniously within a group, value others' ideas, share responsibilities, and seek solutions to problems together. In today's world, bringing together individuals with different knowledge and skills to work in teams plays a key role in achieving social and professional success.

2.4.1. The Importance of Collaboration in the Preschool Period

The preschool period is a critical phase where children develop social skills and experience their first interactions with their surroundings. Laying the foundations of collaboration during this period supports children's communication skills, ability to work with others, and respect for others as they grow older. While learning to collaborate, children experience acceptance of different perspectives, acting in harmony with others, and displaying patience. For example, during a group activity, children learn to work together, distribute tasks, speak in turn, and achieve a common goal. These skills strengthen children's social relationships, making it easier for them to adapt to society.

2.4.1.1. The Necessity of Collaboration from the Perspective of the Turkey Century Education Model

The Turkey Century Education Model is an approach that aims to nurture individuals who are not only knowledgeable but also active and harmonious members of society. In this context, collaboration should be at the core of education programs, as strong collaboration skills enhance social solidarity and develop individuals' capacity to work together. Educational programs that support collaboration prepare children for successful teamwork both in education and in the professional world.

2.4.1.1.1. Recommendations for Developing Collaboration in Children

Teachers and parents can apply various strategies to foster collaboration skills in children during the preschool period. Here are some suggestions:

- **Group Games and Activities:** Involving children in group games and activities teaches them to work together and share. Especially games that require teamwork allow children to interact with each other and produce solutions together.
- **Shared Tasks and Responsibilities:** Assigning children small responsibilities can encourage them to work together. For example, cleaning up the classroom after an activity or sharing toys in a game teaches children to collaborate.
- **Developing Empathy and Tolerance:** For children to collaborate, they need to have empathy and tolerance. Therefore, it is essential to teach children to respect others' feelings and opinions and encourage them to support their friends.

- **Setting Common Goals and Dividing Tasks:** Setting a common goal with children and dividing tasks to achieve it helps them learn to work together. Children understand the importance of their contributions as well as the value of others' efforts.

2.5. Curiosity

Curiosity, one of the 21st-century skills, refers to individuals' intrinsic motivation to learn, explore, and understand the world around them (Engel, 2013). Curiosity underlies the desire to reach knowledge, question surroundings, and follow innovations (Kashdan & Silvia, 2009). Curious individuals enrich the learning process by looking at events from different angles and enhancing their creativity (Grossnickle, 2016). This skill is of critical importance for both personal development and lifelong learning in today's rapidly changing world (Yazıcı & Kartal, 2020).

2.5.1. The Importance of Curiosity in the Preschool Period

The preschool period is when children start to explore their surroundings and themselves, beginning to make sense of the world. Supporting curiosity during this period increases children's motivation to learn and strengthens their desire to explore. Curiosity plays an important role in children's cognitive development and their interactions with their environment. For instance, when a child asks questions about the objects, plants, or animals around them, it enables them to understand nature, scientific events, and social relationships better. Through curiosity, children learn to observe, ask questions, and actively participate in the learning process.

2.5.1.1. The Necessity of Curiosity from the Perspective of the Turkey Century Education Model

The Turkey Century Education Model aims to raise inquisitive, research-oriented individuals who are eager to learn. In this model, curiosity is seen as the cornerstone of education, as curious individuals go beyond simply acquiring information, questioning and deepening their understanding of it. Structuring educational programs to nurture children's curiosity supports their active engagement in research and learning processes, preparing them to become critical and analytical thinkers in the future.

2.5.1.1.1. Recommendations for Developing Curiosity in Children

To keep children's curiosity alive during the preschool period, teachers and parents can use various methods. Here are some suggestions:

- **Providing Exploration-Oriented Activities:** Organizing outdoor activities, experiments, and nature trips that allow children to explore their surroundings contributes to their understanding of the world.
- **Encouraging Questioning:** Children asking questions speeds up their learning process. Parents and teachers should be open to all their questions, creating a supportive environment to encourage them to keep asking.
- **Offering Activities and Experiences in Different Fields:** Allowing children to engage in activities across various fields increases their interest in different topics. Organizing activities in areas such as art, science, and sports helps children discover their interests.
- **Enhancing the Desire to Explore Through Stories and Fairy Tales:** Stories and fairy tales nurture children's imagination and curiosity. Reading books provides them with an opportunity to ask questions, enhancing their creativity.

2.6. Entrepreneurship

Entrepreneurship is a 21st-century skill that represents individuals' ability to think innovatively, seize opportunities, and develop creative solutions. According to the Ministry of National Education (MEB, 2018a), entrepreneurship is defined as the ability of individuals to turn their ideas into actions and is often regarded as a process born from dreams that create value (Arpacı, 2015). While entrepreneurship is defined as discovering and evaluating opportunities and taking action to turn these opportunities into profit (De Soto, 2013), it also includes the desire of individuals to deal with obstacles in creative and innovative ways (Yurtseven, 2020). Emphasizing the importance of developing entrepreneurship skills from an early age, it is understood that individuals with entrepreneurial skills are characterized as creative, risk-taking, opportunity-seizing, independent, adaptable, and success-oriented individuals (Hisrich, Manimala, Peters & Shepherd, 2005). Therefore, entrepreneurship is an essential part of 21st-century skills (Bybee, 2010). Entrepreneurship-focused practices have been shown to enhance this skill in students (Şirin, 2020; Turgutalp, 2021), highlighting the importance of incorporating entrepreneurship education at all educational levels. Integrating entrepreneurship practices into all types of education models, including distance learning, is necessary. Entrepreneurial individuals possess the ability to generate new ideas, take risks to bring these ideas to life, and find solutions to challenges they encounter. Entrepreneurship not only fosters independence and originality in individuals' thinking but also enables them to initiate change in both the business world and daily life.

2.6.1. The Importance of Entrepreneurship in the Preschool Period

The preschool period is when children begin to develop self-confidence, think independently, and make decisions. Instilling the basics of entrepreneurship at this stage supports children's creative thinking and solution-oriented approaches. Early exposure to entrepreneurial thinking allows children to develop their imagination, enhance their ability to seize opportunities, and build self-confidence. For example, when a child sets new rules for a game or creates different solutions to a problem, they are engaging in entrepreneurial thinking.

2.6.1.1. The Necessity of Entrepreneurship from the Perspective of the Turkey Century Education Model

The Turkey Century Education Model aims to cultivate creative, innovative, and independent decision-making individuals with high problem-solving skills. In this model, entrepreneurship is an essential requirement for encouraging original thinking in education and enabling children to develop independent problem-solving skills. Educating entrepreneurial individuals contributes to the social and economic development of the country, while also preparing children for future success in education and work life. Thus, it is crucial that educational programs include activities that foster an entrepreneurial spirit.

2.6.1.1.1. Recommendations for Developing Entrepreneurship in Children

Teachers and parents can implement various activities and methods to support the development of entrepreneurship skills in preschool children. Here are some suggestions:

- **Providing Opportunities for Free Play and Exploration:** Creating environments where children can create their own games and activities develops their innovative thinking and independent decision-making skills.
- **Problem-Solving Activities:** Presenting children with simple problems and encouraging them to find their own solutions fosters entrepreneurial thinking. For example, encouraging them to try different materials while building a tower helps improve their problem-solving skills.

- **Encouraging Alternative Ideas:** Asking children questions like, "How else could we do this?" or "What other game could we play?" encourages them to explore alternative ways of thinking, supporting their creativity.
- **Supporting Experiences of Success and Failure:** Acknowledging children's achievements and encouraging them to learn from their mistakes help them build confidence. Understanding that making mistakes is a natural part of the learning process empowers children to try new things.

2.7. Perseverance

Perseverance is a 21st-century skill that enables individuals to persist in reaching a goal, continue working with determination in the face of challenges, and remain focused on their objectives until they achieve them (Duckworth & Gross, 2014). Persistent individuals overcome obstacles to stay motivated despite the difficulties they face (Miller, 2017). This skill plays a significant role in personal success and contributes to societal well-being, as perseverance supports both personal growth and resilience (Dweck, 2006). Developing perseverance during education has a positive impact on students' long-term success (Shechtman et al., 2013).

2.7.1. The Importance of Perseverance in the Preschool Period

The preschool period is when children begin to take on tasks independently and learn to deal with challenges on their own. Supporting perseverance at this stage teaches children to exhibit determination and work hard toward their goals. For instance, when a child tries to complete a puzzle despite facing difficulty, they are developing perseverance. This skill increases children's self-confidence, enabling them to grow into resilient and successful individuals as they mature.

2.7.1.1. The Necessity of Perseverance from the Perspective of the Turkey Century Education Model

In the Turkey Century Education Model, not only acquiring knowledge but also showing determination and perseverance in achieving goals is valued. Perseverance is essential in this model, as it aids children in overcoming challenges throughout their educational journey. Structuring educational programs to support perseverance encourages children to develop a strong will and work persistently toward their goals. Raising individuals with perseverance contributes to Turkey's vision of a society that values resilience, determination, and self-reliance.

2.7.1.1.1. Recommendations for Developing Perseverance in Children

To support the development of perseverance in preschool children, parents and teachers can use a variety of strategies. Here are some suggestions:

- **Encouraging Task Completion:** Encouraging children to finish tasks they start helps reduce the tendency to leave things unfinished. Instilling this habit at a young age assists in raising determined individuals.
- **Providing Positive Feedback:** Acknowledging the effort children put forth in facing challenges and giving positive feedback boosts their courage, encouraging them to approach new tasks with determination.
- **Encouraging Different Approaches to Overcome Challenges:** Allowing children to try different methods when they encounter a problem, such as suggesting "You could try starting from another spot," fosters perseverance by prompting them to find alternative solutions.
- **Supporting Experiences with Failure:** Explaining that failure is a natural part of life and helping children learn from their mistakes encourage them to keep trying, even when faced with setbacks.

2.8. Leadership

Leadership is the ability of individuals to guide, take responsibility, and bring others together to achieve a common goal within a group (Northouse, 2018). Leadership skills include not only guiding others but also recognizing their strengths, fostering team spirit, and solving problems (Yukl, 2013). In the rapidly changing world of the 21st century, leadership is considered an important skill for individuals to succeed both in social and professional life (Goleman, 2000). Individuals with leadership skills inspire those around them, gaining the power to initiate change (Kotter, 2012).

2.8.1. The Importance of Leadership in the Preschool Period

The preschool period is when children start to recognize their identity, begin to think independently, and establish social relationships. Developing the foundation for leadership during this time contributes to children's self-confidence, communication skills, and their ability to work with others. Assigning responsibilities in small groups, giving children opportunities to express themselves, and allowing them to guide others are essential for developing leadership. For example, when a child shows their friends how to play a game or creates a new game, they are exercising leadership skills.

2.8.1.1. The Necessity of Leadership from the Perspective of the Turkey Century Education Model

The Turkey Century Education Model aims not only to raise knowledgeable individuals but also to develop responsible, confident, and guiding members of society. In this context, leadership is viewed as an essential skill for children to actively contribute to societal progress. Incorporating group activities and collaborative exercises into educational programs nurtures leadership skills, helping children grow into individuals who can inspire others and take on roles in societal change. For Turkey's future, it is crucial to raise confident, responsible, and effective communicators as leaders.

2.8.1.1.1. Recommendations for Developing Leadership in Children

To support the development of leadership skills in preschool children, teachers and parents can use different methods. Here are some suggestions:

- **Assigning Responsibilities:** Giving children small tasks encourages them to take responsibility, enhancing their leadership skills. For instance, assigning roles during activities allows children to experience leadership.
- **Teamwork and Group Games:** Group games help children collaborate and act harmoniously within a team. Allowing children to take turns leading in group activities helps them experience leadership.
- **Involvement in Decision-Making Processes:** Involving children in decision-making by encouraging them to share their ideas builds their confidence and teaches them to respect others' opinions.
- **Introducing Role Models:** Providing children with information about individuals who exhibit leadership qualities helps them understand the concept of leadership. For example, introducing characters with leadership qualities in storybooks encourages positive perceptions of leadership.

2.9. Problem-Solving

Problem-solving is the ability to develop analytical, creative, and constructive approaches to the challenges individuals face. In the rapidly changing world of the 21st century, this skill is essential for adapting to and overcoming complex situations. Problem-solving skills enable individuals to analyze difficulties and produce effective solutions, using critical thinking, creativity, and flexibility throughout the process (Kaptan & Korkmaz, 2001). Individuals with problem-solving skills tend to succeed and perform effectively in various areas of life.

Problem-solving skills are valuable not only for addressing encountered issues but also for supporting cognitive development and enhancing overall life performance (Açık, 2013). This skill comprises mental processes required to overcome obstacles and involves a logical, systematic approach (Smith & Kosslyn, 2008). The ability to solve problems efficiently boosts personal growth and builds self-confidence, facilitating success across different aspects of life (Dweck, 2006; Zimmerman, 2000). Early education in problem-solving skills prepares individuals to learn and apply problem-solving strategies, impacting not only academic achievement but also general life skills (Açık, 2013).

Incorporating problem-solving skills into educational systems supports students in developing this important competence, forming a solid foundation for future challenges. Developing problem-solving skills equips individuals to handle problems constructively and solution-orientedly, making them more capable and adaptable.

2.9.1. The Importance of Problem-Solving in the Preschool Period

The preschool period is the first stage where children gain basic skills, learn to think independently, and handle tasks alone. Laying the foundation for problem-solving skills at this age helps children tackle challenges, think independently, and pursue goals with determination. For instance, when a child tries to place a piece in a puzzle or complete it, they begin the problem-solving process. This process contributes to their cognitive and emotional development, teaching them patience and solution-focused thinking.

2.9.1.1. The Necessity of Problem-Solving from the Perspective of the Turkey Century Education Model

The Turkey Century Education Model aims not only for students to acquire knowledge but also for them to use it effectively. The model emphasizes the importance of students developing critical thinking, innovative approaches, and problem-solving skills. Structuring educational programs to foster problem-solving allows children to grow into independent thinkers capable of making decisions. Problem-solving skill development contributes to Turkey's aspirations for societal, scientific, and economic growth.

2.9.1.1.1. Recommendations for Developing Problem-Solving Skills in Children

To develop problem-solving skills in preschool-aged children, teachers and parents can use specific methods and activities. Here are some suggestions:

- **Allowing Exploration and Trial-and-Error Processes:** Encouraging children to solve problems independently promotes their problem-solving skills. Giving them opportunities to play with various materials, explore objects, and make different attempts encourages independent thinking.
- **Supporting the Questioning and Solution-Seeking Process:** Asking children questions like "How else could we solve this?" or "Can we try a different way?" helps them develop different perspectives, supporting analytical thinking.
- **Encouraging Solutions to Everyday Tasks:** Providing small responsibilities in daily situations helps children develop practical solutions. For instance, asking a child how to clean spilled water encourages them to find practical solutions.
- **Using Puzzles, Mazes, and Strategy Games:** Activities like puzzles and mazes enhance children's problem-solving abilities. These games teach children step-by-step solution production and strategy development.

2.10. Adaptability

Adaptability is the ability of individuals to quickly adjust to changing conditions, show flexibility in new situations, and adapt to different environments. In today's fast-changing and constantly renewing world, this skill is essential for individuals to cope with challenges, be open to innovations, and succeed in various settings. Individuals with strong adaptability are more resilient and flexible in the face of uncertainty, developing a positive attitude toward new experiences.

2.10.1. The Importance of Adaptability in the Preschool Period

The preschool period is when children begin to learn about social adaptation, meeting different people and environments. Supporting adaptability during this stage contributes to children's emotional and social development. For example, when a child starts preschool and has to adapt to a different environment away from their family, it strengthens their adaptability. Developing this skill early makes it easier for children to adjust to new situations and form social relationships as they grow. In professional life, success and stability are often supported by adaptability and flexibility skills, as these improve time management, reduce workload, distribute responsibilities, and allow quick solutions to problems. Savickas (2012) suggests that employees will work in various jobs throughout their careers, noting that staying within a single organizational structure is becoming less important. With technological advancements, flexible, temporary, and independent work forms are becoming more widespread, and workplace loyalty is diminishing. According to Trilling and Fadel, individuals who want to succeed in the evolving job market must continuously improve themselves, solve daily problems, address future needs, and possess adaptability and flexibility skills.

2.10.1.1. The Necessity of Adaptability from the Perspective of the Turkey Century Education Model

The Turkey Century Education Model emphasizes not only equipping children with knowledge but also cultivating a flexible mindset to adapt to a changing world. This model encourages students to develop innovative thinking, open-mindedness, and flexibility in the face of new situations. Enriching educational programs with activities that support adaptability helps children succeed in their future educational journeys and social lives. Flexible and adaptable individuals contribute to social development while promoting social cohesion and solidarity.

2.10.1.1.1. Recommendations for Developing Adaptability in Children

To support the development of adaptability in preschool children, parents and teachers can use various activities and methods. Here are some suggestions:

- **Exposing Children to New Environments and Situations:** Encouraging children to participate in different playgroups, activities, or environments supports their ability to adapt to new social settings. This practice enhances their ability to quickly adjust to various surroundings.
- **Providing Emotional Support:** It is essential to offer emotional support so children feel secure in the face of changes. Providing reassurance when they encounter new situations eases their adjustment process and helps them develop a positive attitude toward new experiences.

- **Supporting Problem-Solving and Flexible Thinking Skills:** Asking questions like, "How else could we approach this?" or "Can we think of other solutions?" helps children explore alternative ways of thinking, supporting their adaptability.
- **Using Games and Simulations:** Providing children with opportunities to assume different roles in games helps develop their adaptability to various situations. For example, role-playing in group games allows children to practice adapting to different scenarios.

3. Conclusion

When examining the associated skills for the development of 21st-century skills in the preschool period:

Critical thinking plays an important role in children's cognitive development and decision-making. Supporting this skill from an early age in the Turkey Century Education Model is seen as essential for raising independent, inquisitive, and self-aware individuals. **Creativity** is highlighted in children's expression, problem-solving, and imagination. Supporting this skill early on in the Turkey Century Education Model contributes to laying the foundation for social development. Developing **communication skills** in the preschool period prepares children to succeed in their future social, academic, and personal lives. In line with innovative educational approaches like the Turkey Century Education Model, fostering this critical skill enhances social cohesion and raises children as contributors to society. **Collaboration** is vital for children's social development and societal adaptation. Early support of this skill in the Turkey Century Education Model encourages children to grow into cooperative individuals both in social life and in educational processes. **Curiosity** is essential for children's understanding of their surroundings, desire for continuous learning, and active participation in exploration. Supporting this skill from an early age in the Turkey Century Education Model allows children to develop critical perspectives, preparing them to be individuals who contribute to society. **Entrepreneurship** supports children in growing as creative, confident, and solution-oriented individuals. Supporting this skill early on contributes to raising independent, innovative thinkers who provide benefits to society. **Perseverance** is a core value that helps children reach their goals, gain self-confidence, and build self-belief. Supporting this skill from an early age in the Turkey Century Education Model fosters resilient individuals who are determined to succeed in both education and life. **Leadership** fosters self-confidence, responsibility, and effective communication. Supporting this skill from an early age in the Turkey Century Education Model helps raise individuals who contribute to society, inspire others, and lead change. **Problem-solving** enhances children's capacity for independent thinking, tackling challenges, and generating solutions. Supporting this skill from an early age in the Turkey Century Education Model prepares children to become independent, analytical thinkers who contribute to society. **Adaptability** is a fundamental value that strengthens children's social relationships and promotes emotional resilience and social harmony. Supporting this skill from an early age in the Turkey Century Education Model contributes to raising adaptable individuals who thrive in social unity and harmony.

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Section 2:

Technology and Innovation in Early Childhood

Chapter 6

The Effects of Digital Literacy Skills on Preschool Science Education

Erkan Yanarates[1]

Abstract

This chapter provides a comprehensive analysis of the effects of digital literacy skills on preschool science education. Digital literacy encompasses critical elements such as information access, analytical thinking, and secure digital content creation, fostering children's abilities in critical thinking, problem-solving, and information retrieval from an early age. Particularly within preschool science education, digital literacy not only facilitates children's understanding of scientific processes but also encourages active engagement in the learning process. This study examines how digital literacy skills can be integrated into preschool science education through developmentally appropriate activities and content. The role of digital literacy in preschool science education is explored through a review of research conducted in Turkey and internationally, educational theories, and practical applications designed to help young children understand science concepts through digital tools. By connecting these findings to theoretical foundations such as Vygotsky's Social Constructivism and Piaget's Cognitive Development Theory, the chapter discusses how digital literacy contributes to children's cognitive and scientific development. Furthermore, practical recommendations and examples of digital literacy activities enriched with digital tools are presented for educators, aiming to support them in integrating digital literacy and science education in children's developmental processes. These recommendations offer a guiding framework for educators and parents to incorporate digital literacy and science education effectively. In this context, the study emphasizes the positive impacts of digital literacy on early science education and its significance in fostering children's scientific curiosity.

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1. Introduction

Raising awareness among students at the primary school level about the effective and correct use of information technologies, enabling them to use these technological tools for communication and research, fostering skills in product development, computational thinking, design, problem-solving, and inquiry through information technology, and thereby increasing their digital knowledge base, are listed among the priority activities to be implemented by the Turkish Ministry of National Education (MoNE). The digital literacy component within the early childhood education program developed for preschool classes (MoNE, 2024) includes specific goals, such as gaining knowledge about communication tools through digital environments, understanding the functions of digital tools needed in daily life, and raising awareness regarding the appropriate use of digital communication tools according to age and skill level (Ayyıldız, Yılmaz, and Baltacı, 2021). A notable feature of this new program is its emphasis on problem-solving and programming units. Special objectives reveal a significant focus on problem-solving and skills related to PC technologies (Günbatar, 2020; MoNE, 2018).

Digital literacy is defined as a competency that includes the ability of individuals to access information, evaluate information, create content, and use digital tools safely and ethically in the digital world. In this context, it can be said to include literacy areas such as "information literacy, computer literacy, technology literacy, visual literacy, internet literacy, media literacy" (Yanarates, 2020). Today, digital literacy skills have become essential not only for adults but also for early childhood.

In early childhood, digital literacy not only provides children with skills in accessing, evaluating, and securely using digital environments but also increases their active participation in science education processes. Experiences such as concept development, problem-solving, and practicing scientific process skills through digital tools help children grow into responsible individuals in the digital world. Preschool science education, supported by digital tools, encourages hands-on activities that allow children to observe and gain experience about their surroundings (Sırakaya and Seferoğlu, 2019).

The development of digital literacy skills also lays a foundation for children to manage their own learning processes. Studies have shown that children's critical thinking and independent learning skills can be fostered through the conscious use of digital resources (Pangrazio and Sefton-Green, 2021). Digital literacy not only enables access to information but also enhances children's creative thinking and problem-solving abilities (Cohen and Livingstone, 2022).

For educators and parents, fostering digital literacy in early childhood is a critical responsibility. This responsibility begins with selecting digital environments that are age-appropriate, safe, and educational. Educators must enhance children's scientific and digital skills through content that contributes to their cognitive development while also raising awareness of the risks associated with the digital world (Gottschalk, 2019). Such digital literacy education contributes not only to children's academic and social success but also to preparing them as individuals capable of adapting to the requirements of the digital age.

2. Digital Literacy

Digital literacy is defined as a comprehensive set of abilities that enables individuals to access information in digital environments effectively, analyze and interpret this information, and produce digital content (Ng, 2019; Tingir and Özmen, 2018). These skills include an individual's proficiency in using technological tools consciously, securely, and ethically, equipping them with the necessary knowledge and skills for the digital age. The growing importance of digital literacy can be explained by the rapid digitization of information and the central role digital platforms play in daily life (Iordache, Mariën and Baelden, 2017).

Digital literacy does not only ensure access to information but also aids in developing critical thinking, problem-solving, and creative thinking abilities (Reyna, Hanham and Meier, 2018; Yilmaz, 2021). Introducing digital literacy skills in early childhood supports children in making a conscious entry into the digital world and exploring this world safely. Gaining digital literacy enables children to access accurate information in digital content, develop awareness regarding secure internet usage, and use digital tools creatively (Livingstone, Davidson and Bryce, 2021).

The acquisition of digital literacy skills during the preschool period can have positive effects on children's social, cognitive, and emotional development. For instance, children familiarized with digital tools can improve their problem-solving abilities in interdisciplinary fields such as science education, mathematics, and language (Smith and Franklin, 2020). Therefore, digital literacy is not only crucial for children's digital skills but also serves as an essential cornerstone that supports critical and analytical thinking abilities from an early age (Eshet-Alkalai, 2019).

Moreover, fostering digital literacy encourages children to act ethically and securely within the digital world. Given the various risks associated with digital environments, raising children's awareness of digital safety helps them handle issues such as cyberbullying, privacy violations, and misinformation (Park, 2021). For educators and parents, supporting children's conscious transition into the digital world and promoting the healthy use of digital resources underscore the growing importance of digital literacy.

2.1. Digital Literacy in Early Childhood Education

The preschool period is a critical time during which children develop fundamental cognitive, social, and language skills. During this period, fostering digital literacy skills enables children to make a healthy and conscious step into the digital world (Erstad, 2018). Digital literacy includes skills that support children in using digital tools safely, accessing and evaluating information, producing digital content, and gaining ethical awareness (Alper and Hodges, 2019). Establishing the foundations of digital literacy at an early age is a crucial step in helping children use technology consciously as they grow older (Hobbs and Coiro, 2020).

Developing digital literacy skills in the preschool period not only contributes to children's cognitive development but also enriches their learning experiences in fields like science education, language development, and problem-solving (Yelland, 2021). Research shows that effectively integrating digital content into early childhood education promotes creativity, critical thinking, and collaboration skills (Wartella and Robb, 2019). These skills enable children to actively participate in the learning process through digital tools, equipping them with the abilities required by the digital age.

Gaining digital literacy in early childhood also positively impacts children's social development and communication skills. Preschool is an ideal environment for children to learn how to communicate safely within digital platforms (Plowman and McPake, 2020). Children who receive digital literacy education gain awareness about potential risks in digital environments and develop knowledge of topics like safe internet use and privacy (Edwards, Nolan and Henderson, 2018). This foundation helps children handle negative aspects of the digital world, such as misinformation and cyberbullying.

The responsibility of fostering digital literacy skills in the preschool period is significant for both educators and parents. Educators should introduce children to age-appropriate digital content, fostering awareness of the proper and secure use of digital tools. The acquisition of these skills provides a substantial foundation for children's future academic success and social lives. Establishing digital literacy in early childhood prepares children to navigate the digital world independently and safely, setting them on a lifelong learning journey (Neumann, 2020).

2.2. Digital Literacy in the Context of Preschool Science Education

The acquisition of digital literacy skills is considered an effective tool in enhancing children's interest in science education processes. Digital literacy not only facilitates children's access to and evaluation of scientific information but also helps make the conceptual content of science education more tangible (Strouse et al., 2018). Through digital tools, children can learn abstract science concepts by experiencing them through digital simulations, animations, and interactive applications. This approach not only increases children's interest in science education but also enhances their scientific thinking and inquiry skills (Hirsh-Pasek et al., 2020).

Integrating digital literacy with science education, especially during preschool, supports children's sense of curiosity and engages them in active learning. For instance, with the help of a tablet or computer, children can observe natural processes such as the water cycle, gravity, or plant growth, participating in learning experiences based on their own observations (Chau, Lee, and Jelfs, 2019). These types of interactive applications keep children's interest in science alive and improve the comprehensibility of the topics (Shin, Sutherland, and Norris, 2020).

Digital literacy skills contribute to children's ability to access information, evaluate it, and create scientific content, which in turn supports their interest in science. Additionally, these skills encourage children to ask scientific questions and utilize digital resources to seek answers. Digital tools integrated into science education allow children to explore at their own pace, enriching individual learning experiences. In this process, children also develop digital content creation skills; for example, they can record their observations by taking digital photographs or share their observations by taking digital notes (Kucirkova and Falloon, 2017).

Educators and parents play a supportive role in fostering children's interest in science through digital literacy skills. By assisting children in using digital environments safely and effectively, educators help them learn scientific knowledge in a more accessible and engaging way (O'Byrne, Schenke, and Lawless, 2020). Science education supported by digital literacy skills not only contributes to children's academic success in science classes but also enhances their critical thinking and problem-solving abilities. In this context, the contributions of digital literacy to science education stand out as an educational tool that increases children's interest in the scientific world, encourages them to learn, and enables them to understand scientific concepts more easily.

Digital literacy plays a significant role, especially in science education, by helping children develop scientific thinking, problem-solving, and information access skills. The integration of digital tools into science education allows children to gain a deeper understanding of scientific concepts in their environment, enhancing their interest in science (Neumann, 2020). Studies examining the impact of digital literacy on science education show that children retain conceptual knowledge more effectively and meaningfully in science education supported by digital tools (Levine and Phipps, 2021).

Many studies indicate that digital literacy skills help children build a better knowledge structure in science education. For example, with digital simulations and virtual laboratory applications, children can experience scientific concepts in a concrete way. Research shows that digital tools are effective in visualizing abstract scientific concepts, enabling children to learn through experience more successfully (Hirsh-Pasek et al., 2020).

Thanks to digital literacy skills, children can closely examine scientific phenomena in their surroundings and access information about them (Smith and Franklin, 2020). By using digital tools to record their observations and analyze data, children can create scientific content. In this process, digital literacy enhances children's scientific process skills, thereby increasing their success in science education (Livingstone et al., 2021).

2.3. Integrating Cognitive Development Theory into Digital Science Education

Piaget's Cognitive Development Theory explains children's learning processes by considering their developmental stages, describing how they think, learn, and perceive their environment. According to Piaget, children go through four stages in their cognitive development: sensorimotor, preoperational, concrete operational, and formal operational stages. Preschool children are typically within the preoperational stage, covering ages 2–7, during which they acquire concrete knowledge about the world, classify objects, and begin to establish cause-and-effect relationships (Piaget, 1952). These developmental stages can be integrated into digital literacy and science education processes to support children's understanding of scientific concepts and digital skills (Livingstone et al., 2021).

Children in the preoperational stage may have difficulty understanding abstract concepts, so it is essential to use concrete, visual, and interactive materials in digital literacy and science education practices. In line with Piaget's theory, digital tools help children make abstract scientific concepts more tangible. For example, digital simulations for understanding the water cycle or animations showing the stages of plant growth allow children to observe natural phenomena in a concrete way (Neumann, 2020). These applications support children's exploration and comprehension of their experiences at their own pace, aligning with Piaget's concept of learning as an active process (Heath, 2020).

According to Piaget's theory, children learn through experimentation and problem-solving. Applications based on digital literacy and science education allow children to engage in problem-solving in digital environments and create their own experiences. For instance, using a tablet or computer, children can simulate simple scientific experiments or make observations about nature, thereby developing their digital literacy skills. Experiencing learning as an experimental process in this way provides a learning environment consistent with Piaget's cognitive development stages (Hirsh-Pasek et al., 2020). These applications strengthen children's problem-solving and exploration skills, fostering their scientific curiosity.

Furthermore, Piaget's Cognitive Development Theory emphasizes the importance of children's interaction with their environment, suggesting that active participation in digital literacy and science education applications is crucial. Educators can support children's scientific thinking by encouraging them to make observations, analyze data, and record their discoveries in digital environments (Edwards et al., 2018). This approach allows children to reach knowledge through their discoveries and supports their individual learning processes.

In conclusion, Piaget's Cognitive Development Theory offers a significant theoretical framework for structuring digital literacy and science education in early childhood. This theory helps foster critical thinking, problem-solving, and scientific process skills in the digital world by encouraging children's active involvement. Structuring digital literacy and science education based on Piaget's theory contributes to children's understanding of their surroundings and nurtures them as conscious, curious, and inquisitive individuals.

3. Digital Literacy Skills

Digital literacy is a multifaceted concept that encompasses skills such as effective access to information in the digital world, analyzing information, content creation, and safe use of digital tools (Ng, 2019). These skills allow individuals to engage actively and consciously on digital platforms, forming one of the essential pillars of modern education systems. The primary components of digital literacy include effective use of digital tools, critical thinking, information management, and ethical responsibility. Each of these aspects is closely related to individuals' ability to evaluate, create, and use the information and resources offered by digital environments in a secure way.

The first dimension of digital literacy, access to information, refers to individuals' ability to reach information quickly and effectively on digital platforms. This skill involves navigating the vast pool of information on the internet, accessing accurate information, and evaluating the reliability of sources (Livingstone et al., 2021). Information analysis and critical thinking, another critical dimension of digital literacy, enable individuals to critically evaluate information sources. This dimension supports children in coping with misinformation and encourages them to engage more consciously in the digital world (Spante et al., 2018). A third dimension of digital literacy, digital content creation, encompasses children's ability to create their own creative content in digital environments. This skill enables children to produce content in written, visual, audio, or video formats on digital platforms, fostering their creative thinking abilities (Jenkins, Ford and Green, 2018). In the preschool period, children can, for example, create their own stories, draw pictures, or express themselves on digital platforms using digital tools. These types of activities not only increase children's interest in technology but also enhance their ability to express themselves in the digital world (Neumann, 2020). The fourth and final dimension of digital literacy, digital safety and ethics, involves children's learning to navigate digital environments safely and with an understanding of ethical responsibilities. Ensuring children's safe navigation of the digital world is an essential component of digital literacy skills. This skill encourages children to protect their personal information online and adhere to ethical standards in digital environments (Edwards et al., 2018).

These dimensions reveal the multi-dimensional nature of digital literacy, emphasizing that digital skills are not merely technological proficiency but also a cognitive, social, and ethical developmental process. Instilling digital literacy skills from preschool onward provides children with essential preparation for navigating the digital world consciously (Heath, 2020).

3.1. Digital Literacy Skills in the Context of Access to Information

One of the fundamental dimensions of digital literacy skills involves individuals' ability to access information in digital environments and use this information effectively. Information access skills enable individuals to find information in digital platforms, evaluate and analyze this information (Ng, 2019). When digital literacy education begins in the preschool period, these skills support children's ability to access information and develop habits of evaluating information sources accurately. In the digital age, access to information contributes significantly to children's learning processes by enhancing their critical thinking and inquiry skills (Livingstone et al., 2021).

Information access skills are crucial in enabling children to reach reliable and accurate information in digital environments. This skill set includes selecting trustworthy sources on the internet, avoiding misleading information, and developing their analytical abilities. Developing information access skills in the preschool period prepares children for their future educational journeys and strengthens their critical thinking abilities (Heath, 2020). The core aspects of information access skills include children's selection of reliable sources, avoidance of misleading information, and ability to analyze their own knowledge (Levine and Phipps, 2021).

In the context of information access, digital literacy skills allow children to navigate the digital world effectively and equip them to handle misinformation. Children learn to question, investigate the accuracy of information they encounter on digital platforms, and seek additional information when necessary. In this process, digital literacy skills encourage children to ask questions, explore ways to access information, and understand how to apply this information in their learning (Edwards et al., 2018). Information access skills also support children's sense of curiosity, involving them in an active learning process.

Educators and parents can support children's information access skills by utilizing digital tools. For instance, introducing children to digital libraries or reliable educational applications fosters their research skills and helps them evaluate information from a critical perspective (Hirsh-Pasek et al., 2020). Such supportive practices develop children's abilities to analyze and question information in digital environments while also fostering their independence as learners (Neumann, 2020). With digital literacy education, children's information access skills strengthen, making it easier for them to reach accurate and reliable information in the digital world.

3.2. Digital Literacy Skills in the Context of Digital Safety

Digital safety, a critical dimension of digital literacy, aims to enable children to navigate the digital world securely. Digital safety skills encompass competencies such as protecting personal information online, developing awareness of digital threats, and adhering to ethical responsibilities in digital environments (Livingstone et al., 2021). These skills are especially important today, as digital platforms rapidly integrate into children's daily lives, providing them with the ability to engage in the digital world safely without encountering online risks (Edwards and Henderson, 2018).

Developing children's digital safety skills helps them recognize potential online risks, such as cyber threats, deceptive content, and cyberbullying, and encourages awareness of online security from an early age (Heath, 2020). The acquisition of digital safety awareness includes teaching children to protect their personal privacy, avoid sharing identity information, and refrain from communicating with unknown individuals online (Hobbs and Coiro, 2020).

Instilling digital safety skills from an early age encourages children to behave ethically and responsibly within the digital world. Providing children with digital safety education helps them develop awareness of issues like cyberbullying, misinformation, and ethical conduct in digital environments.

For instance, educators and parents can help children learn basic principles such as respecting others' rights in digital environments, avoiding unreliable content, and acting respectfully (Chaudron et al., 2020). Digital safety awareness enables children to not only access information but also use it responsibly in a secure manner.

Parents and educators can support children's digital safety awareness by offering age-appropriate digital safety guidance. Teaching children about potential risks on digital platforms, showing them how to use digital safety tools, and raising awareness about cybersecurity promote the development of digital literacy skills.

For example, explaining the weaknesses of simple passwords or providing suggestions for online privacy helps children learn basic security rules (Levine and Phipps, 2021). Acquiring digital safety skills helps children not only navigate the digital world securely but also engage ethically, contributing to their healthy development as responsible digital citizens.

3.3. Digital Literacy Skills in the Context of Content Creation

Another essential dimension of digital literacy skills is individuals' competency in creating content within digital environments. Content creation involves using digital tools to produce information, visuals, videos, and written materials and sharing these creations (Levine and Phipps, 2021). This competency enables children to actively contribute as creators in the digital world rather than merely being passive recipients of information. Content creation skills play a significant role in enhancing children's creative thinking, problem-solving, and self-expression abilities in the digital world (Ng, 2019).

Developing children's content creation skills allows them to produce unique digital content, supporting their cognitive development. In the context of digital literacy, content creation provides children with creative activities, such as storytelling, drawing, or recording short videos, which strengthen their self-expression abilities (Neumann, 2020). Additionally, content creation positively impacts children's learning in areas like science education, language development, and social skills. For example, activities like recording nature observations or creating scientific content with digital tools enhance children's scientific thinking abilities (Heath, 2020).

Supporting content creation skills encourages children to participate in the digital world as not only consumers but also as creators. While creating unique content in digital environments, children have the opportunity to develop creative thinking skills. This process allows children to practice problem-solving by generating new ideas, combining visual and written tools, and creating their own content (Chaudron et al., 2020). Content creation is also a valuable area for developing individual creativity, as children who prepare digital projects not only adapt to technology but also gain confidence by producing original work (Kucirkova and Falloon, 2017).

Educators and parents can support children's content creation skills by encouraging them to use age-appropriate digital tools for content creation. This approach not only enhances their creative thinking capacities but also allows them to express themselves in the digital world (Hirsh-Pasek et al., 2020). Including content creation skills in digital literacy education enables children to experience the process of creating their own digital content, moving beyond passive consumption. Integrating content creation into digital literacy education provides a strong foundation for children to become active participants in the digital age.

3.4. Digital Literacy Skills in Early Childhood Education

Early childhood is a period during which children rapidly develop fundamental cognitive, social, and motor skills. The integration of these skills into daily life is crucial for children to understand their surroundings, acquire problem-solving abilities, and form social relationships (Edwards and Bird, 2017). Digital literacy skills learned at an early age also merge with daily life, providing a solid foundation for children's educational journeys. Digital literacy skills, encompassing areas like information access, content creation, and safe internet use, contribute to children's growth as confident and conscious individuals in their daily lives (Neumann, 2020). Educators and parents play a significant role in integrating digital skills into daily life. For instance, when children access safe information through digital platforms, educators guide them toward reliable sources and support a critical approach to information. Similarly, creative digital skills like content creation are integrated into children's daily lives, fostering problem-solving and creative thinking abilities (Hirsh-Pasek et al., 2020). This integration process allows children to express themselves in digital environments, promoting their development as creative individuals.

The integration of skills acquired in early childhood into daily life positively impacts children's social relationships as well. Digital literacy skills encourage children to act responsibly and communicate safely both online and offline (Livingstone et al., 2021). Teaching these skills in early childhood not only prepares children to be responsible individuals in the digital world but also supports social skills like empathy and cooperation. Digital safety awareness enables children to navigate online environments securely and take precautions against potential risks (Levine and Phipps, 2021). Integrating digital literacy skills into daily life also provides a solid foundation for children's future educational experiences. By using digital tools responsibly in daily life, children develop a conscious approach to their surroundings and enhance their critical thinking abilities (Heath, 2020). In this process, educators can encourage children to develop their own projects using digital tools and create content connected to daily life, boosting their confidence and interest in learning. For example, children who record nature observations in a digital journal or share their scientific discoveries nurture their interest in the environment and integrate learning with daily life (Chaudron et al., 2020).

In conclusion, integrating digital literacy skills acquired in early childhood into daily life is essential for nurturing children as confident, conscious, and responsible individuals in the digital world. This integration supports the development of both digital and social skills, preparing them for future academic and social challenges.

4. Digital Literacy Applications in Preschool Science Education

Integrating digital literacy skills into preschool science education offers teaching approaches that enable children to understand scientific concepts and use digital applications effectively. Educators are developing various digital applications to support these skills. By combining digital literacy with preschool science education, these applications not only encourage children's active participation but also enhance their learning processes (Heath, 2020). Below are examples of digital applications related to digital literacy activities.

4.1. Examples of Digital Applications through Activities

- ***Digital Experiment and Observation Activities:*** Digital experiment applications for preschool children are an effective tool to make scientific concepts more tangible. Educators can introduce children to simple digital simulations that allow them to observe topics such as the water cycle, plant growth, or weather events. For example, children can observe plant growth stages using a tablet application and record their observations in a digital journal. Such activities allow children to explore scientific processes at their own pace (Neumann, 2020).
- ***Digital Photography and Video Journaling Activities:*** Encouraging children to observe nature around them using digital devices and recording these observations helps develop their scientific thinking skills. Educators can encourage children to take photographs during nature walks with digital cameras or tablets. Children can then share these images in the classroom and discuss their experiences. For example, photographing seasonal changes or the growth stages of plants helps children observe their environment more consciously (Chaudron et al., 2020).
- ***Interactive Scientific Story and Simulation Applications:*** Scientific storybooks and interactive simulations are effective tools for capturing children's interest in science topics. Educators can present interactive story applications that cover scientific concepts, such as the water cycle or animal life cycles. For example, digital storybooks on topics like "Chasing a Shadow" help children understand concepts like shadow and light by interacting with the stories, turning abstract ideas into concrete experiences (Livingstone et al., 2021).

- ***Basic Coding and Digital Design Applications:*** Coding activities are valuable tools for enhancing children's digital literacy skills and supporting their problem-solving abilities. Tools such as Scratch Jr. or Coding Cards allow children to create digital designs and animations through basic commands. Educators can use simple coding applications to help children create stories related to science topics, such as the water cycle or animals. These activities support children's digital content creation skills (Heath, 2020).

In summary, integrating digital literacy skills into science education is an effective educational strategy that supports children's scientific thinking skills and fosters their development as conscious digital citizens. Educators can enhance children's digital literacy skills with these application examples and practical suggestions, increase their interest in science, and encourage them to explore their environment with a scientific perspective.

4.2. Digital Literacy Activities for Educators

Developing digital literacy skills during the preschool period is essential for nurturing children as conscious digital citizens. Educators can implement various digital literacy activities that integrate with science education to help children develop these skills from an early age. These activities contribute to enhancing children's digital abilities as well as their scientific thinking capacities (Heath, 2020). Below are some recommended digital literacy activities for educators.

- ***Animation Activities:*** These activities are effective for developing children's problem-solving, creativity, and algorithmic thinking skills. Educators can use simple tools like Scratch Jr. to help children create short animations or stories on science topics. For example, children can create an animation about the changing seasons, reinforcing both their science knowledge and content creation skills (Chaudron et al., 2020).
- ***Creating Digital Nature Journals:*** To help children explore nature, teachers can organize digital nature journal activities. Children can take photos of plants, animals, or weather conditions in their environment using tablets or digital cameras, recording their observations. This activity allows children to note changes in their surroundings and enhances their scientific observation skills. Educators can discuss the photos taken during nature trips in class to reinforce learning experiences (Neumann, 2020).

- ***Digital Experiments and Observation Activities:*** Digital simulations and experiment applications help children understand abstract scientific concepts more easily. Educators can present interactive applications on topics like the water cycle, photosynthesis, or animal life cycles. For instance, children can use a tablet to observe plant growth stages or simulate weather cycles, helping them comprehend scientific concepts (Livingstone et al., 2021).
- ***Digital Storytelling and Presentation Activities***: Digital storytelling activities allow children to present scientific topics in their own words, developing both digital literacy and science knowledge. For example, children can create digital stories about themes like "Chasing a Shadow" or "A Tree's Seasonal Journey," allowing them to visually present what they've learned. During this process, children can add photos or drawings to their stories, supporting their content creation skills (Smith and Franklin, 2020).
- ***Digital Safety and Ethical Awareness Games:*** An essential component of digital literacy education, digital safety aims to foster safe internet use and ethical awareness in children. Educators can use digital safety games or interactive stories to teach children safe online behaviors. For instance, a story can illustrate the importance of protecting identity information online, helping children gain cybersecurity awareness (Edwards and Henderson, 2018). These activities support children in navigating the digital world safely.

With these activities, educators can help children develop digital literacy skills from an early age, nurturing them to become confident and responsible individuals in the digital world.

4.3. Digital Tools for Preschool Science Education

Enhancing digital literacy in preschool science education supports children's understanding of scientific concepts and strengthens their digital skills. Digital tools provide children with significant advantages in accessing information, making observations, recording experiences, and creating content. Below are several digital tool recommendations for supporting digital literacy and science education processes:

Scratch Jr. - Basic Coding and Scientific Storytelling

- ***Purpose:*** Scratch Jr. allows children to create animations and stories through simple coding, fostering creativity and problem-solving skills.

- ***Features:*** Children can use coding to explain scientific concepts (e.g., seasons, the water cycle) and learn science topics in an engaging way.
- ***Contribution to Science Education:*** By coding and animating scientific events, children can gain a better understanding of these phenomena (Chaudron et al., 2020).

Nature Cat's Great Outdoors - Nature Observation and Exploration Application

- ***Purpose:*** This app helps children observe nature and learn about plants, animals, and weather events in their surroundings.
- ***Features:*** Children can explore the outdoors and document their observations on plants, insects, and other natural elements.
- ***Contribution to Science Education:*** Documenting observations digitally fosters children's participation in the scientific research process and raises their environmental awareness (Livingstone et al., 2021).

Toca Lab - Interactive Experiments with Elements

- ***Purpose:*** Toca Lab allows children to learn basic chemistry concepts and conduct interactive experiments with elements.
- ***Features:*** Children explore elements by experimenting with heating, cooling, centrifuging, and observing different outcomes.
- ***Contribution to Science Education:*** This tool sparks curiosity in science and presents fundamental scientific concepts in an engaging format. Children gain hands-on experience with the states of elements (Heath, 2020).

Duck Duck Moose - Digital Stories on Climate and Nature

- ***Purpose:*** This application provides interactive stories on topics like climate changes, weather, and nature, contributing to science education.
- ***Features:*** Through interactive stories, children learn about weather and climate while creating their own narratives.
- ***Contribution to Science Education:*** This tool aids children in understanding natural events while enhancing creativity and understanding of scientific concepts (Neumann, 2020).

Seek by iNaturalist - Plant and Animal Identification Application

- ***Purpose:*** Seek assists children in identifying plants and animals they encounter in nature, encouraging exploration.
- ***Features:*** Using their cameras, children can identify species and learn more about them, documenting their observations.
- ***Contribution to Science Education:*** This app promotes children's interaction with nature and encourages scientific observation and awareness (Edwards and Henderson, 2018).

Bee-Bot - Simple Robotics and Science Education with Movement Commands

- ***Purpose:*** Bee-Bot is a programmable robot that can be used in science education activities, allowing children to use basic commands to control its movements.
- ***Features:*** Children can program the robot to explore science concepts, like the water cycle or food chains.
- ***Contribution to Science Education:*** Programming Bee-Bot helps children concretize scientific concepts and enhances coding, problem-solving, and planning skills (Smith and Franklin, 2020).

These digital tools support children's digital literacy and science education, increasing their interest in scientific topics and helping them develop as active participants in the digital world. Educators can use these tools to support children's learning processes and improve their understanding of scientific concepts.

4.4. Digital Literacy Training for Educators

Integrating digital literacy skills into preschool science education requires educators to effectively use digital tools. Digital literacy training for educators supports their adaptation to technology, helping them gain skills in digital content creation, digital safety, and data analysis. These training programs can include various workshops and seminars aimed at making science education, supported by digital skills, more effective. Below are some key components and benefits of digital literacy training recommended for educators.

Training on Digital Tool Usage and Integration into Science Education

- ***Content:*** This module teaches how to integrate digital tools into preschool science education. Educators learn to adapt tools like tablet applications, simulations, and simple coding tools to science topics.
- ***Benefits:*** Educators gain practical knowledge on using digital tools to enhance children's scientific thinking, observation, and content creation skills. For example, they learn how to use digital applications that explain science concepts like the water cycle or plant growth (Chaudron et al., 2020).

Digital Content Creation and Creative Pedagogy Training

- ***Content:*** In this training, educators acquire digital content creation skills, allowing them to produce digital stories, animations, and visual materials suitable for science education. The program also emphasizes teaching strategies that foster creative thinking.
- ***Benefits:*** Educators gain the ability to create digital stories or simple animations to explain scientific concepts to children in an understandable way, increasing their interest in science and making learning more enjoyable (Livingstone et al., 2021).

Digital Safety and Ethical Awareness Training

- ***Content:*** Covering topics related to digital safety and ethical use, this training provides educators with information on online security, data privacy, and digital ethics. It equips them to encourage children to adopt safe online behaviors.
- ***Benefits:*** This module ensures that educators are well-versed in essential digital safety knowledge, enabling them to educate children on safe online behaviors in digital environments (Edwards and Henderson, 2018).

Coding and Robotics-Based Digital Literacy in Science Education

- ***Content:*** This training aims to teach educators how to use basic coding and robotics applications suitable for the preschool period. It includes tools like Scratch Jr., Bee-Bot, and other robotic tools that can be integrated into science topics.
- ***Benefits:*** By using coding and robotics tools, educators support children's ability to create short animations or robotic tasks related to science topics. This training contributes to enhancing children's problem-solving and creative thinking skills (Heath, 2020).

Digital Pedagogy and Technology-Enhanced Learning Strategies Training

- ***Content:*** This training provides educators with knowledge about digital pedagogy and introduces technology-enhanced learning strategies. The focus is on effective use of digital tools, technology integration, and student-centered learning approaches.
- ***Benefits:*** Educators learn how to integrate digital tools using a child-centered approach, helping children develop digital literacy skills and increasing their interest in science through effective methods (Neumann, 2020).

Digital literacy training for educators enables them to participate actively in science education and enrich children's learning processes with digital tools. Such programs help educators use digital tools effectively, fostering children's development as safe, creative, and conscious individuals in the digital world.

5. Conclusion and Discussion

Integrating digital literacy into preschool science education is an important approach that enhances children's scientific thinking, problem-solving, creative content creation, and safe navigation skills in the digital world. Digital tools offer children opportunities for information access, observation, and content creation, increasing their interest in science education and facilitating their understanding of scientific concepts. Teaching digital literacy skills to children from an early age not only nurtures them as conscious individuals in the digital world but also raises their awareness of scientific processes.

In conclusion, digital literacy allows children to learn abstract scientific concepts through concrete experiences. With the help of digital tools, children can better understand concepts such as the water cycle and photosynthesis and gain knowledge about natural phenomena.

Experiments, observations, and content creation experiences with digital tools strengthen children's scientific thinking abilities and foster their curiosity about science. In this sense, digital literacy contributes to children's analytical thinking, creative problem-solving, and critical perspective on information.

Digital safety and ethical awareness training help children develop safe online behaviors and become responsible digital citizens.

Integration of Digital Literacy into the Science Curriculum: Educators can offer an interactive and engaging learning environment by integrating digital tools into science education. Adding digital literacy activities to the preschool curriculum supports children's development in scientific thinking and problem-solving (Heath, 2020).

Organizing Digital Literacy Training Programs for Educators: Supporting educators with training on the effective use of digital tools and integration into science education is essential. Workshops and seminars on digital content creation, digital safety, and data analysis can enhance educators' skills in these areas (Edwards and Henderson, 2018).

Promoting Nature Observation and Digital Journals: Encouraging children to observe nature and record their observations digitally increases their interest in science education. Digital nature journals, for instance, help children develop observation skills and environmental awareness (Neumann, 2020).

Supporting Science Topics with Coding and Robotics Activities: Simple coding and robotics tools help children better understand science topics and learn scientific concepts through hands-on experiences. Coding tools and robotics kits suitable for the preschool period provide an engaging and meaningful way to teach science concepts (Chaudron et al., 2020).

Encouraging Family Involvement and Informing Families on Digital Safety: To enhance the success of digital literacy education, family involvement is vital. Informing families about digital safety and basic internet usage rules helps children engage with digital environments more safely (Livingstone et al., 2021).

In general, integrating digital literacy skills with science education from an early age equips children with scientific thinking and digital awareness. Educators can use digital tools effectively to increase children's interest in science and support their development as safe, creative, and conscious individuals in the digital world. This integration between digital literacy and science education provides a forward-looking educational approach that supports children's academic success and social development.

6. Recommendations

Preschool science education is essential for fostering children's curiosity about the world, developing scientific thinking, and acquiring problem-solving skills. Science education supports children in developing a positive attitude toward lifelong learning by nurturing scientific curiosity from an early age. In this process, educators and parents can use the following recommendations to attract children's interest and support their learning journey:

Encourage Nature Observations to Spark Scientific Curiosity

- ***Recommendation:*** Organize nature walks, garden tours, or outdoor activities to encourage children to observe nature, notice changes in their surroundings, and ask questions.
- ***Implementation:*** Provide children with digital cameras or tablets to observe and record environmental elements like plants, animals, and weather. Encourage them to take notes and ask questions about their observations. Such activities help children develop observation and curiosity skills (Neumann, 2020).

Additionally, tools like Google Expeditions or National Geographic Virtual Tours offer children the chance to explore ecosystems like forests or marine life. Through virtual observations, they can learn about animal species and plant diversity (Hwang and Wang, 2016).

Organize Experiential Learning Activities

- ***Recommendation:*** Support science education with simple experiments that promote experiential learning, as children learn by directly observing scientific processes through experiments.
- ***Implementation:*** Virtual chemistry lab simulations, such as Labster, allow children to create experimental setups and learn by combining different materials, fostering experiential learning (De Jong, Linn and Zacharia, 2013).

Use Digital Tools to Make Scientific Concepts More Tangible

- ***Recommendation:*** Utilize digital tools to create an interactive learning environment in science education. Digital simulations and animations make abstract concepts more comprehensible for children.
- ***Implementation:*** For example, a tablet or computer animation explaining the water cycle can help children observe processes like evaporation, condensation, and precipitation more concretely. Digital tools increase children's interest in scientific concepts and make learning easier (Heath, 2020).

Provide On-Site Experiences with Augmented Reality Applications

- ***Recommendation:*** Augmented reality applications allow students to examine specific objects in their physical environment or view 3D science concepts. For example, supporting the experience of growing a plant at home with augmented reality enables children to observe each stage of growth.

- ***Implementation:*** With applications like Plantale AR, children can virtually care for a plant, observing each phase from seed germination to full growth (Wu et al., 2013).

Offer Science Teaching Opportunities Through Digital Games

- ***Recommendation:*** This study investigates how digital games can be effective tools in learning processes. It provides extensive insights into the impact of educational games on science education and how game-based learning environments enhance children's motivation.
- ***Implementation:*** Educational applications like BrainPOP or Tinybop allow children to play games on topics like physics, chemistry, and biology. For example, they can reinforce concepts related to the water cycle or life cycles by engaging in digital games (Gee, 2003).

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Chapter 7

AR and AI Applications Supporting Listening Skills in Early Childhood: Innovative Solutions in Language Teaching

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Abstract

This study examines the impact of augmented reality (AR) and artificial intelligence (AI)-based applications on enhancing listening skills in early childhood. Listening is a foundational skill in language development and is crucial for acquiring social and cognitive abilities. Integrating digital technologies into educational processes offers an innovative approach to support children's attention spans and listening habits. In this context, the study investigates how AR and AI-supported applications can engage children, increase their focus duration, and develop their listening skills. The AR applications used in the study facilitated children's interaction with auditory and visual stimuli, thereby providing a multisensory learning experience. AI-based storytelling, on the other hand, helped children extract meaning from stories and focus on details while listening. The findings reveal that AR and AI technologies effectively strengthen children's listening skills and improve their attention spans. These technologies not only contribute to language development but also foster active participation and motivation in the learning process. In conclusion, integrating AR and AI applications into early childhood education has the potential to enhance children's linguistic and cognitive skills. The study's findings suggest that technology-supported learning environments offer a valuable complement to traditional methods and provide innovative solutions in children's education.

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1. Introduction

Listening skill, which is accepted as the first step of the mother tongue acquisition process, is considered as one of the foundations of cognitive development and language development in early childhood. The listening process is not only limited to the physical perception of the sounds heard, but also includes making sense of these sounds, interpreting them and using them in a social context (Jalongo, 2010). Therefore, although listening seems to be a learning process that occurs spontaneously in the natural environment, it also takes place depending on innate genetic characteristics and personal development.

Listening is one of the most effective ways of acquiring information and communicating in children's learning process. The verbal inputs that children gain through listening skills form the basis of language development. According to research, children learn by making sense of the sounds they hear from birth. Especially the 0-3 age period is a critical period in terms of brain development and auditory experiences in this period affect long-term learning and language skills (Vouloumanos & Werker, 2007). Listening, as the first language skill acquired, is also important for the development of other skills.

Listening skills begin to develop at an early age and this process is a part of language acquisition. Akhtar (2004) states that children begin to understand certain words as early as 9 months of age and that listening experiences in this early period positively affect language development. Listening habits acquired during this period also form a foundation for children's literacy and language skills. In addition, children's vocabulary increases and enriches as their listening skills improve (Hurtado, Marchman & Fernald, 2007). Listening skills also have an important place in children's socio-emotional development. Through listening, children develop empathy skills by understanding the feelings and thoughts of others. In this context, Jalongo (2010) emphasizes the importance of listening skills in social relationships and states that listening habits enable children to respect others, express themselves and be more successful in their relationships. In addition, studies by McDevitt (1990) and Imhof (2002) show that children can recognize the characteristics of effective listeners at an early age.

Listening is a skill that supports children's language development and can be developed both in the family and in the school environment. In particular, parents can contribute to this process through interactive readings and daily conversations to strengthen children's listening skills (Dougherty & Paul, 2007; Robinshaw, 2007). In addition, these skills can be strengthened and developed through regular listening activities in schools and activities that will ensure children's active participation.

On the other hand, the digital age, which has become the center of our lives in recent years due to the development of technology, artificial intelligence and changes and transformations in distance learning practices, deeply affects children's interaction styles, information acquisition processes and language development. Children's interaction with their environment and listening experiences are being reshaped through digital tools and technologies. Research shows that the impact of digital media and technologies on language development is multidimensional; some technologies can be supportive while others can negatively affect children's language skills (Vulchanova et al., 2017). In the digital age, children develop their language skills through digital tools such as tablets, computers and smart devices in addition to traditional book reading and face-to-face communication. Especially tablets and interactive books are thought to support children's symbolic comprehension and vocabulary learning skills (Allen et al., 2015). However, overuse of digital tools can negatively affect children's attention and motivation to learn (Anderson & Pempek, 2005).

In digital technology, robot-assisted language teaching is another innovative application that has attracted attention in the digital age. Social robots are designed as companions to support children's language learning and contribute to the learning process by providing interactive games and language activities (Westlund et al., 2016). The fact that robots can give emotional feedback to children and adapt to their language level is an important factor that strengthens interaction (Kennedy et al., 2015).

The most important question regarding the use of digital technologies in educational research is whether these tools facilitate children's learning to read and write. In particular, methods such as educational games and interactive storytelling can attract children's attention and help them develop their language skills in a fun way (Kucirkova et al., 2014). However, it is emphasized that educational practices should be designed in accordance with children's cognitive levels (Bavelier et al., 2010). In this context, in this study, the effects of artificial intelligence and augmented reality applications on listening skills, which are considered one of the most important steps of language teaching in early childhood and form the basis of language teaching, will be discussed.

2. Listening Skills in Early Childhood

Listening skill forms the basis of language development and is of great importance especially in the preschool period in terms of providing the child with all thoughts, feelings and knowledge. In this period, children learn to listen and try to make sense of it, but it is possible to make this process effective with the guidance of families and teachers (Çetinel, 2016; Sever, 2000). The child's listening skill is first acquired in the family and this skill is important as a basic communication skill that the individual will use throughout his/her life (Melanlıoğlu, 2012).

Listening is a process in which speaking and communication skills come to the fore in preschool education. Since children do not have reading and writing skills, they turn to speaking and listening in their communication (Cin Şeker, 2020). In the process of listening education, it is important for children to be able to direct their attention, focus and make sense of what they listen to. For example, activities such as listening to sounds in nature, recognizing sounds or matching them with visuals aim to focus children's attention on sound and strengthen their listening skills (Çetinel, 2016). It is also possible for teachers to make children's listening skills effective by using strategies such as planning, evaluation and metacognitive awareness (Jones, 2007).

Listening education, when carried out through a well-planned process, has positive effects on children's language and cognitive development. The teacher has a great influence in this process. The teacher needs to prepare the environment and equip himself/herself in order to help children acquire listening skills (Özbay, 2005; Jalongo, 2010).

Since listening is the first skill acquired by an individual, it will be important throughout his/her life. Language teaching develops by the individual imitating his/her environment. Therefore, preschool period is one of the critical periods for shaping listening and speaking skills. Listening activities carried out in this period form the basis of other language skills as it is the only comprehension skill until the school period in terms of developing sensory memory (Doğan, 2011; Damar, 2024). The development of listening skills in early childhood will be effective in the future of the individual.

3. Innovative Technologies in Language Teaching

In the 21st century, rapid developments in computer and information technologies require societies and individuals to keep pace with this change. Integrating technology into educational environments enables individuals to have basic skills such as accessing, organizing, evaluating and presenting information effectively. These skills are critical for both the personal development of individuals and their contribution to social life. The use of multiple learning tools such as computers, videos, augmented reality and virtual reality in education makes teaching-learning processes more effective and efficient (İşman, 2013; Yılmaz, 2005). This situation offers us very important opportunities in areas such as teaching Turkish as a foreign language, teaching Turkish to Turkish children abroad, teaching Turkish descendants, teaching to disadvantaged groups, especially mother tongue teaching. Especially with the developments in the global pandemic period, the emergence and commissioning of distance learning applications suddenly increased the need for technologies and innovative technologies in language teaching. On the other hand, the use of technological tools provides the opportunity to visualize information in education, allowing information to become more permanent in the mind. This visual support can make what is learned more meaningful, especially in areas that are difficult to concretize, such as language teaching. By going beyond traditional methods in language teaching, activities such as gamification, interaction and creating a perception of reality are used with the opportunities offered by technology, thus making the learning process more fun and motivating (Kılıç Avan, 2024).

Since language education also encompasses the culture of the language, the use of technology is of great importance. Presenting the language not only auditorily but also visually facilitates the comprehension of the language in terms of meaning. For example, making various situations and concepts concrete helps learners to form a meaningful whole in their minds. In this context, students, who have the opportunity to learn by doing and experiencing, move away from ordinary lesson environments and engage in a process that is more interesting and in which the learner is active. Because the motivation and participation of individuals who are supported by the unique educational materials offered by technology increases; this makes learning more efficient and effective. In addition, the ability of individuals to progress according to their own learning pace, to repeat subjects when necessary and to receive feedback improves the quality of the educational process (Li, 2016). Technology also saves time, allows learners to focus their attention more effectively, and improves their ability to multitask. In this framework, technology stands out not only as a tool in language teaching but also as an element that supports and facilitates language acquisition.

When innovative technologies in language teaching are examined, some of the technologies that come to the fore are as follows:

1. **Augmented Reality (AR)**: Augmented reality makes language learning more immersive by adding digital content to the physical world. For example, by associating words with 3D models or everyday objects, learners can visually recall words and concepts more easily.
2. **Virtual Reality (VR)**: Virtual reality transports users into virtual environments where the target language is spoken, allowing them to experience the natural use of the language. Students gain a stronger understanding of language use through practice, such as ordering in a café or visiting a museum.
3. **Artificial Intelligence (AI) Based Language Assistants**: AI-powered applications provide instant feedback to students while improving their speaking, listening and writing skills. For example, AI-powered speech recognition systems can identify student pronunciation errors and make suggestions for correct pronunciation.
4. **Chatbots** In language teaching, chatbots provide students with the opportunity to practice by chatting in the target language. Chatbots can help students improve their written and spoken language skills and allow them to practice language through natural dialogues.
5. **Gamified Language Learning Apps**: Language learning apps like Duolingo make learning more fun by adding game elements. Gamification techniques such as earning points, rewards, levels and competitions increase students' motivation and keep them engaged in the language learning process.
6. **Mobile Apps and Microlearning**: Mobile apps support language learning with short and focused content. This method, called microlearning, provides learners with short lessons, breaking down knowledge into chunks and allowing it to be reinforced over time.
7. **Voice Recognition and Natural Language Processing (NLP)**: Voice recognition technologies analyze students' speech to ensure correct pronunciation. Natural language processing can analyze students' speech and give meaningful feedback. Thus, students can better analyze their own mistakes.
8. **Writing and Speech Analysis Tools**: Written language development tools such as Grammarly improve writing skills by providing grammar, spelling and style suggestions. In addition, AI-based speech analysis tools analyze students' speaking errors and provide feedback.

9. **Online Language Exchange Platforms**: Applications such as HelloTalk and Tandem offer the opportunity to practice with native speakers of the target language. Students participate in a natural language acquisition process through cultural exchange and language practice.

10. **Language Learning Podcasts and Videos**: Podcasts and video series allow students to familiarize themselves with the natural conversational flow of the target language while improving their listening skills. These resources address a variety of topics and provide content of interest to language learners.

11. **Adaptive Learning Technologies**: These systems provide a personalized learning experience by delivering content based on students' learning speed and difficulty level. Adaptive learning, which is shaped according to the strengths and weaknesses of the student, offers a more effective learning process.

When these technologies are examined, it is seen that they contribute to different dimensions of language teaching. Within the scope of the study, especially AR applications and Artificial Intelligence applications will be discussed in the context of in-class activities.

4. Supporting Listening Skills with AR Applications

An example of the use of AR applications in preschool course activities is presented below.

Listening Skills - "Discover Animal Sounds"

Class Level: Preschool (4-6 Years) **Duration:** 30-40 minutes

Tools and Equipment:

- Tablet or smartphone (can be used for each student or in small groups)
- Augmented reality (AR) app (e.g. an AR app with animal sounds or AR cards)
- Animal figures (toy animals, pictures or cards)

Course Objectives:

1. Developing children's listening skills.
2. Listening to animal sounds and guessing which animal the sounds belong to.
3. Using augmented reality applications to provide students with audio stimuli to practice focusing and listening.

4. Engaging children to actively participate and increase their focus on listening.

Entrance (5 minutes):

1. The teacher talks to the class about animal sounds and explains that some animals identify themselves by making different sounds.
2. Introduces the purpose of the activity by saying "Today we will try to recognize animal sounds and learn which sound belongs to which animal."
3. Animal figures that will be involved in the practice are shown (e.g. cat, dog, bird, cow, etc.), so that children are visually prepared.

Development (20 minutes):

1. **Introducing the AR App:** The teacher introduces the augmented reality app to the children and shows how to use it. For example, the app can be an AR experience where sounds are made when the tablet camera is pointed at animal figures.
2. **Listening Activity:**

- o Children take turns using the tablet or smartphone to open the image of the selected animal.
- o When the sound of the animal is heard, children listen quietly and make guesses: "Which animal does this sound belong to?"
- o The teacher listens to the children's answers and gives clues to help them guess correctly.

3. **Matching Game:**

- o Ask the children to match the sound they hear with the toy animals or cards in the classroom.
- o Children can create a story by sorting the stuffed animals according to the sounds they hear during the listening activity. At this stage, children can come together and work in small groups.

4. **Question and Answer and Hint Game:**

- o The teacher asks children questions for each animal sound: "Where does this animal live?" or "Where else do we hear this sound?"
- o Children reinforce their listening skills and knowledge by talking about the animals' environment, where they live and how they live.

Conclusion and Evaluation (5-10 minutes):

1. **Feedback:** At the end of the activity, the teacher evaluates each child's participation in the activity and provides feedback on the children's answers.
2. **Rewarding:** Each child is given positive reinforcement such as small rewards or applause for his/her effort in the activity.
3. **Sharing:** Children are given a short opportunity to share their feelings and learning about the activity.

Evaluation Criteria:

- Observing children's listening skills and attention span.
- Correct animal recognition rate when using the AR app.
- The level of cooperation in group work and guessing games.

With the lesson plan given as an example, children's attention and listening skills can be improved by using augmented reality technology. Active participation of children can be ensured with topics that can attract their interest, such as animal sounds, and they will be able to use their different senses at the same time while supporting their ability to match and predict the sounds they hear with the AR application. In this context, some AR applications that can be used in the lesson are given below:

QuiverVision

<table>
<tr><td rowspan="3">
Image 1. Images from the QuiverVision AR app
You can access online content related to the application via the QR code.</td><td>**Usage:** Children can color animals on coloring pages and bring them to life through AR. They can focus their attention with visual and auditory stimuli while watching the sounds and movements of the animals.</td></tr>
<tr><td>**Benefits:** Develops color and sound matching skills, supports fine motor skills, increases focus and listening skills by observing the movements and sounds of animal figures.</td></tr>
<tr><td>**Benefit to the Child:**
It develops color and sound matching skills because children see the animals they paint with their voices.
Supports fine motor skills through the coloring process. Watching the movements and sounds of animal figures increases children's listening and focusing skills.</td></tr>
</table>

AR Flashcards

	**Usage:** Children learn about different animals and their sounds through the cards.
	Benefits: Memory and comprehension skills are developed through animal figures and sounds, and attention spans are extended with audio-visual stimuli. Logical thinking and prediction skills are supported with sounds and visuals.
Image 2. Images from the Google AR Animals AR app You can access online content related to the application via the QR code.	**Benefit to the Child:** Develop memory and comprehension skills by recognizing animal figures and sounds. Audiovisual stimuli increase attention spans and enable active participation. Listening to animal sounds and guessing which sound belongs to which animal supports logical thinking and inference skills.

Narrator AR

	**Usage:** Children follow the stories visually with AR and watch the animations of the characters of the story.
	Benefits: Visually following the characters during storytelling improves focus and listening skills. Children's interaction with the characters supports their imagination and language development.
Image 3. Images from the Google AR Animals AR application You can access online content related to the application via the QR code.	**Benefit to the Child:** By supporting storytelling with three-dimensional visualizations, it strengthens children's listening and comprehension processes. Visually following the characters in the story helps children focus and improves listening comprehension. Contributes to their imagination and language development by participating in the story with AR.

Google AR Animals

<table>
<tr><td rowspan="3">

Image 4. Images from the Google AR Animals AR application

You can access online content related to the application via the QR code.</td><td>**Usage:** Through the devices, children can see life-size 3D models of animals and listen to their sounds.</td></tr>
<tr><td>**Benefits:** Increases the sense of curiosity through direct observation of animals and offers concrete learning experiences. The combination of visual and auditory information develops children's environmental awareness and observation skills.</td></tr>
<tr><td>**Benefit to the Child:**

The child's three-dimensional examination of animals in their natural size and listening to their sounds offers a concrete learning experience.

It develops the child's sense of curiosity and helps them learn about new animals.

By combining visual and auditory information, it develops children's environmental awareness and observation skills.</td></tr>
</table>

Assemblr EDU

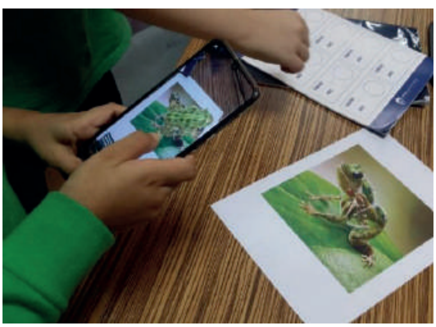
<table>
<tr><td rowspan="3">

Image 5. Images from Assemblr EDU AR application

You can access online content related to the application via the QR code.</td><td>**Usage:** Allows children to observe and investigate by creating a variety of 3D models.</td></tr>
<tr><td>**Benefits:** Improves children's listening skills and supports their ability to recognize different voices and characters. The AR experience boosts children's self-confidence and intrinsic motivation to learn.</td></tr>
<tr><td>**Benefit to the Child:**

With a variety of 3D models and AR content, it enables children to observe and research so that they can actively participate in the learning process.

While developing listening skills, it also supports the ability to distinguish and recognize different sounds.

Studying animals and story characters on their own boosts their self-confidence and intrinsic motivation to learn.</td></tr>
</table>

Wonderscope

Image 6. Images from the Wonderscope AR app

You can access online content related to the application via the QR code.

Usage: Presents stories in an interactive way, making children feel part of the story.

Benefits: Interactive storytelling develops empathy and emotional intelligence. Children interact with characters, reinforcing language, listening and attention skills.

Benefit to the Child:

It makes storytelling interactive, making children feel part of the story. This promotes empathy and emotional intelligence.

Reinforces attention and language skills by interacting with characters and listening to commands.

As an active participant in the story, it develops children's listening and questioning skills, while offering a fun experience.

Catchy Words AR

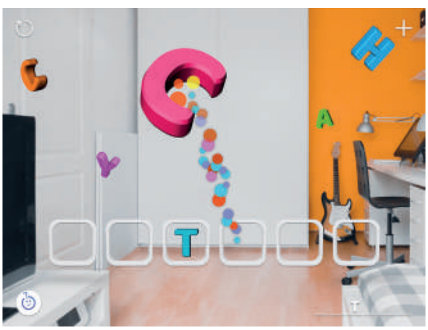


Image 7. Images from the Catchy Words AR app

You can access online content related to the application via the QR code.

Usage: It contributes to children's language development by visualizing letters and words in three dimensions in AR environment.

Benefits: Supports phonological awareness through letter and sound matching and strengthens visual word learning skills. Sorting words improves memory and concentration skills.

Benefit to the Child:

It supports language development through letter and sound matching and contributes to children's phonological awareness. Learning words visually provides a basic preparation before reading and writing skills.

Keeping track of words and placing them in the correct order in a fun game environment improves children's memory and concentration skills.

5. Supporting Listening Skills with Artificial Intelligence Applications

An example of an application for the use of artificial intelligence applications in preschool lesson activities is presented below.

Listen to the Story, Answer the Magic Questions!

Objective

- Developing children's attentive listening skills.
- To reinforce their ability to distinguish important details during listening.
- Increasing children's interest and motivation with artificial intelligence-supported audio storytelling.

Age Group

- 4-6 years (preschool level)

Required Materials

- AI-powered audio storytelling app (e.g. Storytime or a similar digital assistant)
- Tablet or smart device
- Story questions and picture cards related to the activity (main characters, events and objects in the story)

Event Duration

- 20-25 minutes

Event Implementation

1. **Introduction (5 minutes)**: The teacher explains to the children the importance of listening skills. She emphasizes that listening is not just sitting quietly but also trying to understand what is being said. The teacher then explains how to use AI-supported storytelling.
2. **Choosing the Story (2 minutes)**: Choose a simple and fun story that can attract children's attention. For example, a short story that arouses curiosity such as "The Lost Teddy Bear" is preferred.
3. **Listening to a Story with AI (8-10 minutes)**: The story is started with an artificial intelligence application and children are asked to listen carefully to the story. In the meantime, the teacher can give small clues to help children remember some important events and objects in the story.

4. **Listening Comprehension with Questions (5 minutes)**: When the story ends, children are asked questions about the story. For example:
   - o "Where did the teddy bear go?"
   - o "Who was the main character and what was he trying to do?"
   - o "Which part of the story did you like the most?"

As the children respond, the teacher emphasizes that careful listening is important for accurate responses.

5. **Game Reinforcement (5 minutes)**: The teacher places the picture cards of the characters and events in the story on the table and asks the children to make the correct order in the story. Thus, children are given the opportunity to reinforce what they have listened to with visual memory.

During this activity, the teacher observes the children's level of focus while listening to the story, their responses to questions and their participation during the game. Thus, she can make an overall assessment of each child's listening skills. Some artificial intelligence applications that can be used here are:

Listening to Stories with Google Assistant and Alexa

- **How to use it**: Smart assistants, such as Google Assistant or Amazon Alexa, offer a choice of stories tailored to children. Children can listen to stories with simple commands like "Tell me a story".
- **Advantage**: These assistants work with simple commands that are easily accessible to children. They also respond by voice, encouraging interaction.

Storytime

- **How to Use**: Storytime is an app that offers age-appropriate, short and educational stories. The AI-powered storyteller is a great tool for developing children's listening and attention skills.
- **Advantage**: Engages children with interactive and audio storytelling, and some stories include question-and-answer sections.

Kahoot Kids

- **How to Use**: Kahoot's version for children helps children practice their listening skills by asking questions after the story. Teachers or parents can create small quizzes related to the story being listened to.

- **Advantage**: Children both listen to the stories and reinforce what they learn through fun games. The question and answer format encourages careful listening.

YouTube Kids Story Channels

- **How to use it**: The YouTube Kids app features audio story channels for children. These story videos usually engage children with animated visuals and simple narration.
- **Advantage** Children's attention span is supported by presenting visual and auditory content together. It can also be controlled under the guidance of parents or teachers.

Spotify Children's Stories

- **How to Use**: Spotify has audio story playlists created specifically for children. Parents or teachers can choose an age-appropriate playlist and play it.
- **Advantage**: There is also a Spotify Kids app that offers an ad-free experience. Such playlists allow children to develop their listening skills in a relaxed environment.

Lingokids

- **How to Use**: Lingokids is an app that provides educational content and stories for children. It develops children's language and listening skills through stories, games and music.
- **Advantage**: Reinforces listening skills by providing a multi-sensory experience. There are also interactive features, so children actively participate in learning while listening.

These practices can help preschool children develop the habit of listening attentively and increase their ability to think through stories.

6. Conclusion

In recent years, there has been a significant increase in academic studies on listening skills, which is the first step in the language acquisition process. In particular, much attention has been paid to the learning processes of individuals at the preschool and primary school levels in basic education based on the four basic skills. The most important skill that naturally comes to the fore in this process is listening. Because individuals with well-developed listening skills will also develop their comprehension, speaking and writing skills linearly. For this reason, a healthy listening process, environment, digital technology and artificial intelligence-supported applications developed based on scientific research are of great importance at all levels, especially at basic education levels. In line with these considerations, this study examined the effects of augmented reality (AR) and artificial intelligence (AI)-based applications on supporting listening skills in preschool period. AR and AI applications play an important role in increasing children's attention span and improving their listening skills. In particular, activities supported by AR provide children with a multidimensional learning experience with audio and visual stimuli and provide significant improvements in their listening and focusing skills.

Thanks to the sample applications used in the study, children's interaction with visualized content encourages them to participate more actively in the learning process. AI-based storytelling tools improve children's listening and comprehension skills and increase their interest and motivation in listening activities. Technology-supported learning tools are not only an entertaining tool in children's language development but also an effective educational material.

In conclusion, the integration of AR and AI technologies into the preschool educational environment has the potential to improve children's cognitive and linguistic skills. It is important for educators and parents to carefully manage children's interactions with digital tools in order to gain maximum benefit from these technologies. AR and AI technologies offer a valuable alternative to traditional methods in developing children's listening skills.

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Chapter 8

STEM and AI Integration in Early Childhood: First Steps for Future Scientists

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Abstract

This chapter examines the importance of integrating artificial intelligence (AI) and STEM (Science, Technology, Engineering, and Mathematics) in early childhood education, highlighting how this integration contributes to foundational skill development in young children. AI's role in education is emphasized through its ability to provide interactive and personalized learning experiences, thereby fostering independent learning processes among students. Integrating AI tools in early learning increases children's interest in STEM subjects and supports teachers in various instructional tasks. The chapter presents three main paradigms of AI-based STEM education: AI-directed, AI-supported, and AI-empowered STEM education. These models serve distinct functions in the learning process, such as as automating access to information, providing real-time feedback, and creating student-centered learning environments. Specifically, natural language processing tools like ChatGPT support students' individualized learning paths by offering instant information on STEM topics and assisting teachers in preparing educational materials. A practical example, "Plant Exploration with a Smart Assistant," demonstrates a model for enhancing children's scientific observation skills and environmental awareness through AI. This activity enables young learners to explore nature with the support of AI, illustrating the potential of educational technologies in early childhood education. Finally, the chapter underscores AI's contribution to the development of critical thinking and creativity skills. AI's capabilities in providing instant feedback and accessible information encourage in-depth learning experiences in STEM education, equipping students with a more informed approach to data analysis and knowledge evaluation.

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1. Introduction

AI concepts can be traced back historically to ancient myths, for example the Greek figure of Talos, who can be seen as a form of artificial intelligence (Mayor, 2018; Sheikh et al., 2023). The term "artificial intelligence" was first officially coined in the 1950s with the idea of machines simulating human intelligence (Bini, 2018); however, the definition of this rapidly evolving technology is vague and fluid (Murdick, 2020). Kaplan and Haenlein (2019) define AI as a system that can accurately interpret external data, learn from it and flexibly adapt to achieve specific goals.

AI in education is seen as a versatile tool that supports teachers. For example, it can perform time-consuming tasks such as automating student assessments, scoring, and adapting instruction to student needs (Bryant et al., 2020). According to Matzakos et al. (2023), AI tools can complement teachers, enabling them to guide students to explore knowledge independently. However, the widespread availability of AI tools has led to calls for limitations in some educational settings due to concerns about content production (Maoet et al., 2024).

Despite the broad educational potential of AI, research on its use in preschool education is limited. Several studies highlight that tools that develop practical AI projects, especially "Learning ML" or personalized learning experiences for preschoolers, such as the smart game "Maya", offer interactive and age-appropriate experiences by increasing children's engagement (Rodríguez-García et al., 2021; Akdeniz & Özdinç, 2021). Such tools reveal the role of AI in fostering interest in STEM-related topics and its importance in preschool education.

2. The Role of STEM and Artificial Intelligence in Preschool Education

The integration of artificial intelligence (AI) technologies in STEM education constitutes significant advantages in several studies. Okonkwo and Ade-Ibijola (2021) address the opportunities offered by these technologies, while Khosravi et al. (2023) highlight the benefits offered by chatbots, such as continuous access and scalability. Such tools can increase interactivity, personalization, educator support, and student understanding for those who require additional support in the STEM field. ChatGPT in particular has attracted attention as an educational tool due to its natural language communication capabilities; users can interact without programming knowledge (Baidoo-Anu & Owusu Ansah, 2023; George & George, 2023).

The fact that it reached 100 million users in just two months shows how much interest it has gained among students (Wu et al., 2023).

By using GPT-based NLP techniques to provide human-like responses, ChatGPT offers instant information for teachers and students and provides personalized learning experiences in STEM subjects (Wang et al., 2023; Verma, 2023). Teachers can enhance their teaching effectiveness by using ChatGPT for lesson planning and material development (Koraishi, 2023; Van Den Berg & du Plessis, 2023). It also helps students develop problem-solving abilities in the STEM field and its accessibility on various digital platforms facilitates learning anytime and anywhere (Rahman & Watanobe, 2023; Vasconcelos & Santos, 2023). The goals of early childhood STEM education include supporting language development, increasing interest and motivation in STEM subjects, developing problem-solving skills, and promoting individualized learning (Uğraş & Genç, 2018; Wan et al., 2021). ChatGPT's interactive features can support these goals; for example, they can improve language skills and increase students' interest and motivation by providing them with appropriate learning experiences.

3. STEM and Artificial Intelligence Supported Learning Environments and Integration

By focusing on the paradigmatic shifts that artificial intelligence has brought about in STEM (Science, Technology, Engineering, Mathematics) education, it directly impacts how the use of AI in education is transforming in the context of research, practice and technology. There are three main paradigms for how AI can be integrated into teaching and learning environments.

3.1.AI-Directed STEM Education

The AI-directed education paradigm is a behaviorism-based approach where students act as a passive receiver and AI directs the teaching process. In this paradigm, AI determines the student's learning path and progressively guides the learning process. For example, the Stat Lady Intelligent Tutoring System automates the learning process by presenting students with statistics course content in a sequential manner, expecting a specific response (Shute, 1995). Similarly, systems such as Cognitive Tutors provide students with ways to solve problems using a variety of knowledge representations and help students reinforce a particular topic (Koedinger et al., 1997). AI-directed STEM education offers a model where students follow a specific learning objective and reinforce knowledge through predetermined activities. In this model, students progress in the learning process by following the steps determined by the AI. For example, the Stoichiometry Tutor, developed by McLaren and colleagues, supports students in learning chemistry, enabling student development on a predefined learning path (McLaren et al., 2011)

3.2. AI-Supported STEM Education

AI-supported STEM education creates a social learning environment where the learner collaborates with AI as an active participant. The social constructivist theory on which this paradigm is based emphasizes that learning takes place through social interactions (Bandura, 1986). In this context, AI acts as a tool that supports the student's learning process and is in constant interaction with the student. For example, the natural language processing tool developed by Gerard et al. analyzes students' scientific explanations and provides real-time feedback, allowing the teacher to monitor student performance (Gerard et al., 2019).

Under this paradigm, a student-centered learning environment is created and AI allows the student to individualize his/her learning process. This continuous interaction that optimizes the student's learning process has an important place in the context of STEM education. AMOEBA, a tool developed by Berland and colleagues, allows students to collaborate in real time in programming courses, analyzes students' programming processes and provides an interactive learning environment (Berland et al., 2015).

3.3. AI-Empowered STEM Education

AI-empowered STEM education offers a complex, multifactorial learning environment where the student and teacher collaborate with AI. In this paradigm, students manage their own learning process with the feedback provided by AI and become active learning leaders. In this process, AI supports students' direct involvement in learning processes by providing high transparency, more accurate feedback and personalized advice (Riedl, 2019). For example, the Lumilo glasses developed by Holstein et al. allow teachers to monitor student learning processes in real time. This AI-powered device helps teachers analyze students' interactions in the classroom and provide support based on this data (Holstein et al., 2019).

4. Practical Application Examples: STEM Based Artificial Intelligence Activities

STEM applications require the individual to use many disciplines together. In this process, the individual will be able to solve the problems experienced in daily life by using science, technology, mathematics and engineering skills. Developing technologies directly affect this process. Artificial intelligence has recently started to be effective in our lives. An activity that can be implemented in the classroom in the context of STEM-based artificial intelligence activities is presented below.

"Plant Discovery with Smart Assistant"

Aim of the activity: To enable children to learn the basic characteristics of plants, to arouse their interest in knowing and exploring the environment and to develop their scientific observation skills.

Age Group: 4-6 years (preschool)

Duration: 30-40 minutes

Required Ingredients:

- Tablet or phone (equipped with an artificial intelligence app that can recognize plants)
- Real plants that children can observe (simple plants grown in the classroom or leaves, flowers, etc. brought for the activity)
- A simple drawing or activity sheet on which children can take notes (so they can draw the shapes of the leaves)

Event Flow:

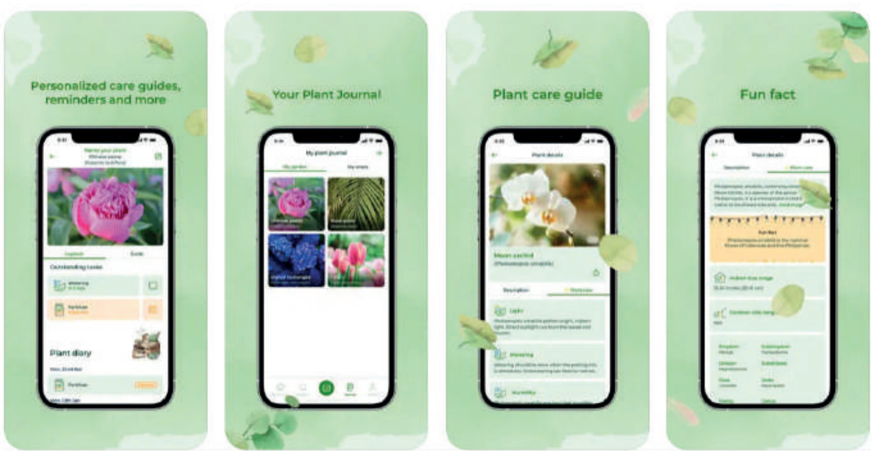
1. **Introduction and Preparation (5 minutes)**
    - Tell the children that today they will learn about plants with the help of a "Smart Assistant".
    - Give each child a plant leaf or a small potted plant.
    - Explain that the Smart Assistant will help them recognize plants and the AI will provide information about them.
2. **Recognizing and Observing Plants (10-15 minutes)**
    - Ask the children to take each plant in their hands and pay attention to the leaves, flowers or roots.
    - Identify plants with children using an AI app on a tablet or phone. When children point to their plants, the app can explain aloud the name of the plant, its characteristics and where it grows.
    - Each child can draw on paper the main characteristics of the plant they are observing or paint its colors.
3. **Plant Care and Environmental Awareness (5-10 minutes)**

- o Explain to the children what plants need to grow (water, sunlight, etc.) and the importance of the environment.
- o Talk about how AI can help with a plant's needs, such as the amount of water or light it needs. Encourage children to think with questions such as, "Our Smart Assistant says this plant loves the sun, what can we do?"

4. **Conclusion and Discussion (5 minutes)**
   - o Ask the children again the names and characteristics of the plants they have discovered and summarize this information together.
   - o Ask children questions like "What other plants would you like to explore?" or "What would you like to ask the Smart Assistant to find out more about another plant?". This way you can keep their curiosity alive.

In addition to providing children with basic knowledge about plants, this activity will be effective in giving them the first ideas about how AI can be used in scientific discoveries. Children can see AI as a "science friend" that helps them in their discoveries and start to gain environmental awareness. With this activity, children can make science-based observations through AI and increase their interest in the environment while learning about plants. Some artificial intelligence applications that can be used in this process are presented below.

PlantSnap



Visual 1. Content Visuals for PlantSnap Application (URL-1)

- **Features:** An app that can quickly recognize plant species. Thanks to its AI-powered algorithm, it can identify plants, flowers, leaves, trees and even more exotic plants like cacti.
- **Child Friendly Use:** Provides the child with short and simple information after identifying the plants, making it easy for preschoolers to understand.
- **Advantages:** The app not only identifies the plant, but also provides plant care tips and helps children learn about the needs of plants.

Seek by iNaturalist

Visual 2. Content Visuals for Seek by iNaturalist Application (URL-2)

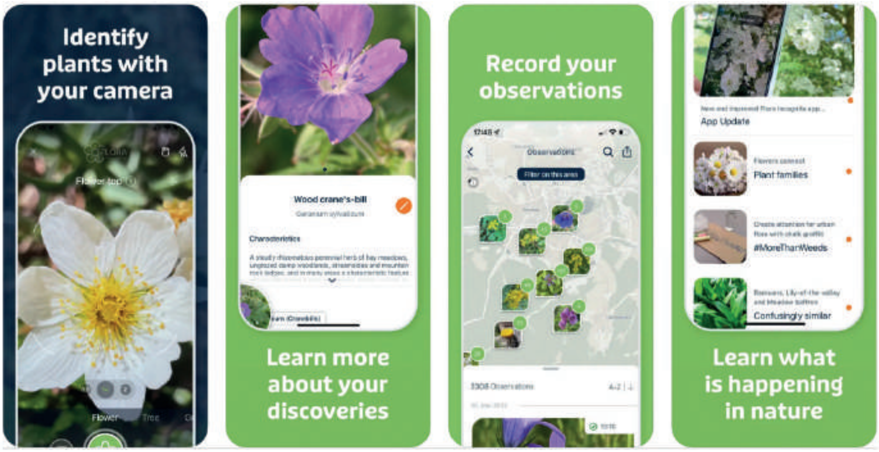
- **Features:** Developed in collaboration with National Geographic and iNaturalist, this app is an AI-powered identification tool that can be used to identify plant and animal species encountered in nature.
- **Child Friendly Use:** Although it does not provide detailed information, it encourages children to observe nature and allows them to explore the environment in a safe environment.
- **Advantages** It has a safe and simple interface for children; it keeps children's sense of curiosity alive with reward systems such as games.

PictureThis

Visual 3. Content Visuals for PictureThis Application (URL-3)

- **Features:** With a highly sophisticated artificial intelligence algorithm for plant identification, this app offers information on the growing and care conditions of each plant, as well as identifying plant species.
- **Child Friendly Use:** Thanks to its simple interface, it is an application that children can use easily. It provides short, child-friendly information about plants.
- **Advantages:** The inclusion of information on plant care can support children's ability to take care and responsibility for plants.

Flora Incognita



Visual 2. Content Visuals for Flora Incognita Application (URL-4)

- **Features:** Flora Incognita is an AI-powered application that can quickly recognize plant species. It has a large database of plants, especially European plants, and can identify different plant parts such as leaves, flowers, stems.
- **Child Friendly Operation:** It has a simple and straightforward interface. It offers a fun process when photographing plants and is visually engaging for children.
- **Advantages:** The app helps children gain basic botanical knowledge by providing brief information about the characteristics of plants. It also allows children to learn about plants native to the local ecosystem to increase their environmental awareness. It has a safe content developed for educational use.

When artificial intelligence tools are examined, it is seen that each of them stands out with different aspects. At this point, it is important to select applications in accordance with the sub-objectives in the activity process.

5.Development of Critical Thinking and Creativity in Children Supported by STEM and Artificial Intelligence

While AI facilitates access to information in STEM education, it also improves students' analytical, synthesis and data evaluation skills. The functioning of AI as a critical tool in this process promotes a deep understanding of concepts in the STEM field and active engagement of students in the learning process (Baisova, 2024).

The integration of AI into STEM education contributes positively to the development of critical thinking. Critical thinking is a very important skill in terms of problem solving and innovation, which includes the process of analyzing, evaluating and interpreting information. STEM education offers a structure that supports critical thinking due to the need for analytical thinking. Therefore, AI supports the development of critical thinking skills in the STEM field and helps students detect logical errors and recognize biases (Baisova, 2024)(the-impact-of-artificia...).

AI also enables students to develop the ability to evaluate alternatives by providing simulations and virtual laboratories within STEM education that allow them to test different hypotheses. In this way, students have the opportunity to see the consequences of their decisions and analyze various approaches, which helps them make more informed decisions in the problem-solving process (Ruiz-Rojas et al., 2024)

AI-based adaptive learning systems provide a personalized learning experience by delivering educational materials based on each student's knowledge level and learning style. These systems analyze the student's achievement based on their learning preferences and offer additional resources as needed. For example, if a student is found to be struggling with a particular subject, the system suggests additional videos or interactive exercises appropriate to the student's level (Cheng, Tan & Tan, 2023). This contributes to the development of critical thinking skills and allows students to evaluate their own learning process.

The instant feedback features offered by AI enable students to quickly recognize logical errors and develop critical thinking skills. For example, AI-based platforms can point out logical flaws when analyzing students' work and encourage students to revise their mistakes. Thus, students strengthen their critical evaluation habits by examining their own arguments more deeply (Nagaraj et al., 2023).

AI's ability to provoke questions and curiosity is another element that encourages critical thinking. By posing provocative questions to students, AI encourages them to analyze and research topics in more depth. This interaction makes students more interested in learning and develops their research skills (Ruiz-Rojas et al., 2024). It also promotes an interdisciplinary approach, developing the ability to integrate knowledge from different fields and allowing students to see the big picture (Bushuev, 2024).

6.Conclusion and Recommendations

Artificial intelligence (AI)-supported STEM education has significant potential to increase the speed of access to information, personalize the learning process and develop students' critical thinking skills. These technologies complement traditional learning methods, enabling students to understand complex scientific concepts, develop analytical thinking skills and transform their knowledge into practical solutions. In particular, AI tools used from early childhood onwards support children's sensitization to the environment, develop a predisposition for scientific thinking and strengthen their problem-solving abilities. In this process, AI stands out as a "learning friend" that allows students to conduct logical analysis, develop hypotheses and try different solutions.

Another contribution of AI to educational environments is that it increases students' creative thinking capacities. AI-supported simulations and virtual laboratories expand the boundaries of learning by offering students the opportunity to experiment in a safe environment. These tools both enable students to put theoretical knowledge into practice and encourage them to learn by making mistakes. For example, AI-based adaptive learning systems make learning more effective for each individual by providing a personalized educational experience according to the learning pace of students. Thanks to such technologies, students have access to additional resources to fill their gaps, while they have the opportunity to gain more in-depth knowledge in their areas of strength.

However, despite all these advantages AI offers, there are also some limitations and risks associated with its applications in education. In particular, excessive automation can lead to a weakening of students' independent thinking and problem-solving abilities. Moreover, students' dependence on technology may negatively affect their capacity to think critically and generate original ideas. Therefore, it is important to define the role of AI in education as a "helper" that supports but does not replace students. The aim of education should be to develop students' creative and critical thinking skills by using AI as a tool.

This holistic approach enables students not only to access existing knowledge, but also to learn to question and interpret this knowledge through a critical filter. AI applications in education contribute to the development of students as conscious, responsible and creative individuals integrated with technology. Thus, it is aimed that they become individuals who develop the skills to produce solutions to the challenges they will face in a rapidly changing world. Accordingly, AI-supported STEM education stands out as a powerful tool for students to acquire 21st century skills such as analytical thinking, problem solving and creativity.

Recommendations:

1. **Develop Comprehensive Education Programs:** Programs using STEM-based AI tools should be developed from an early age. These programs can encourage critical thinking and creativity by allowing students to experience both scientific concepts and AI technologies.
2. **AI Training for Trainers:** Educators should be provided with the necessary training to be able to use AI-based tools effectively. Teachers who understand the functionality of AI technology can adapt these tools to the individual needs of students.
3. **Ensuring Fairness of Access:** AI-supported STEM education opportunities should be expanded to provide equal access to all students. It is important to address inequalities in access to technology through digital resource access projects.
4. **Establishing Data Privacy and Security Policies:** Data privacy issues arising from the use of AI in education should be addressed and measures should be taken to protect students' personal information.
5. **Developing Applications that Support Creativity and Critical Thinking:** AI applications to be used in education should have features that will nurture students' sense of curiosity, improve their problem-solving skills, and increase their creative thinking capacities. These applications can support creative thinking by providing students with the opportunity to ask questions, develop hypotheses and test various solutions.

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Chapter 9

Ethical Use of Artificial Intelligence Applications in Early Childhood Education

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Abstract

The integration of Artificial Intelligence (AI) in education holds the potential to provide personalized learning and enhance educational experiences. However, it also raises significant concerns about data privacy and security, especially for young children who may not fully understand several aspects of data collection or usage practices. Protecting this data is of paramount importance. This text addresses ethical AI practices for safeguarding children's information, principles of data privacy, legal regulations, and the collaboration between parents and teachers. The use of AI in education must consider cultural sensitivities to accommodate diverse learner needs. Additionally, the discussion includes AI's potential risks, such as algorithmic bias, and strategies to mitigate these issues.

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1. The Importance of Ethics in AI for Early Childhood Education

1.1. Understanding Ethics in AI

1.1.1. Defining AI Ethics

Artificial Intelligence (AI) ethics refers to the moral guidelines and principles that govern the development and deployment of AI technologies. It encompasses a range of considerations, including fairness, transparency, accountability, privacy, and the overall impact on society (Jobin, Ienca & Vayena, 2019). AI ethics seeks to ensure that AI systems are designed and used in ways that respect human rights and promote well-being. In the context of early childhood education, AI ethics becomes particularly significant. Young children are in a critical stage of development, and the technologies they interact with can have profound effects on their cognitive, social, and emotional growth (Donohue & Schomburg, 2017). Therefore, integrating AI into early education requires careful ethical consideration to protect and nurture children's development.

1.1.2. Relevance to Early Childhood Education

AI technologies are increasingly being integrated into early childhood education settings. From interactive educational apps to AI-driven toys, these tools offer personalized learning experiences and can enhance engagement (Bers, 2018). However, without ethical oversight, they may also pose risks such as privacy invasion, bias reinforcement, or over-reliance on technology. Ethical considerations ensure that AI tools support educational goals without compromising children's rights or well-being (Zhu & Xie, 2019). This involves assessing the appropriateness of content, safeguarding personal data, and ensuring that AI interactions are developmentally suitable.

1.1.3. Ethical Principles in AI

Key ethical principles in AI include:

- **Beneficence**: AI should promote the well-being of users (Floridi et al., 2018).
- **Non-Maleficence**: AI should not cause harm.
- **Autonomy**: Respecting users' ability to make informed decisions.
- **Justice**: Ensuring fairness and equality in AI applications.
- **Explicability**: AI operations should be transparent and understandable.

Applying these principles in early childhood education ensures that AI tools are designed to benefit children, avoid harm, respect their emerging autonomy, promote fairness, and operate transparently.

1.1.4. Global Standards in AI Ethics

International bodies like UNESCO and the IEEE have proposed guidelines for ethical AI development (IEEE, 2019; UNESCO, 2019). These guidelines emphasize the importance of human rights, fairness, and transparency. For instance, UNESCO's Beijing Consensus highlights the need for AI in education to be inclusive and equitable. Adhering to global standards ensures consistency in ethical practices and protects children across different jurisdictions. It also fosters international collaboration in developing AI tools that meet high ethical standards.

1.2. The Role of Educators in Ethical AI Implementation

Educators are central to the ethical implementation of AI in early childhood education. Their roles include:

- **Ethical Awareness Among Educators**: Educators must understand the ethical implications of AI tools to make informed decisions about their use (Holmes et al., 2022).
- **Training for Responsible AI Use**: Professional development programs can equip educators with knowledge about AI ethics, data privacy, and appropriate pedagogical integration (Passey et al., 2018).
- **Guiding Children in Safe Technology Use**: Educators can teach children about responsible technology use, fostering digital literacy and ethical understanding from an early age (Livingstone & Blum-Ross, 2020).
- **Role of Institutions in Supporting Educators**: Schools and educational institutions should provide resources and support for educators, including policies and infrastructure that prioritize ethical AI use (Williamson & Eynon, 2020).

1.2.1. Case Studies on Educator-Led Ethical AI Use

Research indicates that when educators lead the ethical integration of AI, it results in:

- **Enhanced Learning Outcomes**: Thoughtful use of AI can personalize learning and address individual needs (Holmes et al., 2019).

- **Increased Ethical Awareness**: Educators can model ethical behavior and discuss ethical considerations with students, fostering critical thinking (Baker & Smith, 2019).
- **Community Engagement**: Involving parents and the community in discussions about AI use strengthens trust and collaboration.

1.3. Parental Concerns in AI Use

Parents play a crucial role in children's interactions with AI. Common concerns include:

- **Privacy and Data Security**: Worries about how children's data is collected, stored, and used (Chaudron et al., 2018).
- **Exposure to Inappropriate Content**: Fears that AI might expose children to content that is not age-appropriate.
- **Impact on Development**: Questions about how AI interactions might affect social skills, attention spans, and physical activity levels.

1.3.1. Privacy and Data Security for Children

Protecting children's personal data is a significant ethical issue. Regulations like the General Data Protection Regulation (GDPR) and the Children's Online Privacy Protection Act (COPPA) mandate strict controls over data collection and usage (European Commission, 2018; Federal Trade Commission, 2013). Ethical AI practices involve:

- **Data Minimization**: Collecting only the data necessary for functionality.
- **Transparency**: Clearly informing parents about data practices.
- **Security Measures**: Implementing robust protection against data breaches.

1.3.2. Parents' Role in AI Ethical Education

Parents can support ethical AI use by:

- **Engaging in Open Dialogue**: Discussing technology use with their children and setting appropriate boundaries (Livingstone & Byrne, 2018).
- **Educating Themselves**: Staying informed about AI technologies and their implications.

- **Collaborative Approaches with Schools**: Working with educators to ensure consistent practices between home and school.

1.3.3. Addressing Parental Misinformation on AI

There is a need to address misconceptions about AI. Providing accurate information through:

- **Workshops and Seminars**: Educational sessions for parents.
- **Resource Materials**: Guides and fact sheets explaining AI in accessible language.
- **Communication Channels**: Regular updates from schools about AI initiatives.

1.4. Ethics in AI: Cultural Sensitivity in Early Childhood

1.4.1. Cultural Factors in Ethical AI Use

Cultural context influences how AI is perceived and utilized. Ethical AI must consider:

- **Language Diversity**: Supporting multiple languages to be inclusive.
- **Cultural Norms and Values**: Respecting different beliefs and practices.
- **Representation**: Ensuring diverse cultural backgrounds are represented in AI content.

1.4.2. Diversity and Inclusion in AI Tools

Inclusive AI design involves:

- **Avoiding Bias**: Ensuring algorithms do not favor certain groups over others (Mehrabi et al., 2021).
- **Culturally Relevant Content**: Providing materials that reflect the backgrounds of all students.
- **Accessibility**: Designing for children with different abilities and needs.

1.4.3. Addressing Cultural Bias in AI Algorithms

Bias in AI can reinforce stereotypes or exclude certain groups. Mitigating bias involves:

- **Diverse Data Sets**: Training AI on data that represents a wide range of populations.
- **Algorithm Audits**: Regularly checking AI outputs for bias.
- **Stakeholder Involvement**: Including input from various cultural groups in development.

1.4.4. Promoting Multicultural Awareness

AI can be a tool to:

- **Enhance Cultural Understanding**: Exposing children to different cultures through interactive experiences.
- **Support Language Learning**: Offering multilingual options.
- **Foster Inclusion**: Creating collaborative activities that celebrate diversity.

1.4.5. Case Studies on Culturally Sensitive AI

Successful implementations demonstrate:

- **Improved Engagement**: Children engage more with content that reflects their identity (Santos et al., 2016).
- **Positive Social Outcomes**: Inclusive AI promotes empathy and reduces prejudice.

1.5. Future Perspectives in Ethical AI Education for Children

1.5.1. Emerging Ethical Challenges in AI

As AI evolves, new challenges arise:

- **Deepfakes and Misinformation**: Potential for AI to create realistic but false content.
- **Autonomy and Agency**: Balancing AI assistance with encouraging independent thinking.
- **Emotional AI**: AI that reads or responds to emotions raises privacy concerns.

1.5.2. Preparing Children for Future AI Interactions

Education should:

- **Develop Critical Thinking**: Teach children to question and analyze AI outputs.
- **Promote Ethical Reasoning**: Encourage discussions about right and wrong in technology use.
- **Enhance Digital Literacy**: Equip children with skills to navigate a tech-rich world.

1.5.3. Ethical Curriculum Development

Integrating ethics into curricula involves:

- **Interdisciplinary Approaches**: Combining technology education with social sciences and humanities.
- **Active Learning**: Using projects and discussions to explore ethical issues.
- **Assessment of Ethical Understanding**: Evaluating students' grasp of ethical concepts.

1.5.4. Role of Policy in Shaping Future AI Ethics

Policies can:

- **Set Standards**: Establish clear guidelines for AI use in education.
- **Provide Resources**: Fund initiatives that promote ethical AI.
- **Facilitate Collaboration**: Encourage partnerships between educators, technologists, and policymakers.

1.5.5. Encouraging Ethical Mindsets Early On

Fostering ethics in early childhood lays the foundation for responsible citizenship. Strategies include:

- **Modeling Ethical Behavior**: Adults demonstrating integrity and respect.
- **Creating Ethical Environments**: Classrooms that value fairness and empathy.
- **Empowering Children**: Involving them in decision-making processes.

The provided section offers a comprehensive exploration of the critical role that ethics plays in integrating Artificial Intelligence (AI) into early childhood education. It systematically addresses the definition of AI ethics, its relevance to young learners, ethical principles, global standards, the roles of educators and parents, cultural sensitivity, and future ethical challenges. This evaluation aims to analyze the strengths of the section and suggest areas for enhancement, supported by relevant academic literature.

The section begins by defining AI ethics as the moral guidelines and principles that govern the development and deployment of AI technologies, emphasizing considerations such as fairness, transparency, accountability, privacy, and societal impact (Jobin et al., 2019). This foundational explanation is crucial as it sets the context for the ethical discourse surrounding AI. By highlighting the profound effects that AI technologies can have on children's cognitive, social, and emotional development (Donohue & Schomburg, 2017), the section underscores the necessity of ethical considerations when integrating AI into early education.

The increasing integration of AI technologies in early childhood settings, such as interactive educational apps and AI-driven toys, offers personalized learning experiences and enhanced engagement (Bers, 2018). However, the section rightly points out the potential risks without ethical oversight, including privacy invasion, bias reinforcement, and over-reliance on technology (Zhu & Xie, 2019). This balanced perspective acknowledges both the benefits and drawbacks of AI in education, aligning with current academic discussions on the responsible use of technology in learning environments (Holmes et al., 2022).

The enumeration of key ethical principles—beneficence, non-maleficence, autonomy, justice, and explicability—is well-articulated (Floridi et al., 2018). Applying these principles to early childhood education ensures that AI tools are designed to benefit children, avoid harm, respect their emerging autonomy, promote fairness, and operate transparently. This approach aligns with ethical frameworks proposed by leading scholars and organizations, emphasizing the importance of human-centered AI (Floridi & Cowls, 2019).

By referencing global standards set by organizations like UNESCO and the IEEE (IEEE, 2019; UNESCO, 2019), the section effectively situates the discussion within an international context. The mention of UNESCO's Beijing Consensus highlights the global commitment to inclusive and equitable AI in education. This emphasis on adhering to international guidelines ensures consistency in ethical practices and protects children across different jurisdictions. It also fosters international collaboration in developing AI tools that meet high ethical standards (Jobin et al., 2019).

The section appropriately identifies educators as central figures in the ethical implementation of AI in early childhood education. It outlines their roles in fostering ethical awareness, receiving training for responsible AI use, guiding children in safe technology practices, and being supported by institutions (Aksoy & Küçük Demir, 2019; Ayyıldız & Yılmaz, 2021; Holmes et al., 2022). This aligns with research that underscores the importance of teacher professional development in technology use (Passey et al., 2018). By equipping educators with the necessary knowledge and skills, they can make informed decisions and model ethical behavior, thereby fostering critical thinking among students (Baker & Smith, 2019).

The inclusion of research indicating positive outcomes when educators lead ethical AI integration adds credibility. The mention of enhanced learning outcomes, increased ethical awareness, and community engagement demonstrates the multifaceted benefits of educator-led initiatives (Holmes et al., 2019; Yılmaz, Şahin-Atılgan & Güzel-Sekecek, 2024). However, the section could be strengthened by providing specific examples or studies that detail these results, offering concrete evidence of the impact of such practices.

Acknowledging the crucial role of parents, the section addresses common concerns such as privacy, data security, exposure to inappropriate content, and the impact on development (Chaudron et al., 2018). By highlighting these issues, the section emphasizes the need for transparency and collaboration between schools and families. The reference to regulations like the GDPR and COPPA (European Commission, 2018; Federal Trade Commission, 2013) underscores the legal imperatives for protecting children's personal data.

The discussion on ethical AI practices involving data minimization, transparency, and security measures is timely and relevant. With increasing awareness of data privacy issues, particularly in education, these practices are essential for safeguarding children's information (Livingstone & Blum-Ross, 2020). The section effectively connects ethical principles with practical measures, promoting responsible data handling.

Encouraging parents to engage in open dialogue, educate themselves, and collaborate with schools reflects best practices in digital parenting (Livingstone & Byrne, 2018). The section recognizes that parents' involvement is pivotal in ensuring consistent practices between home and school, which can enhance children's understanding and responsible use of AI technologies.

The suggestion to provide accurate information through workshops, resource materials, and communication channels is proactive. Misinformation can lead to unwarranted fears or misuse of technology. By equipping parents with knowledge, schools can build trust and facilitate a supportive environment for integrating AI ethically (Livingstone & Blum-Ross, 2020).

The section's focus on cultural factors in ethical AI use is commendable. It highlights the importance of language diversity, respecting cultural norms and values, and ensuring representation in AI content. This aligns with the principles of inclusive education and addresses concerns about bias and fairness in AI systems (Mehrabi et al., 2021; Yılmaz, Uysal & Nacar, 2024).

By discussing inclusive AI design—avoiding bias, providing culturally relevant content, and ensuring accessibility—the section underscores the need for AI tools that cater to diverse learners. This approach supports educational equity and can contribute to reducing disparities in educational outcomes (Chen & Li, 2010; Öztürk, 2023).

The acknowledgment of bias in AI algorithms and strategies to mitigate it, such as using diverse data sets and conducting algorithm audits, is critical. Bias in AI can perpetuate stereotypes and systemic inequalities (Buolamwini & Gebru, 2018). The emphasis on stakeholder involvement ensures that multiple perspectives are considered, enhancing the fairness and accuracy of AI applications.

The section suggests that AI can enhance cultural understanding, support language learning, and foster inclusion. These applications of AI can enrich the educational experience and promote social cohesion. By providing interactive and engaging content, AI tools can expose children to different cultures, fostering empathy and global awareness (Santos et al., 2016).

Identifying emerging ethical challenges such as deepfakes, autonomy, and emotional AI reflects an awareness of the rapidly evolving AI landscape. Preparing children for future AI interactions by developing critical thinking, ethical reasoning, and digital literacy is essential (Long & Magerko, 2020). This proactive approach equips children with the skills needed to navigate complex technological environments responsibly.

Integrating ethics into curricula through interdisciplinary approaches, active learning, and assessment aligns with contemporary educational strategies (Gašević et al., 2015; Yılmaz, Gülgün, Çetinkaya & Doğanay, 2018). By embedding ethical considerations into learning experiences, educators can cultivate ethical mindsets and promote lifelong ethical awareness.

The section appropriately highlights the role of policy in setting standards, providing resources, and facilitating collaboration. Policies can drive systemic change and ensure that ethical considerations are embedded at all levels of education (Selwyn & Gašević, 2020). Encouraging partnerships among educators, technologists, and policymakers can foster a holistic approach to ethical AI integration.

The emphasis on modeling ethical behavior, creating ethical environments, and empowering children is aligned with theories of moral development and ethical education (Kidron & Rudkin, 2020). By instilling ethical values early, educators and parents can lay the foundation for responsible citizenship and ethical decision-making in the digital age.

The section provides a thorough examination of the importance of ethics in AI for early childhood education, integrating theoretical concepts with practical applications. It effectively addresses the multifaceted nature of ethical considerations, from individual interactions to global standards. To enhance the section further, incorporating empirical studies or specific examples of successful implementations could provide stronger evidence of the concepts discussed. Additionally, exploring potential challenges in implementing ethical AI practices, such as resource constraints or resistance to change, could offer a more nuanced perspective.

2. Privacy and Security in AI for Early Childhood Education

The integration of Artificial Intelligence (AI) in early childhood education offers significant opportunities for personalized learning and enhanced educational experiences. However, it also raises critical concerns regarding privacy and security, particularly when it involves young children who are less capable of understanding and consenting to data collection and use practices. This section explores the multifaceted issues surrounding privacy and security in AI applications for early childhood education, emphasizing the importance of protecting children's data, implementing robust cybersecurity measures, balancing personalization with privacy, and fostering collaboration between parents and educators.

2.1. Children's Data Privacy Concerns

2.1.1. Understanding Data Privacy for Children

In the digital age, data has become a valuable commodity, and the education sector is no exception. AI systems in education often rely on collecting and analyzing data to tailor learning experiences to individual students (Ayyıldız, Yılmaz & Baltacı, 2021; Holmes et al., 2019). When dealing with young children, data privacy concerns become more pronounced due to their vulnerability and limited capacity to comprehend the implications of data sharing. Children's data can include personal identifiers, learning behaviors, emotional responses, and even biometric information collected through AI-enabled devices (Livingstone & Stoilova, 2021). This sensitive information, if mishandled, can lead to serious consequences such as identity theft, profiling, or unauthorized surveillance.

Protecting children's data privacy is crucial for several reasons:

- **Legal and Ethical Obligations**: There are stringent laws and ethical guidelines governing the collection and use of children's data, recognizing their inability to provide informed consent (European Commission, 2018).
- **Psychological Well-being**: Infringements on privacy can affect a child's sense of security and trust in educational institutions (Barth & de Jong, 2017).
- **Long-term Implications**: Data collected during childhood can have lasting effects, influencing future opportunities and personal development if not properly safeguarded (Lievens et al., 2018).

2.1.2. Legal Regulations on Children's Data

Several international and national regulations have been established to protect children's data privacy. Notably:

- **General Data Protection Regulation (GDPR)**: Implemented by the European Union, GDPR sets strict rules for data processing, requiring parental consent for children under 16 and emphasizing transparency and the right to be forgotten (European Commission, 2018).
- **Children's Online Privacy Protection Act (COPPA)**: In the United States, COPPA imposes requirements on online services aimed at children under 13, mandating parental consent and clear privacy policies (Federal Trade Commission, 2013).
- **United Nations Convention on the Rights of the Child (UNCRC)**: Provides a global framework recognizing children's rights to privacy and protection from exploitation (United Nations, 1989).

These regulations highlight the necessity for educational institutions and AI developers to comply with legal standards, ensuring that data collection practices are lawful, transparent, and respectful of children's rights.

2.1.3. Risks of Data Collection in AI Tools

AI tools often require extensive data to function effectively, which can pose several risks:

- **Data Breaches**: Unauthorized access to databases can expose sensitive information, leading to identity theft or other malicious activities (Ponemon Institute, 2019).
- **Misuse of Data**: Collected data might be used for unintended purposes, such as targeted advertising or profiling, without parental knowledge or consent (Zhao et al., 2019).
- **Surveillance and Autonomy**: Excessive monitoring can infringe on children's autonomy and create a culture of surveillance, affecting their development and behavior (Taylor & Rooney, 2017).

To mitigate these risks, it's essential to limit data collection to what is necessary, implement strong security measures, and ensure transparency with parents and guardians.

2.2. Importance of Parental Consent

Parental consent is a critical component in safeguarding children's data privacy. It involves:

- **Informed Consent**: Providing clear, accessible information to parents about what data is collected, how it will be used, and who will have access to it (van der Hof, 2016).
- **Opt-in Mechanisms**: Default settings should favor privacy, requiring active consent from parents rather than passive acceptance (Nemorin, 2017).
- **Continuous Communication**: Keeping parents informed about any changes in data practices or breaches, fostering trust and collaboration.

By actively involving parents, educational institutions can ensure compliance with legal requirements and reinforce ethical practices.

2.2.1. Data Privacy Education for Parents and Educators

Education plays a vital role in enhancing data privacy. Parents and educators should be informed about:

- **Data Privacy Principles**: Understanding concepts like data minimization, purpose limitation, and rights to access and erasure (ICO, 2018).

- **Risks and Threats**: Recognizing potential dangers associated with data collection and AI technologies (Livingstone et al., 2018).
- **Best Practices**: Implementing strategies to protect data, such as secure passwords, cautious sharing, and regular updates (Stoilova et al., 2020).

Workshops, seminars, and resource materials can empower parents and educators to take proactive steps in protecting children's data.

2.2.2. Common Security Risks in AI Systems

AI systems in education face several cybersecurity threats:

- **Malware and Ransomware**: Malicious software can infiltrate systems, encrypt data, and demand payment for its release (Huang & Zhu, 2019).
- **Phishing Attacks**: Deceptive communications aiming to trick users into revealing sensitive information (Jansen & van Schaik, 2019).
- **Insider Threats**: Unauthorized access or misuse of data by individuals within the organization (Schneider et al., 2015).

These risks necessitate robust cybersecurity strategies to protect sensitive data and maintain the integrity of educational systems.

2.3. Protecting Early Childhood Data from Breaches

Key measures to safeguard data include:

- **Encryption**: Encoding data to prevent unauthorized access during transmission and storage (Almohri et al., 2016).
- **Access Controls**: Implementing role-based access to limit who can view or modify data (Ferreira et al., 2014).
- **Regular Audits and Monitoring**: Continuously assessing systems for vulnerabilities and unusual activities (Kallberg, 2016).
- **Incident Response Plans**: Establishing protocols to respond swiftly to breaches, minimizing damage and restoring security (NIST, 2018).

Implementing these measures helps protect children's data and reinforces trust in AI-based educational tools.

2.4. Role of IT in Ensuring AI Security

Information Technology (IT) departments play a pivotal role by:

- **Designing Secure Systems**: Integrating security into the architecture of AI systems from the outset (Bishop, 2018).
- **Implementing Updates and Patches**: Keeping software current to address known vulnerabilities (Alqahtani et al., 2019).
- **Training Staff**: Educating educators and administrators on security protocols and best practices (Wilson & Hash, 2003).
- **Collaborating with Stakeholders**: Working with developers, educators, and policymakers to align security measures with educational goals.

Effective IT management ensures that security is an integral part of AI implementation in education.

2.5. Educator's Role in Cybersecurity Awareness

Educators contribute to cybersecurity by:

- **Modeling Responsible Behavior**: Demonstrating proper use of technology and adherence to security protocols (Johnson et al., 2016).
- **Teaching Digital Literacy**: Incorporating cybersecurity education into the curriculum, empowering students to protect themselves (Huang et al., 2020).
- **Reporting Issues**: Identifying and reporting suspicious activities or potential threats to IT departments promptly.

Their engagement enhances the overall security posture and promotes a culture of vigilance.

2.5.1. Case Examples of Security Breaches

- **Edmodo Breach (2017)**: A massive data breach exposed millions of user accounts due to inadequate security measures, highlighting the vulnerability of educational platforms (Cimpanu, 2017).
- **UK School Ransomware Attack (2019)**: Cybercriminals targeted a school's network, disrupting operations and emphasizing the need for robust cybersecurity defenses (BBC News, 2019).

These cases illustrate the real-world consequences of security lapses and the importance of proactive measures.

2.6. Benefits of Personalized Learning

Personalized learning through AI offers:

- **Customized Content**: Adapting lessons to individual learning styles and paces (Pane et al., 2015).
- **Improved Engagement**: Increasing motivation by aligning materials with students' interests and needs (Walkington, 2013).
- **Data-Driven Insights**: Providing educators with valuable information to support student development (Daniel, 2015).

2.6.1. Risks of Over-Personalization

However, over-personalization can lead to:

- **Privacy Intrusions**: Excessive data collection infringing on personal privacy (Regan & Jesse, 2019).
- **Algorithmic Bias**: AI systems reinforcing existing biases, leading to unfair treatment (Noble, 2018).
- **Reduced Exposure**: Limiting students' exposure to diverse ideas and challenges by tailoring content too narrowly (Selwyn, 2019).

It's crucial to find a balance that leverages personalization benefits without compromising privacy or educational breadth.

2.6.2. Ethical Boundaries of Data Usage

Establishing ethical boundaries involves:

- **Transparency**: Clearly communicating data practices to students and parents (Floridi, 2016).
- **Consent and Control**: Allowing users to consent to data collection and control how their data is used (Solove, 2013).
- **Purpose Limitation**: Using data solely for educational purposes and not for commercial exploitation (Wachter et al., 2017).
- **Accountability**: Implementing oversight mechanisms to ensure compliance with ethical standards (Mittelstadt et al., 2016).

By adhering to these principles, educators and developers can use data responsibly.

2.7. Minimizing Data Collection in AI

Strategies include:

- **Data Minimization**: Collecting only data essential for functionality (Cavoukian, 2011).

- **Anonymization and Pseudonymization**: Removing identifiable information to protect privacy (El Emam & Arbuckle, 2013).
- **Local Processing**: Keeping data on local devices rather than transmitting it to central servers (McMahan & Ramage, 2017).

These approaches reduce privacy risks while maintaining the effectiveness of AI tools.

2.8. Transparency with Personalization Techniques

Ensuring transparency involves:

- **Explainable AI**: Designing systems that can explain how decisions are made (Gunning, 2017).
- **User Education**: Informing users about how personalization works and its implications (Abdul et al., 2018).
- **Feedback Mechanisms**: Allowing users to correct or challenge AI-generated recommendations (Ananny & Crawford, 2018).

Transparency builds trust and empowers users to engage with AI technologies confidently.

Parental and Educator Collaboration on Security

2.9. Joint Efforts in Child Data Protection

Collaboration enhances security by:

- **Sharing Knowledge**: Parents and educators exchanging information about risks and best practices (Livingstone & Haddon, 2009).
- **Coordinated Policies**: Aligning rules and guidelines across home and school environments (Powers & Green, 2018).
- **Support Networks**: Creating communities that support each other in safeguarding children (Zilka, 2017).

2.9.1. Developing Privacy Policies with Parents

Involving parents in policy development:

- **Increases Relevance**: Policies reflect the concerns and values of the community (Shapiro & Stefkovich, 2016).
- **Enhances Compliance**: Parents are more likely to support and adhere to policies they helped create (Epstein et al., 2018).

- **Fosters Trust**: Collaborative processes build stronger relationships between schools and families.

2.9.2. Regular Security Audits in Schools

Audits help maintain security by:

- **Identifying Gaps**: Revealing weaknesses in systems and processes (Safa et al., 2016).
- **Updating Practices**: Ensuring that security measures keep pace with evolving threats (Ashford, 2017).
- **Demonstrating Commitment**: Showing stakeholders that the institution prioritizes security.

2.9.3. Educator Training on Data Security

Training programs should:

- **Provide Practical Skills**: Teach educators how to implement security measures effectively (Johnson, 2012).
- **Update Knowledge**: Keep staff informed about the latest threats and technologies (Alshammari & Singh, 2018).
- **Promote a Security Culture**: Encourage proactive attitudes toward data protection.

2.9.4. Community Forums on AI Safety

Forums can:

- **Raise Awareness**: Educate the community about AI and associated risks (Hassani et al., 2018).
- **Encourage Dialogue**: Facilitate discussions between stakeholders (Feenberg & Bakardjieva, 2004).
- **Develop Solutions**: Collaboratively address challenges and share best practices.

These collaborative efforts strengthen the overall security framework and promote responsible AI use. The provided section offers a comprehensive exploration of the multifaceted issues surrounding privacy and security in the integration of Artificial Intelligence (AI) into early childhood education. It delves into the critical concerns of children's data privacy, the importance of parental consent, cybersecurity risks, and the collaborative roles of educators and parents. This evaluation aims to analyze the key themes presented, assess their relevance and alignment with current academic discourse, and suggest areas for further enhancement. The section begins by highlighting the growing value of data in the digital age and its implications for the education sector (Bellman, 1978; Holmes et al., 2019; Yılmaz & Salman, 2022). It astutely recognizes that young children are particularly vulnerable due to their limited understanding of data sharing implications (Livingstone & Stoilova, 2021). The emphasis on the sensitivity of children's data—including personal identifiers, learning behaviors, emotional responses, and biometric information—is timely and significant. Mishandling such data can lead to severe consequences like identity theft, profiling, or unauthorized surveillance (Aydoğdu et al., 2019; Barth & de Jong, 2017). The discussion on legal and ethical obligations, psychological well-being, and long-term implications underscores the necessity of stringent data protection measures. References to international regulations like the General Data Protection Regulation (GDPR) and the Children's Online Privacy Protection Act (COPPA) reinforce the global importance of these concerns (European Commission, 2018; Federal Trade Commission, 2013). This alignment with legal frameworks adds credibility and context to the argument.

The section effectively underscores parental consent as a critical component in safeguarding children's data privacy. By detailing elements such as informed consent, opt-in mechanisms, and continuous communication, it emphasizes the need for transparency and active parental involvement (Nemorin, 2017; van der Hof, 2016). This approach is consistent with best practices in data protection, recognizing parents as key stakeholders in their children's digital experiences.

Highlighting the role of education in enhancing data privacy awareness is a strong point. By advocating for informing parents and educators about data privacy principles, risks, threats, and best practices, the section promotes proactive engagement (ICO, 2018; Yılmaz, 2021a). This strategy is essential in fostering a culture of vigilance and responsibility among those directly involved with children's education and technology use.

The enumeration of cybersecurity threats such as malware, ransomware, phishing attacks, and insider threats provides a realistic portrayal of the challenges faced by AI systems in education (Huang & Zhu, 2019; Jansen & van Schaik, 2019; Schneider et al., 2015). By identifying these risks, the section sets the stage for discussing robust cybersecurity strategies, emphasizing the need for a comprehensive approach to protect sensitive data and maintain system integrity.

The proposed measures i.e., encryption, access controls, regular audits and monitoring, and incident response plans are practical and align with established cybersecurity practices (Almohri et al., 2016; Kallberg, 2016; NIST, 2018). Emphasizing these technical safeguards demonstrates an understanding that data protection requires both policy and technical solutions. The integration of these measures helps build trust in AI-based educational tools, which is crucial for their acceptance and effectiveness.

Acknowledging the pivotal role of Information Technology (IT) departments adds depth to the discussion. By outlining responsibilities such as designing secure systems, implementing updates and patches, training staff, and collaborating with stakeholders, the section highlights the multifaceted efforts required to ensure AI security (Alqahtani et al., 2019; Bishop, 2018). This comprehensive view reinforces the idea that security is not solely a technical issue but also an organizational one that necessitates coordination across various domains.

The section aptly identifies educators as key players in promoting cybersecurity. By modeling responsible behavior, teaching digital literacy, and reporting issues, educators contribute to a culture of vigilance and safety (Huang et al., 2020; Johnson et al., 2016). This aligns with current research emphasizing the importance of incorporating cybersecurity education into the curriculum to empower students (Öztürk & Demiroğlu Çiçek, 2024; Tisdale, 2015).

Inclusion of real-world examples such as the Edmodo breach (2017) and the UK school ransomware attack (2019) adds practical significance to the discussion (BBC News, 2019; Cimpanu, 2017; Sevgi, Ayyıldız & Yılmaz, 2023). These cases illustrate the tangible consequences of inadequate security measures and underscore the urgency for proactive defenses. However, the section could benefit from a more detailed analysis of these incidents to extract lessons learned and best practices for prevention.

The section presents a balanced view of personalized learning through AI, highlighting benefits such as customized content, improved engagement, and data-driven insights (Daniel, 2015; Küçük-Demir, 2023; Pane et al., 2015; Walkington, 2013). It also cautions against risks like privacy intrusions, algorithmic bias, and reduced exposure to diverse ideas (Noble, 2018; Regan & Jesse, 2019; Selwyn, 2019; Yanarateş & Yılmaz, 2022). This nuanced perspective aligns with scholarly debates on the ethical implications of AI in education (Williamson & Eynon, 2020; Yılmaz, 2024).

By advocating for transparency, consent and control, purpose limitation, and accountability, the section aligns with fundamental ethical principles in data usage (Floridi, 2016; Mittelstadt et al., 2016; Solove, 2013; Yılmaz, 2023). This framework provides practical guidelines for educators and developers to use data responsibly, emphasizing the importance of ethical considerations in technological advancements.

The strategies suggested for minimizing data collection—data minimization, anonymization, pseudonymization, and local processing—are effective means to protect privacy while maintaining AI functionality (Cavoukian, 2011; El Emam & Arbuckle, 2013; McMahan & Ramage, 2017). Additionally, promoting transparency through explainable AI, user education, and feedback mechanisms fosters trust and empowers users (Abdul et al., 2018; Ananny & Crawford, 2018; Gunning, 2017).

The emphasis on joint efforts in child data protection is a significant strength of the section. By encouraging sharing knowledge, coordinated policies, and support networks, it acknowledges the collective responsibility of parents and educators (Livingstone & Haddon, 2009; Powers & Green, 2018; Yılmaz, 2021b; Zilka, 2017). This collaborative approach is essential in creating a consistent and secure environment for children.

Involving parents in policy development increases relevance, enhances compliance, and fosters trust (Epstein et al., 2018; Shapiro & Stefkovich, 2016). This participatory process ensures that policies reflect community values and concerns, leading to more effective implementation and adherence.

The recommendation for regular security audits helps identify gaps, update practices, and demonstrate commitment to security (Ashford, 2017; Safa et al., 2016; Sevgi & Yılmaz, 2023). Training educators result in practical skills, updates knowledge, and promotes a security culture (Alshammari & Singh, 2018; Johnson, 2012). These measures are vital for maintaining robust security protocols and fostering an environment of continuous improvement.

The suggestion to organize community forums enhances awareness, encourages dialogue, and develops collaborative solutions (Feenberg & Bakardjieva, 2004; Hassani et al., 2018). Such forums can bridge gaps between stakeholders, promote shared understanding, and contribute to the responsible use of AI.

Overall, the section provides a thorough and well-structured examination of privacy and security concerns in AI applications for early childhood education. It effectively integrates legal frameworks, ethical principles, technical measures, and collaborative strategies. The use of relevant and current academic references strengthens the arguments and situates the discussion within the broader scholarly context.

To further enhance the section, it could include more detailed case studies to illustrate the practical application of the proposed measures. Additionally, exploring challenges in implementing these strategies, such as resource constraints or varying levels of digital literacy among parents and educators, could provide a more comprehensive view.

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Chapter 10

Innovative Out-of-School Learning Environments in Early Childhood: Digitally Supported Discovery and Experience-Based Approaches

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Abstract

This study investigates the use of digitally supported and nature-based activities in out-of-school learning environments to enhance the impact of STEM education in early childhood. Digital technologies such as augmented reality (AR) and virtual reality (VR) increase children's interest in STEM fields and develop their scientific observation and problem-solving skills. Through these technologies, children can experience abstract concepts in a more concrete way, fostering positive attitudes toward STEM fields. Out-of-school learning environments like museums, science centers, and science festivals enable children to engage with science in a direct and interactive manner. These environments strengthen children's scientific attitudes and curiosity while supporting creative thinking, observation, and social skills. Science festivals, in particular, allow children to interact directly with scientists and experience the scientific process firsthand, thereby fostering an interest in STEM. Science festivals and similar activities provide opportunities to relate STEM concepts to daily life, increasing children's future interest in STEM

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and motivating them to pursue careers in these fields. In conclusion, digitally supported and nature-based STEM applications in out-of-school learning environments stand out as powerful tools for developing children's scientific thinking, problem-solving, and social skills. These activities strengthen children's connection to science, provide a more lasting understanding of STEM subjects, and foster a positive perspective toward STEM in their future educational and career choices.

1.Introduction

Today, rapidly developing technology and scientific advances have made it imperative for students to acquire 21st century skills. Science, Technology, Engineering and Mathematics (STEM) education stands out as an important tool in developing these skills. However, classroom learning environments alone may be insufficient to support the multidimensional knowledge and skill development required by STEM. In this case, out-of-school learning environments (OLE) can contribute to children's learning. OLEs such as museum visits, nature camps, and science centers increase students' interest in science by enabling them to associate abstract STEM concepts with real life experiences (Çevik & Bakioğlu, 2024).

CFLs provide students with the opportunity to relate the knowledge they acquire at school to daily life and explore STEM concepts in the real world. While these learning environments develop students' skills such as creative thinking and problem solving, they also contribute positively to their interest in science. Various studies have shown that OST-based STEM activities help students explore their interest in STEM fields and career options in these fields. In a study conducted by Baran et al. (2019), it was determined that STEM activities in CFLs positively affected students' attitudes towards STEM. CFLs can also be effective in increasing students' interest in professions related to STEM fields. In particular, it has been shown that students who participate in STEM activities in FLCs during middle school are more likely to pursue a career in STEM fields at university (Dabney et al., 2012). Afterschool Alliance (2011) and other studies suggest that FLCs increase students' interest in STEM careers, encouraging them to consider a potential future in STEM fields. Such activities enable students to encounter real-world problems, while at the same time helping them to see more clearly the connections of STEM to everyday life (Bell et al., 2009).

One of the main aims of STEM education is to provide students with 21st century skills such as problem solving, collaboration and critical thinking. Çevik and Bakioğlu (2024) state that STEM activities based on CFL improve students' analytical thinking, problem solving and teamwork skills. Thanks to its interdisciplinary nature, STEM education can be implemented more effectively in CFLs and students gain scientific thinking skills (Afterschool Alliance, 2011; Krishnamurthi et al., 2014). FLCs such as museum trips or nature camps provide students with direct experience and help them develop a lasting sense of curiosity about STEM subjects.

Another important advantage of FLCs is that they can appeal to different learning styles by offering a flexible learning environment. Students have the opportunity to reinforce their knowledge and gain practical experiences by participating in STEM activities in various FLCs according to their own interests. Panizzon and Gordon (2003) and Smith (2017) emphasize that CFLs are effective in providing students with individual and social skills. The freedom and flexibility offered by these learning environments support students to develop a lasting interest in STEM and encourage them to think in STEM fields on their career path (Mohr-Schroeder et al., 2014).

In this study, the process of creating and implementing the content of digitally supported applications, nature-based activities, and museum and science center experiences to support children's development in out-of-school learning environments in early childhood will be discussed.

2. Digitally Assisted Exploration and STEM Experiences

Digitally supported exploration applications are becoming increasingly widespread today. These applications enable children to digitally experience environments that they cannot physically be in through AR and VR technologies (Hsu et al., 2017). For example, children can explore a virtual version of a forest or an ocean and get to know animals and plant species closely. Such technologies offer children the opportunity to learn about environmental awareness and biodiversity while interacting with nature (Soberanes-Martín, 2022). They can also be used as a virtual preparation stage before real-world explorations. The benefits of AR and VR applications can be listed as follows (Wang et al., 2024; Arjit, 2021):

- **Increasing Interest in Learning**: Increases children's interest in STEM subjects with visual and interactive structures.
- **Active and Child-Centered Learning**: Supports children to learn through independent exploration, making knowledge more permanent.
- **Problem Solving Skills**: Teaches children how to cope with challenges and think critically.

- **Digital Literacy**: Increases children's familiarity with technology and develops their digital skills.
- **Interactive Learning**: Makes learning more inclusive and engaging through multi-sensory experiences.
- **Social Skills**: Strengthens cooperation, communication and social skills through group work.

Below is a VR-based STEM activity.

Journey to the World of Dinosaurs

Age Group 5-6 years old **Event Duration**: 35 minutes

<table>
<tr><td>Achievements:
☐ Children recognize dinosaurs that lived in prehistoric times.
☐ Makes scientific discovery using VR technology.
☐ Create a dinosaur habitat using engineering skills.
☐ Develop basic mathematical thinking skills about the size of dinosaurs.</td><td>Materials:
☐ VR glasses
☐ Flashcards about the size of different dinosaurs
☐ Cubes or lego pieces (for children to create the dinosaur height)
☐ Dinosaur and natural habitat posters, picture cards
☐ "Dinosaur World Map" drawing papers and crayons</td></tr>
<tr><td colspan="2">Entrance (5 minutes):

o Give children a brief introduction about dinosaurs. Explain that dinosaurs come in different sizes and shapes and live in different environments.
o Explain how STEM-based learning will help them explore the world of dinosaurs.</td></tr>
<tr><td colspan="2">Main Activity: STEM Experience (25 minutes)
In this section, cover the content for the four pillars of the STEM approach.</td></tr>
<tr><td>Science:

o Offer children the opportunity to explore the world of prehistoric dinosaurs using VR goggles.
o Children are introduced to natural sciences by observing dinosaur habitats, vegetation and climatic conditions. For example: "In which environment does this dinosaur live?" and ask them to make observations.</td><td>Technology:

o Guide children in putting on and using VR glasses. Simply explain how VR technology works, how to create experiences that seem real in a virtual environment. Emphasize how useful the technology is for scientific discovery and learning.</td></tr>
</table>

<table>
<tr>
<td>Engineering:

o After the VR experience, encourage children to think like an engineer. Ask them to imagine and make small models of the habitats where the dinosaurs they saw lived (e.g. a forest, a swamp or a mountain).
o Ask them to create a dinosaur habitat with materials such as Lego or cubes. Encourage them to make their own creative designs by asking them questions such as “In what environment did this dinosaur live and what kind of shelter or environment did it need?”.</td>
<td>Mathematics:

o Give children cards to compare the size of different dinosaurs. For example, explain that the size of a T-Rex is about the length of 4 children.
o Ask the children to estimate the size of a particular dinosaur by stacking Legos or cubes on top of each other. Thus, children gain the ability to measure and compare objects.</td>
</tr>
<tr>
<td colspan="2">Evaluation (10 minutes):

o Observe the habitats the children created and the measurements they made. Observe how they understand the STEM activity by having each child share their experiences.
o Ask children questions about the world of dinosaurs they discovered with VR and the habitat they designed.
o End the activity by asking what the children learned from their STEM experiences.
o Ask each child to draw or color something about the dinosaurs they saw at the end of the activity.</td>
</tr>
</table>

When the activity is examined, it is seen that a structure that allows preschool students to handle different skills together and interactively with technology is presented. VR technologies will be especially useful in presenting areas such as living things, plants and places that are impossible to see today.

3. Nature-Based STEM Activities and Science Teaching

Nature-based STEM practices offer many benefits to children in preschool education. These practices enable children to develop an interest in nature and science by exploring their environment. In particular, digital tools such as augmented reality (AR) and tablet technologies enable children to experience natural phenomena and STEM concepts in a more concrete way, contributing to the development of scientific thinking and problem-solving skills (Bagiati & Evangelou, 2016; Kastriti et al., 2022).

Digital technologies such as augmented reality and virtual reality allow individuals to concretize subjects. Thanks to these applications, children can observe natural phenomena (such as the water cycle or plant life cycle) in a virtual environment and experience these processes in a more concrete way. In this way, digitally supported nature-based STEM activities will support children's imagination and help them develop digital literacy at an early age. Children also develop their social skills by using such technologies, as these applications will encourage collaboration, often requiring group work (Larkin & Lowrie, 2019).

These activities will ensure children's active participation and encourage them to make discoveries in science, technology, engineering and mathematics. This will help children develop STEM skills in a natural learning environment and prepare them for future learning processes (Kastriti et al., 2022). The characteristics of such activities can be as follows.

1. **Focus on Direct Exploration and Experience**: It should allow children to directly experience science through observation in the natural environment.
2. **Help to Concretize**: Make abstract science concepts understandable by making them concrete with various materials (e.g., simulating the water cycle with water containers and leaves).
3. **Supported by Digital Technologies**: Using tools such as augmented reality (AR) and tablet applications, processes in nature should be observed in a more detailed and engaging way.
4. **Promote Social Interaction and Cooperation**: Group work should strengthen cooperation skills and enable children to learn socially.
5. **It should stimulate curiosity and encourage questioning**: Children should be encouraged to observe and ask questions such as "Why?" and "How?".
6. **Promote Sustainability and Environmental Awareness**: Include activities that instill environmental awareness and a love of nature (e.g. recycling projects or growing plants).
7. **Use Natural Materials and Environments**: Activities that enrich children's sensory experiences should be carried out with natural materials such as soil, water and leaves.
8. **Help them understand the scientific process**: Include steps of the scientific method such as observation, hypothesizing, experimenting and drawing conclusions.

In this context, the following lesson plan is presented:

Discover the Mysteries of Nature: Navigation and Exploration Mission with AR

Age Group: 5-6 years (preschool) **Event Duration**: 40-50 minutes

<table>
<tr>
<td>Achievements:
☐ Children develop orientation and exploration skills in nature.
☐ Their ability for scientific observation and recognition of the environment increases.
☐ Gain digital literacy using AR technology.
☐ Develops awareness of nature and observation skills.</td>
<td>Materials:
☐ Tablet or smartphone (with augmented reality (AR) app installed for the exploration mission)
☐ Exploration mission map or mission cards with clues
☐ Small notebook or drawing paper and crayons
☐ Magnifier</td>
</tr>
<tr>
<td colspan="2">Preparation for a Discovery Mission in Nature (10 minutes):
☐ Excitement is aroused by telling the children that they are going on a special exploration mission in nature. They are told that there are clues hidden in nature such as “mysterious plants” and “animal tracks” that they need to discover.
☐ Children are given task maps or task cards and it is explained that they will explore certain points in nature by seeing them.
☐ Children are told that AR technology will help them see these mysterious places and show them the “unseen secrets” of nature.</td>
</tr>
<tr>
<td colspan="2">Exploration Mission with AR: Finding Mystery Spots and Clues (10 minutes):
☐ Children take turns guiding the tablet or phone to specific points and discover hidden clues with the AR app. For example, a type of mushroom may appear next to a tree or an anthill may appear on the ground.
☐ When children see plants, insects or animal tracks with AR, you can ask them about them and ask them questions to share their observations. For example: “Have you seen this plant before? Which animal do you think this trace belongs to?”
☐ The children are asked to draw these “mysterious” plants or animal tracks in their notebooks or on drawing paper.</td>
</tr>
<tr>
<td colspan="2">Exploration and Investigation in Nature (10 minutes):
☐ Continue exploring the mystery spots with the children and use the magnifying glass to find similar plants or animal tracks in the real world.
☐ They are guided to closely examine these objects in nature. Help them recognize the similarities between the digital elements they see with AR and real objects in nature.</td>
</tr>
<tr>
<td colspan="2">Creating and Sharing an Exploration Journal (10 minutes):
☐ Children are asked to record what they find and learn in their “Discovery Diary”. Each of them can express their clues and observations with drawings or short explanations.
☐ In the journal, they are asked to write and illustrate what they think about animal tracks, plants or hidden “treasures” they encounter in nature.
☐ They are encouraged to share with other children what they have learned during the discovery process and what interests them the most.</td>
</tr>
</table>

Evaluation (10 minutes):
☐ How children express their observations and follow the clues throughout the exploration task can be assessed.
☐ It can be observed how effectively they complete the discovery task by linking AR and nature observations.

This activity enables children to make both a physical and digital exploration in nature. It supports their learning process by interacting with AR technology in nature while developing orientation, observation and environmental recognition skills. This task allows children to use digital technology creatively in nature while increasing their sense of curiosity about the natural world. AR applications such as Seek by iNaturalist, PlantSnap and Arloon Plants can be used in this activity.

4. Innovative Museum, Science Festivals and Science Center Experiences

Innovative museums, science centers and science festivals stand out as powerful tools for promoting STEM in preschool education. Such learning environments provide children with a natural connection to scientific concepts, stimulate interest in science, technology, engineering and mathematics (STEM) subjects and develop their discovery skills.

4.1. Museums and Science Centers: Museums and science centers are ideal for children to develop scientific discovery and observation skills. Abacı and Usbaş (2010) argue that museums contribute to children's social-emotional and cognitive development and that museum visits add diversity to the educational process and offer different learning environments. In this context, in line with Hein's constructivist approach, Tallou (2022) stated that museum activities, in which children learn through direct experience, increase interest in science, especially in the early age group within the framework of multiple intelligences theory. Unlike the traditional classroom environment, the information that children learn by observing in museums provides a multi-sensory experience and encourages children to participate more actively in the scientific thinking process. The main characteristics of innovative museums can be listed as follows.

☐ **Interactive and Participatory Experiences**: Innovative museums encourage visitors to actively participate in exhibitions rather than just watching them. Digital technologies such as touchscreens, motion sensors, augmented reality (AR) and virtual reality (VR) can be used to participate in exhibitions. In this way, visitors can learn by living and experiencing the information instead of just watching it.

- **Education-Focused and Age-Adapted Content**: Innovative museums offer educational content that appeals to all age groups, engaging visitors from children to adults. While fun activities such as science experiments, games and creative workshops are organized for children, interactive content that provides more in-depth information can be offered for adults.
- **Online and Digital Access Opportunities**: With digitalization, innovative museums offer online exhibitions and virtual tours, enabling access without being tied to a location. Visitors can view exhibitions, participate in online workshops and explore museum content at their own pace through the museum's digital platforms.
- **Environmental and Social Awareness**: Innovative museums are effective in raising visitor awareness about environmental issues, sustainability and social responsibility. For example, interactive exhibitions on issues such as climate change, water conservation or biodiversity can raise awareness among visitors.
- **Highlighting the Connection between Art and Science**: Innovative museums can showcase the interactions between science, art, and technology, enabling visitors to see information from different fields together. In addition to STEM (Science, Technology, Engineering, Mathematics) based education, such museums also support STEAM (Art) integration. Thus, by combining science and art, they provide multifaceted learning experiences.

There are many innovative museums in Turkey that offer engaging experiences of science and technology. Among these, the Istanbul Museum of Illusions offers an environment that captures the attention of visitors through optical illusions, perceptual illusions and interactive experiences. The museum makes scientific concepts more fun and understandable through various interactive exhibits such as light, shadow and perspective games. These features especially help children to develop their perception and observation skills.

Another important innovative museum, Konya Science Center is Turkey's first TUBITAK-supported science center. The center has interactive exhibition areas in many different fields of science such as astronomy, physics, biology and robotics. Enriched with VR and AR technologies, these exhibitions help visitors learn scientific concepts in a more concrete and impressive way. In addition, the observatory at the center offers children and young people a practical learning environment in astronomy.

Istanbul Rahmi M. Koç Museum is an important museum that sheds light on Turkey's industrial, transportation and communication history. Exhibiting a wide collection of historical steam engines, classic vehicles, airplanes and submarines, the museum provides a very impressive environment for those who want to explore the historical development of technology. It also offers an educational experience on science and technology with various workshops and interactive areas for children.

IBB Kültür AŞ Digital Experience Museum in Istanbul is a digital art and science-themed museum that uses virtual reality (VR) and augmented reality (AR) technologies to provide visitors with an interactive experience. Applications such as space travel with VR glasses or exploring nature in a virtual environment make science fun and immersive. Exhibitions enriched with digital technologies enable visitors to understand scientific topics with a modern approach.

Kayseri Science Center is another science center supported by TÜBİTAK and has exhibition areas covering many scientific fields such as robotics, space, natural sciences and human anatomy. VR-supported activities and hands-on science activities, especially for children, are designed to increase young visitors' interest in science. Kayseri Science Center makes learning more fun by offering children the opportunity to make scientific discoveries.

Finally, Eskişehir Science Experiment Center and Sabancı Space House have specially designed areas for children interested in science and astronomy. Various experiments at the Science Experiment Center help children better understand scientific concepts, while the Sabancı Space House provides astronomy education and helps them learn about space and planets. Observation activities supported by VR technology allow children to meet science in a more interactive way.

These museums offer a variety of learning opportunities to raise awareness of science and technology in Turkey and inspire children in STEM. Attracting the interest of both children and adults, these museums support scientific education in Turkey with innovative approaches that bring science together with society.

4.2. Science Festivals: Science festivals increase children's interest in science as events where STEM topics are presented in a fun and accessible way. Organizations such as the TUBITAK 4007 Science Festival support program in Turkey play a critical role in developing scientific attitudes as they provide children with the opportunity to meet scientists while introducing them to scientific processes (Başaran & Karakoç Topal, 2022). Robotics and experimental learning activities offered at these festivals contribute to children's positive attitudes towards scientific knowledge by increasing their interaction with STEM. Ates et al. (2021) also stated that science festivals are effective in introducing scientists as accessible people who are related to daily life by shaping participants' perceptions of scientists. These activities trigger children's curiosity about science by providing both a fun and educational environment for them. As emphasized in Jensen and Buckley's (2012) study, through these festivals, children have direct contact with scientists, learn about scientific research, and have the opportunity to make their own discoveries. However, Kennedy et al. (2018) pointed out that such events tend to attract individuals who are already interested in science and that more inclusive strategies are needed and that structural changes are necessary for science festivals to reach wider audiences.

Science festivals are useful in showing children and young people the fun and hands-on side of science. Activities such as experiment workshops, robotics, augmented reality (AR) and virtual reality (VR) experiences allow participants to explore science first-hand. Such activities help children and young people develop scientific thinking skills and learn basic scientific processes such as critical thinking, observation, and hypothesis formulation.

Another important contribution of science festivals is that they raise scientific awareness in society. These events show the importance of science and the necessity of scientific thinking to different segments of society. At the same time, they allow participants to communicate directly with scientists, thus developing a more informed perspective on the role of scientists in society.

Science festivals held in various provinces in Turkey within the framework of the TÜBİTAK 4007 Science Festivals program aim to arouse interest in science all over the country. These festivals, organized under the 4007 Science Festivals Support Program, are held all over Turkey with the aim of generating interest in science and technology and promoting the culture of scientific thinking. TÜBİTAK supports these festivals in cooperation with various municipalities, universities, schools, science centers and non-governmental organizations, thus reaching a wide segment of the society. TÜBİTAK 4007 Science Festivals Support Program was launched in 2015. This program aims to disseminate science culture and communication to wider segments of the society, to deliver scientific knowledge to the participants and to understand the interaction between science-technology-society through events.

The activities to be organized at science festivals should be designed to attract children's interest and offer a fun experience as well as being educational. Below is an activity that can be implemented in science festivals:

Finger Rockets: Launching Our Own Rocket!

Age Group: 4-6 years (pre-school) **Activity Duration**: 30-40 minutes

Achievements:	**Materials**:
☐ Children build a simple launch system and experience the concept of air pressure. ☐ Develops observation, prediction and inference skills. ☐ Fine motor skills and hand-eye coordination are strengthened. ☐ Problem solving and creative thinking skills develop.	☐ Paper (cut to size for finger rocket) ☐ Scissors ☐ Adhesive or tape ☐ Colored pencils or paints (to decorate the rocket) ☐ Plastic pipette (thin pipette and a thicker pipette)
Introduction and Rocket Introduction (5 minutes): ☐ Children are introduced to the activity by saying "Today we are going to make our own little rockets and launch them!". Draw their attention by giving simple explanations such as how rockets fly and why they need pressure for launching. ☐ Explain to the children that finger rockets are made of paper and that they will be launched with a straw.	
Finger Rocket Making (10 minutes): ☐ Each child is given paper and straws prepared for finger rockets. Children are asked to shape the paper into a small rocket. They are shown that they should roll the body of the rocket to fit the straw and secure it with tape or glue. ☐ Explain that they should close the tip of their rocket so that no air can escape during launch. ☐ Children decorate their rockets with colored pencils or paints.	
Rocket Launch (5-10 minutes): ☐ Children are asked to place the thin straw inside the rocket body. Then, they are asked to launch their rockets by blowing or gently pressing the thin straw placed inside a thicker straw. ☐ Children are asked to observe how far the rocket goes and share their results. They are allowed to experience how to launch the rocket with different blowing power or angle.	
Conclusions and Observations (5 minutes): ☐ Together with the children, talk about how rockets fly. They are encouraged to make simple observations, trying to understand which rocket goes the farthest, why it moves faster or slower. ☐ The activity is completed with questions such as "Do you know how rockets fly now?" by asking the children to share what they have learned.	
Evaluation (10 minutes): ☐ Children's skills in rocket building, their observations and their ability to draw conclusions can be observed. ☐ The experience of launching rockets at different angles helps them understand simple processes of experimentation and observation.	

This activity will help children understand the concepts of pressure, air and motion by presenting a simple scientific experiment. With its fun and easy-to-implement structure, it supports children's interest in science and creative thinking skills.

5. Conclusion

This study examined how digitally supported and nature-based activities can be implemented in out-of-school learning environments to increase the impact of STEM-based learning processes for preschool children. In particular, digital technologies such as AR and VR have been found to increase children's interest in learning processes and contribute to the development of positive attitudes towards STEM fields (Hsu, Lin, & Yang, 2017; Wang, Abdul Rahman, & Nizam Shaharom, 2024). These technologies help children connect with nature by strengthening their scientific observation and problem-solving skills (Ajit, 2021).

Out-of-school learning environments such as museums, science centers, and science festivals are powerful tools to develop children's interest and motivation towards STEM. Çevik and Bakioğlu (2024) emphasize that these environments develop students' creative thinking and analytical skills, while studies such as Tallou (2022) show that interactive exhibitions in museums increase interest in science. Thanks to such environments, children directly experience scientific processes and associate them with daily life, which reinforces their interest in STEM fields (Abacı & Usbaş, 2010; Bell et al., 2009).

Children's direct interaction with scientists in activities such as science festivals strengthens their scientific attitudes and curiosity and increases their interest in STEM fields (Jensen & Buckley, 2012; Kennedy, Jensen, & Verbeke, 2018). In particular, organizations such as TÜBİTAK-supported science festivals in Turkey enable children to develop a lasting curiosity about STEM-related concepts (Başaran & Karakoç Topal, 2022). In conclusion, digitally supported and nature-based STEM practices in out-of-school learning environments play an important role in developing children's scientific thinking, problem solving and social skills. By providing children with the opportunity to interact with science, these activities provide more lasting learning about STEM concepts and contribute to their development of a positive perspective towards STEM in their future educational and career choices.

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Chapter 11

The Importance of Artificial Intelligence in Preschool Science Education in the Context of Long-lasting Learning

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Abstract

This chapter examines the role of artificial intelligence (AI) technologies in enhancing long-lasting (permanent) learning in preschool science education. The use of AI in developing scientific thinking skills during early childhood offers numerous advantages, increasing children's engagement with the subject matter and encouraging active participation in learning processes. AI-based tools can be adapted to meet individual learning needs, allowing for the personalization of educational experiences. By providing an interactive and engaging environment, AI applications offer experimental learning opportunities that contribute to long-lasting retention of scientific concepts. The chapter discusses how AI supports children's cognitive development, problem-solving skills, curiosity, and self-confidence. Particularly in developing problem-solving and analytical thinking, AI technologies equip children with tools to tackle complex problems and think critically. Additionally, the chapter emphasizes the role of teachers in AI-supported learning environments and the pedagogical knowledge required for the effective use of these technologies. Moreover, ethical and safety considerations surrounding AI technologies in early childhood education are explored. Ensuring children's data privacy and digital safety is essential for the broader acceptance and application of AI in educational contexts. In this regard, the chapter provides recommendations for the safe and effective implementation of AI in education and presents projections on the potential future impact of this technology on educational practices.

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1. Introduction

In recent years, the role of artificial intelligence (AI) technologies in education has been increasingly emphasized, and the use of these technologies in early childhood education has also drawn significant attention. Early science education plays a critical role in providing children with fundamental knowledge and skills related to scientific concepts. Science education designed to support long-lasting learning fosters children's innate curiosity and directs them towards scientific thinking (Şahin, 2020).

The rapid development of AI technologies has led to the adoption of innovative approaches in the field of education, resulting in transformative changes in learning processes. Integrating AI into early childhood education presents new opportunities for children's cognitive, social, and emotional development (Kaya and Çakır, 2021).

Teaching fundamental knowledge and skills related to scientific concepts during preschool education is of great importance for children's development of scientific thinking skills in the long term (Demir and Yılmaz, 2019). In this regard, AI emerges as a crucial tool in providing an interactive and enduring learning experience in children's educational processes.

Long-lasting learning refers to a process in which students retain information for extended periods and can apply this knowledge in various contexts. This type of learning requires in-depth understanding rather than surface memorization (Caine and Caine, 2011). AI-supported learning environments help children understand scientific concepts through experience, making the learned information more long-lasting.

Studies indicate that AI contributes to children's deep comprehension of scientific topics by offering interactive and personalized learning experiences (Özkan and Çakır, 2020). These learning processes allow children to apply what they have learned in real-life situations and different contexts.

The personalization opportunities offered by AI contribute to equity in education by adapting the learning process to each child's individual needs (Yılmaz, 2017). For instance, AI-based applications that can be customized to match children's learning speeds and interests encourage deeper learning in disciplines like science education (Akın and Demir, 2022). This approach allows each child to progress at their own pace, exploring scientific concepts independently.

Such personalized learning experiences help children ascribe more meaning to knowledge, thus supporting long-lasting learning (Gökçe and Karaman, 2020).

AI applications that encourage active participation in learning processes during the preschool period increase children's motivation to learn, fostering long-term interest and commitment to science. AI-supported games and simulations enhance children's interest in science and encourage them to explore and inquire. This process transcends mere knowledge transmission, enabling children to develop scientific inquiry skills (Yıldırım, 2018).

Additionally, AI contributes to children's social and emotional development in the context of science education; children learn through teamwork and interaction with peers (Korkmaz, 2019).

In summary, this chapter focuses on the potential impact of AI on long-lasting learning in preschool science education, highlighting the importance of this technology in developing children's scientific thinking skills. T

This section aims to detail the contributions of AI-supported educational applications to children's science education, offering an in-depth analysis of their pedagogical and technological effects on the learning process.

2. The Relationship Between Artificial Intelligence and Long-lasting learning

Artificial intelligence (AI) creates a profound transformation in knowledge-based learning processes, assisting students in retaining learned information over the long term. Long-lasting learning is a process that enables students to remember acquired information not just temporarily but for an extended period, applying it in daily life (Atkinson and Shiffrin, 2016).

AI offers personalized and interactive learning environments that facilitate this level of knowledge retention. Learning processes supported by AI-based applications allow children to understand, apply, and retain learned information more long-lastingly (Korkmaz and Çetin, 2020).

The effect of AI on long-lasting learning is based on its capacity to tailor learning experiences to students' individual needs. AI provides personalized guidance and educational content at a pace suited to each learner's progress. Individualized education is crucial in promoting long-lasting learning, especially during early childhood when children exhibit varying learning speeds (Shute and Zapata-Rivera, 2012).

Thus, children can progress at their own pace within a learning process adapted to their needs, allowing for a deeper comprehension of the knowledge they acquire. In the context of long-lasting learning, AI does more than transmit information; it helps children make sense of and apply knowledge. For example, virtual tutors or interactive digital games encourage children to explore scientific concepts while actively engaging in the learning process (Çiftçi and Erdoğan, 2018). When children have the opportunity to experience scientific concepts through games or simulations, they construct these concepts mentally more robustly, retaining the knowledge for longer. In this way, AI stands out as one of the tools promoting long-lasting learning in preschool education.

AI technologies are also effective in supporting children's cognitive and affective learning goals, enhancing skills like scientific thinking and problem-solving. Understanding scientific concepts in preschool supports children's interest in science in later years, guiding them toward scientific inquiry (Aksoy and Şimşek, 2019). AI in this process becomes a supportive technology in preschool science education that fosters long-lasting learning through experiential and observational learning.

AI's impact on long-lasting learning in preschool science education is significant. AI-supported interactive learning environments help children relate abstract scientific concepts to tangible experiences, aiding comprehension and retention. In this context, the personalization, interactivity, and feedback mechanisms AI provides enable children to engage more actively in learning processes, allowing them to retain knowledge of scientific topics for extended periods (Güneş and Çakmak, 2020).

2.1. The Contribution of Artificial Intelligence to Long-lasting and Meaningful Learning

Artificial intelligence (AI) has become a powerful tool in supporting long-lasting learning in education. Long-lasting learning enables students to retain knowledge for extended periods and use it effectively across various contexts (Eysenck, 2015).

AI technologies make learning processes more meaningful by helping children internalize and retain information. In other words, as meaningful learning increases, knowledge becomes more concentrated and long-lasting. Through AI-supported applications, children do not merely acquire information superficially but have the opportunity to actively experience and apply it (Johnson, 2018). This engagement fosters a deep involvement in learning processes, thereby contributing to the meaningful and long-term retention of knowledge.

AI personalizes the learning process by considering individual learning differences, tailoring each student's learning journey. Personalized learning experiences allow children to learn at their own pace and according to their interests. For example, some children are more inclined toward visual learning, while others prefer learning by doing. AI-supported tools cater to these individual differences, providing suitable content for each learner (Chauhan, 2021). Consequently, learning experiences become more effective and enduring, as research has shown that personalized learning has a stronger impact on long-lasting learning.

AI's contribution to long-lasting learning is also evident in its ability to offer interactive learning environments where children actively engage with the content. Interactive learning enables children to understand and apply knowledge through experience. For example, AI-supported simulations or games in science education allow children to experience scientific concepts visually and auditorily. These applications enhance retention by reinforcing learned information through multisensory experiences (Clark and Mayer, 2016). Interactive learning prevents children from passively receiving information, instead encouraging them to investigate and make sense of knowledge. Another significant contribution of AI to long-lasting learning lies in its capacity to provide continuous feedback. AI-based systems monitor children's learning processes, identifying areas needing improvement, and offer immediate feedback (Özkan and Çakır, 2020). This feedback makes learning more effective and aids in the long-term retention of knowledge (Chen, Rau, and Chen, 2019). Additionally, such feedback allows children to manage their learning processes by recognizing and learning from mistakes. Students can build a solid knowledge base by correcting errors and learning from them.

AI technologies' personalization, interactivity, and feedback mechanisms create an ideal environment for long-lasting learning. These technologies facilitate meaningful and profound learning processes that help children retain knowledge over extended periods. In preschool science education, AI emerges as a valuable tool, enabling children to learn scientific concepts more effectively and retain this knowledge in the long term (Mitchell, 2020).

3. The Role of Artificial Intelligence in Preschool Science Education

Artificial intelligence (AI) plays an essential role in preschool science education by enabling children to understand scientific concepts and participate more actively in learning processes (Zhu, Han, and Gao, 2021). Science education aims to help children comprehend the world around them and develop scientific thinking skills, and the knowledge acquired at this age can impact their future scientific success (Chen et al., 2019). AI facilitates the involvement of young children in science education, allowing them to have meaningful and enduring learning experiences (Holmes, 2018).

One of AI's most important functions in preschool science education is to provide children with opportunities to learn abstract scientific concepts through concrete experiences. AI-based technologies such as AR (Augmented Reality) and VR (Virtual Reality) allow children to observe abstract topics like the solar system, water cycle, or plant life cycle. These experiences make it easier for children to understand scientific concepts and retain this knowledge for extended periods (Billinghurst, 2016). For instance, an AR application can enable children to observe the growth and development of a plant in 3D, thereby deepening their understanding of environmental processes.

AI-supported educational tools also increase children's interest in science topics, encouraging greater engagement in the learning process. For example, AI-based simulations and games allow children to explore scientific subjects in an enjoyable and interactive way. These engaging experiences maintain children's interest in science and motivate them to ask questions and explore further (Luckin et al., 2016). Studies show that children learn more effectively and retain knowledge better in interactive learning environments (Chen, 2018).

Additionally, AI provides a personalized learning experience that considers individual differences in children's learning processes. As each child has a unique learning pace and set of interests, AI-supported tools can adapt to meet each child's needs (Holstein, McLaren, and Aleven, 2019). For example, while some children learn better through visual content, others prefer learning by doing. AI monitors children's learning processes and provides suitable content for each child, allowing them to learn at their own pace.

AI, therefore, emerges as an important technology supporting children's comprehension of scientific concepts and development of scientific thinking skills in preschool science education. AI-supported tools and applications enable children to participate actively in science education, making the learning process more meaningful and long-lasting. In this context, AI technologies can be seen as innovative educational tools that help children understand scientific concepts better and retain this knowledge in the long term (Mitchell, 2020).

3.1. AI-Based Interactive Tools in Preschool Science Education

Artificial intelligence (AI)-based interactive tools are effectively utilized in preschool science education to enhance children's scientific skills and ensure active participation in learning processes. These tools provide visual, auditory, and experiential learning experiences that support children's science knowledge skills (Papert, 2020).

Interactive AI-based tools enable children to understand the world around them from a scientific perspective, allowing them to explore fundamental scientific concepts in-depth. By learning science knowledge skills in a hands-on way through these tools, children make knowledge more long-lasting (Chen et al., 2019).

One of the most significant features of AI-based interactive tools is their ability to offer applications aimed at developing children's scientific process skills. For instance, through educational robots or simulations, children can experience scientific processes such as observation, data collection, analysis, and drawing conclusions. In these processes, children recognize that knowledge is not only theoretical but also an applied process. Developing scientific process skills contributes to children's positive attitude toward science and advances their scientific thinking skills. In preschool science education, AI-based tools provide children with opportunities to make mistakes and learn from them. Interactive tools allow children to develop solutions through trial and error while learning scientific concepts. By using AI-supported simulations, children can try their own solutions, make mistakes, and receive instant feedback to correct these errors (Holmes, Bialik, and Fadel, 2020). This process enables children to understand scientific processes more deeply and boosts their self-confidence.

AI-based tools encourage children to ask questions about science and foster their curiosity. When children interact with AI-supported games or simulations, they begin to ask questions about events they observe in their environment. For example, a child observing seasonal changes through an AI simulation may develop curiosity about weather phenomena (Rosenberg and Jack, 2017). Such interactions enhance children's curiosity toward science and foster their scientific inquiry skills.

AI-based interactive tools that play a crucial role in building the foundation of scientific thinking skills in preschool science education encourage children to actively participate in scientific thinking processes while developing their science knowledge skills. These tools make the learning process more meaningful by allowing children to explore scientific concepts practically (Zhu and Leung, 2020).

3.2. AI-Supported Applications in the Context of Cognitive and Affective Development

Artificial intelligence (AI) provides significant support for children's cognitive and affective development in preschool education, contributing positively to their learning processes. Cognitive development encompasses skills such as thinking, problem-solving, reasoning, and comprehension, while affective development involves emotional processes like self-confidence, curiosity, interest, and motivation (Piaget, 2001). AI-supported applications offer interactive and adaptive learning environments designed to enhance children's cognitive and affective skills. Particularly in early childhood, AI-based educational tools are effective in fostering scientific thinking skills and increasing interest in science (Bower and Sturman, 2015).

In terms of cognitive development, AI enables children to develop problem-solving and analytical thinking skills. For example, educational robots and interactive games actively engage children in problem-solving processes. In these AI-supported applications, children encounter various challenges, search for solutions, and generate hypotheses. Such applications support children's logical thinking abilities and help them develop solutions when faced with complex problems (Resnick, 2017). Furthermore, children are encouraged to apply what they have learned in different situations, promoting long-term knowledge retention. For affective development, AI-supported applications boost children's self-confidence and support their motivation to learn. In interactive learning environments, children can direct their own learning processes and receive instant feedback in cases of failure, improving their learning experiences. Instant feedback provided by AI allows children to recognize and correct their mistakes, increasing their self-confidence (Papadakis, 2020). Additionally, AI-supported games and simulations maintain children's interest in science and encourage them to explore, which fosters their active engagement in learning processes.

AI also has the potential to enhance children's social-emotional skills. AI-based applications offer learning experiences that promote teamwork and collaboration. For example, AI-supported educational games used in groups allow children to improve communication skills and interact with each other. These interactions help children develop social skills such as empathy, patience, and cooperation. Supporting social interactions enriches children's individual and group learning experiences. AI-supported educational tools contribute to both children's cognitive and affective development, increasing their interest and achievement in science. Interactive, adaptable, and instant feedback-providing AI learning environments support children's cognitive processes and positively influence their affective development (Zhu et al., 2021). Consequently, AI-supported applications enable children to acquire fundamental skills related to science and retain this knowledge over the long term.

4. Applications of Artificial Intelligence in Preschool Science Education

Artificial intelligence (AI) offers a range of applications that enable children to explore and understand scientific concepts in preschool science education. While developing children's science knowledge skills, AI-based applications also support their scientific thinking and problem-solving abilities. AI tools in science education make it easier for children to access scientific knowledge and actively engage in learning experiences (Tzafestas, 2020). In preschool, AI technologies help connect abstract scientific concepts with concrete experiences, increasing children's interest in science.

One of the most common uses of AI in preschool science education is educational robots. These robots enable children to explore fundamental concepts in science and enhance their problem-solving skills. Educational robots present task-based learning opportunities, encouraging children to participate in scientific experiments (Alimisis, 2013). Through these robots, children can conduct experiments, solve problems, and develop hypotheses. Such interactions support children's understanding of scientific processes and contribute to the retention of knowledge.

AI also provides instant feedback during children's learning experiences in science, allowing them to identify their shortcomings and correct errors. For instance, an AI-supported science education application can analyze children's mistakes and offer corrective feedback. This type of feedback enhances the learning process and reinforces the retention of knowledge (Sarikaya and Aydin, 2018). Learning experiences supported by instant feedback contribute to long-lasting knowledge retention.

In summary, AI offers a wide range of applications in preschool science education that help children understand scientific concepts through various tools. AI-supported tools like educational robots, AR/VR applications, and feedback mechanisms increase children's interest in science and make knowledge retention more long-lasting. In this context, integrating AI technologies into preschool science education enables children to develop scientific thinking skills and gain a deeper understanding of scientific topics (Zhang et al., 2019).

4.1. Integration of Artificial Intelligence with Virtual and Augmented Reality in Science Education

One significant application of artificial intelligence (AI) in preschool science education is its integration with augmented reality (AR) and virtual reality (VR). AR and VR allow children to explore abstract concepts in science education through visual and interactive experiences, making learning more meaningful and long-lasting (Chang, Chang, and Shih, 2020). Thus, AI enhances the learning process through active participation.

AI-supported technologies such as VR and AR create engaging learning experiences in science, enabling children to understand scientific concepts more effectively. Through these technologies, children can observe and interact with abstract scientific concepts in a three-dimensional environment.

With VR and AR, children can experience scientific theories and processes in a concrete way, developing a deeper understanding of scientific knowledge (Billinghurst and Duenser, 2012). The integration of AR and VR with AI encourages children to actively participate in the learning process, making scientific concepts more enduring.

The integration of VR and AR in science education allows children to explore the world around them from a scientific perspective. For example, with VR, children can observe planetary movements in space or examine the structure of the human body. These experiences help children understand abstract scientific concepts in a more concrete way (Radu, 2014). Additionally, with AR, children can directly associate scientific information with objects in their environment and relate them to scientific processes. For example, through AR, children can observe information about photosynthesis on a leaf, gaining a better understanding of this process.

AI-supported VR and AR applications enable children to participate actively in the learning process and learn at their own pace. Adaptive VR and AR tools powered by AI provide tailored educational content based on children's individual learning speeds and preferences (Cheng and Tsai, 2013). This personalized learning experience allows children to gain a deeper understanding of scientific knowledge. Moreover, interactive elements in VR and AR applications increase children's interest in science, motivating them to explore and learn.

VR and AR technologies are also effective in helping children develop scientific observation, analysis, and hypothesis-building skills. Through VR and AR, children can observe and analyze various scientific processes, strengthening their scientific thinking abilities. For instance, a VR application that demonstrates the water cycle allows children to observe the processes of evaporation, condensation, and precipitation, enabling them to make inferences about this cycle. Such experiences contribute to the long-lasting retention of scientific knowledge.

The integration of AI-supported VR and AR technologies in science education provides children with opportunities to understand scientific concepts and develop scientific thinking skills. The visual and interactive experiences offered by VR and AR keep children engaged in science while nurturing their curiosity about scientific phenomena. In this context, AI-integrated VR and AR applications emerge as powerful tools that enrich and enhance the learning process in preschool science education (Chen and Chan, 2019).

4.2. The Role of Games and Simulations in Science Education

AI-supported games and simulations provide interactive and enjoyable learning experiences in science education, allowing children to better understand scientific concepts. Games and simulations enable children to make abstract science topics more tangible and encourage active participation in the learning process. Through games, children can experience scientific concepts in a fun environment, making the knowledge they gain more long-lasting (Gee, 2008). AI-based games and simulations increase children's motivation to explore and learn, making science education more engaging.

AI-supported games offer children the opportunity to develop scientific thinking and problem-solving skills. For example, in an ecosystem simulation, children can observe the effects of environmental factors on plants and animals, helping them understand cause-and-effect relationships. In these types of games, children have the opportunity to explore scientific concepts through various scenarios, supporting their comprehension and long-term retention of scientific knowledge.

Games and simulations also encourage children to develop curiosity and scientific inquiry skills by supporting their science knowledge skills. AI-supported games provide children with the opportunity to make mistakes and learn from them. While developing a hypothesis or experimenting in a game setting, children can make mistakes and receive instant feedback, helping them improve their learning processes (Connolly et al., 2012). This process fosters active participation in learning and contributes to the development of scientific thinking skills.

AI-supported games and simulations help children enhance their scientific observation and analysis skills. Through AI-based simulations, children can make direct observations and analyze scientific events to make inferences. For instance, a game simulating the water cycle allows children to observe the stages of this cycle and understand how each phase occurs. Such games enable children to develop a deeper understanding of science topics.

In conclusion, AI-supported games and simulations are innovative and effective tools for science education. These tools facilitate children's understanding of scientific concepts and support the development of scientific thinking and problem-solving skills. AI-supported games encourage children's interest in science and their active participation in learning processes (Wouters et al., 2013). Therefore, the use of AI-supported games and simulations in science education contributes to building a solid foundation of scientific knowledge in children.

5. Artificial Intelligence-Supported Learning Approaches

Artificial intelligence (AI) enables new teaching approaches in education, making learning processes more effective for both teachers and students. AI-based instructional approaches provide individualized content to students while offering data to teachers for monitoring student performance and improving teaching strategies (Luckin et al., 2016). In preschool science education, AI-supported teaching helps children gain a deeper understanding of science topics and actively engage in the learning process. AI-supported instructional approaches make learning experiences more meaningful, supporting long-lasting learning.

One key advantage of AI-supported instructional approaches is the ability to improve teaching processes by providing teachers with data on children's individual learning progress. Through AI-based tools, teachers can analyze students' achievement levels, interests, and learning speeds to adapt their teaching strategies. Such data-driven instruction makes learning experiences more effective, encouraging children to engage more in the learning process (Chen and Chen, 2018). Teachers can identify each child's strengths and weaknesses and provide support tailored to their needs.

AI-supported instruction also offers teachers the opportunity to personalize the learning environment. Each child has unique learning styles, speeds, and needs, making it essential to adapt teaching environments to individual differences. AI-based systems analyze children's learning processes and tailor the learning experience to meet their needs, supporting individualized learning (Baker and Smith, 2019). This approach allows each child to progress at their own pace in science education, enhancing the durability of knowledge.

AI-supported instructional approaches increase children's interest and motivation toward science, fostering active engagement in learning. For instance, children can experience science topics through AI-supported simulations or educational games. Such teaching methods nurture children's curiosity and encourage them to explore scientific concepts. Thus, AI-supported instructional approaches go beyond mere information transfer, aiming to develop children's scientific thinking and problem-solving skills (Rosenberg and Jack, 2017).

AI-supported instructional approaches offer teachers numerous opportunities to support children's individual learning processes and personalize instruction. These approaches allow children to develop a lasting understanding of science while also enabling teachers to enhance instructional processes and tailor them to student needs. Integrating AI technologies into instructional approaches contributes to a more efficient and long-lasting science education.

5.1. AI-Supported Interactive Learning

AI-supported interactive learning enables children to actively participate in the learning process, making knowledge more long-lasting. AI-based interactive learning environments make it easier for children to engage with abstract concepts in science education, providing meaning to these concepts (Clark and Mayer, 2016). Interactive learning environments prevent superficial learning by allowing children to reinforce learned information through various experiences. Especially in early childhood, active involvement in exploration, experimentation, and learning processes helps retain information longer in memory.

AI-supported interactive learning tools help students associate abstract concepts with tangible experiences. Technologies such as augmented reality (AR) and virtual reality (VR) enable children to better understand complex concepts in science education by visualizing them. These technologies allow children to establish a direct connection with the world around them, making learning more meaningful. When children explore scientific concepts through interactive simulations and games, these experiences ensure long-lasting knowledge retention and contribute to the development of scientific thinking skills.

Furthermore, AI-supported interactive learning environments allow children to actively discover information. In these environments, children learn science by conducting experiments or making observations. For instance, an AI application simulating the growth process of a plant helps children understand the life cycle of plants. Experiential learning like this not only helps children acquire information but also enables them to understand it deeply and retain it for a long time. Thus, AI-supported interactive learning supports long-lasting learning by promoting children's active involvement in the learning process.

AI-supported interactive learning not only aids cognitive development but also contributes to affective development. Children take responsibility for their learning processes in interactive learning environments, which enhances their self-confidence. Additionally, active participation in the learning process increases children's motivation, sustaining their interest in science education. This motivation drives children to ask scientific questions and fuels their desire to explore, thereby fostering their scientific thinking and inquiry skills (Chen et al., 2019).

5.1. AI-Supported Discovery and Experiential Learning

AI-supported learning environments allow children to explore science topics and learn through hands-on experiences. Discovery and experiential learning involve children actively experiencing and understanding information through their own investigations rather than memorization. This approach helps children make sense of their surroundings and fosters the development of scientific thinking skills. AI provides an interactive learning experience that guides children in this process, adapts to their learning pace, and offers instant feedback (Kim, Park, and Lee, 2020).

In discovery and experiential learning, children can experience scientific concepts visually through AI-supported simulations and virtual reality (VR) applications. Complex scientific concepts, such as the water cycle, planetary movements, or life cycles, can be made accessible to children through AI-based simulations, allowing them to observe and interact (Billinghurst and Duenser, 2012). These experiences enable children to understand abstract scientific concepts better and support long-lasting knowledge retention.

AI encourages children to learn independently in the discovery-based learning process, offering opportunities to ask scientific questions, develop hypotheses, and create solutions. In an AI-supported learning environment, children tackle scientific problems by creating their solutions, enhancing their problem-solving abilities (Resnick, 2017). This process not only improves children's scientific thinking skills but also boosts their confidence, as they can validate the accuracy of their discoveries.

Interactive AI tools allow children to make mistakes in experiential learning processes and learn from them. During their learning journeys, children receive instant feedback from AI systems as they make mistakes, allowing them to reassess their solutions based on this feedback. This process enables children to learn through experience and make knowledge more long-lasting by learning from errors (Johnson, 2018). Thus, AI-supported learning environments help children direct their learning processes.

In conclusion, AI-supported discovery and experiential learning enable children to understand scientific concepts better and experience a learning process that supports long-lasting knowledge retention. Interactive learning environments that actively involve children in the learning process enhance their interest in science and promote the development of scientific skills (Dede, 2009). AI serves as a guiding tool in children's exploration of science, contributing to their long-term knowledge and skills.

5.3. AI-Supported Personalized Learning

AI-based personalized learning approaches ensure that each child has an educational experience tailored to their learning pace, interests, and needs. In preschool science education, aligning learning processes with children's individual learning differences makes learning more effective and meaningful (Chen et al., 2019). AI analyzes children's learning processes, assesses each student's information retention rate and level of comprehension, and offers an adaptive learning experience accordingly. This personalized learning experience enhances children's interest and motivation toward science.

In AI-supported personalized learning environments, educational materials are adapted to meet the needs of each child. For example, a child inclined toward visual learning might be provided with more visual materials, while a child who prefers hands-on learning could be given interactive simulations (Shute and Zapata-Rivera, 2012). This approach allows each child to develop science knowledge skills using materials that suit their learning style. By offering content aligned with children's needs, AI supports long-lasting knowledge retention.

AI individualizes learning by providing instant feedback during the learning process. As children study a topic, they receive immediate feedback on their mistakes or deficiencies, allowing them to improve based on this feedback. In science, learning through mistakes fosters children's ability to think critically about knowledge, cultivating a deep understanding of scientific processes (Van Lehn, 2011). Therefore, the instant feedback mechanisms provided by AI support individualized learning.

AI-supported personalized learning approaches also contribute to the development of children's self-regulation skills. Self-regulation refers to children's ability to manage their own learning processes, set goals, and develop strategies to achieve them. AI-supported learning environments allow children to monitor their own progress, raising their awareness of their learning process (Holmes, 2018).

Developing self-regulation skills helps children manage their learning processes more effectively, particularly in science education.

In conclusion, AI-supported personalized learning approaches enrich children's learning experiences, making science knowledge more long-lasting. AI supports active participation in learning by offering content and feedback tailored to each child's individual learning needs (Chen, 2018). These personalized learning approaches increase children's interest in science, contributing to the development of scientific skills.

5.4. Pedagogical Approaches in AI-Supported Learning

Pedagogical approaches in AI-supported learning processes aim to enrich children's learning experiences and support long-lasting learning. These approaches provide adaptive and personalized learning environments that support children's cognitive and affective development (Holmes, 2018). AI-supported pedagogical approaches increase children's interest in science, promoting the development of scientific thinking skills by presenting a structure tailored to each child's individual needs. Grounded in pedagogical principles, these approaches encourage children to take an active role in science education, making the learning process more meaningful (Baker and Alexander, 2018).

From a pedagogical perspective, AI integration into learning processes offers a structure adaptable to each child's learning speed and style. Every child has a unique learning style and pace, and instructional strategies that consider these individual differences are more effective.

AI-based systems analyze children's learning processes, personalizing the learning experience and supporting individualized learning (Uskov, Howlett, and Jain, 2018). This way, each child can progress at their own pace in science topics, enhancing knowledge retention.

AI-supported pedagogical approaches encourage children to be interactive and participatory in the learning process. Through AI-based games, simulations, and educational software, children can explore and understand scientific topics. Interactive learning environments do more than expose children to information; they help children interpret and understand it (Roll and Wylie, 2016). Thus, AI-supported pedagogical approaches contribute to long-lasting retention of scientific knowledge by promoting children's active participation in the learning process.

Teachers play a crucial role in these processes. In AI-supported learning environments, teachers guide children's learning processes, helping them give meaning to knowledge. In a pedagogically strong AI-supported education, teachers direct the learning process according to the children's needs and provide the necessary support (Holstein, McLaren, and Aleven, 2019). It is essential for teachers to have adequate knowledge and training on AI technologies to use these technologies effectively for pedagogical purposes.

In conclusion, pedagogical approaches in AI-supported learning processes provide a structure that supports long-lasting learning in science education. These approaches adapt to children's individual needs, promote active engagement, and benefit from teacher guidance, contributing to the long-lasting understanding of scientific concepts (Luckin et al., 2016). In this context, AI-supported pedagogical approaches hold great potential for enhancing preschool science education and making learning processes more effective.

6. Conclusion and Discussion

AI emerges as an effective tool that enables children to understand scientific concepts more deeply and develop scientific thinking and problem-solving skills. AI-based applications used in preschool promote children's active participation in learning processes, making these processes more meaningful (Holmes et al., 2020). Additionally, personalized and interactive AI-supported learning environments increase children's interest in science, supporting long-lasting knowledge retention.

AI technologies can adapt to children's individual learning needs, enriching the learning process by providing content that aligns with each student's pace, interests, and requirements. As children progress at their own pace, they can enjoy learning while gaining a better understanding of scientific concepts. Research has shown that AI-supported personalized learning environments enhance children's engagement in learning processes and make learning more long-lasting (Chen, 2018). In this context, the adaptability and personalization offered by AI make learning processes more efficient.

However, there are challenges associated with using AI in preschool education. Developing and implementing AI-based tools requires technical knowledge, which necessitates enhancing teachers' competencies. Additionally, ethical concerns, such as data privacy and children's safety, should be addressed when implementing AI. Effective policies and procedures are needed to ensure children's digital security (Luckin et al., 2016). Thus, supporting teacher training and strengthening security measures are crucial for the effective use of AI in education.

Another aspect to discuss is the impact of AI-supported learning tools on children's social interaction skills. While AI-based education supports individualized learning experiences, it should also provide environments that enhance children's social skills. Research indicates that AI can support social skill development; however, more programs promoting collaboration, teamwork, and empathy among children are needed (Holstein et al., 2019). Socially interactive learning environments support both cognitive and affective development, offering a more comprehensive approach to science education.

In conclusion, AI-supported educational technologies can be seen as innovative tools that help preschool children acquire scientific skills, increase their interest in science, and support long-lasting learning experiences. Ethical, safety, and teacher training aspects must be considered for the effective use of AI in education. In the future, with the broader use of AI in education, preschool science education can better support children in understanding scientific concepts and retaining this knowledge in the long term (Zhu and Leung, 2020).

7. Recommendations

To effectively utilize artificial intelligence (AI)-supported educational technologies in preschool science education, certain strategic recommendations must be developed. Firstly, it is essential to create a comprehensive teacher training program on the use of AI in education. Teachers need to develop their knowledge and skills regarding AI-based tools to use them effectively. Therefore, teacher education programs should be enriched with content on the pedagogical use of AI (Holstein et al., 2019). These programs will enable teachers to implement AI in classrooms more effectively and consciously.

Secondly, strong security measures must be taken to protect children's data privacy and security in AI-supported educational applications. Particularly in early childhood, attention should be given to the collection and use of children's data. Educational institutions and AI developers are advised to clearly establish data collection policies and apply security protocols to ensure children's digital safety (Luckin et al., 2016). Additionally, informing parents about this matter will help ensure that children are safe when interacting with AI-supported tools.

Thirdly, it is recommended to increase collaborative applications in AI-supported learning environments to develop children's social skills. While AI is a tool that supports individualized learning, creating environments where children can develop social interaction skills is also important. AI-based games and simulations designed for group activities can support teamwork and cooperation, helping children learn collaboratively (Chen et al., 2019). Such applications will not only support individual learning but also enhance social learning processes for children.

The fourth recommendation involves making AI-supported learning tools suitable for children's age and developmental levels in terms of content and functionality. In preschool, considering children's cognitive development levels is essential when designing AI-based applications. Providing content appropriate to children's ages will make their participation in learning processes more effective and improve their understanding of scientific concepts (Cheng and Tsai, 2013). Thus, it is important for AI developers to adapt educational content according to children's developmental needs.

Finally, it is recommended to establish continuous research and feedback mechanisms to assess and improve the impacts of AI on education. Collecting more data on how AI-supported learning environments affect children's academic and social development can guide the future use of these technologies. Regular evaluation of AI's effectiveness by educational institutions and continuous adjustments based on children's needs are essential (Baker and Smith, 2019). In this context, ongoing research and new strategies should be developed to maximize AI's role in preschool science education.

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Section 3:

Sustainability and Environmental Education

Chapter 12

Nature-based Learning in Early Childhood Education

Gülşah Uluay[1]

"The most beautiful gift of nature is that it gives one pleasure to look around and try to comprehend what we see."

Albert Einstein

Abstract

The nature-based learning approach involves the direct integration of nature into learning processes and the facilitation of firsthand nature experiences. Considering the benefits it provides across a wide range of areas, including social development, cognitive development, emotional development, motor skills, and health, it becomes evident that the integration of this approach into early childhood, a critical period for individual development, is significant. In this context, this study primarily examines the nature-based learning approach from a theoretical framework perspective. At this point, Bronfenbrenner's bioecological theory, experiential learning theory and place-based learning theory, which are noted in the literature as having an impact on the nature-based learning approach, are mentioned. Furthermore, the implementations of nature-based learning during early childhood and the underlying approaches supporting these implementations are examined in general terms. This study aims to highlight the diversity of educational models that provide nature-based learning experiences through nature-integrated learning environments offered by various approaches, including Kindergarten, Montessori, Waldorf, Reggio Emilia, and forest schools.

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1. Introduction

Albert Einstein (2011)'s quote, "The most beautiful gift of nature is that it gives one pleasure to look around and try to comprehend what we see." refers to the feelings of wonder and awe that nature arouses in human beings. Indeed, while observing nature and its processes, individuals are not only influenced by its beauty but also seek to understand its functioning. This quest for meaning encourages individuals to observe and explore. Children, often described as little scientists (e.g., MacDonald, Huser, Sikder & Danaia, 2020; Cremin, Glauert, Craft, Compton, & Stylianidou, 2018; Stylianidou, Glauert, Rossis, Compton, Cremin, Craft & Havu-Nuutinen, 2018), possess a natural inclination to discover their environments (Temiz & Semiz, 2019). It can be stated that children's curious approaches to their surroundings effectively contribute to this natural tendency. Indeed, little scientists who seek to understand their environment and the world around them conduct inquiries by asking questions and learning. From this perspective, it can be stated that one of the environments in which effective learning occurs for children is nature itself. A review of the relevant literature indicates that the outcomes of nature-based learning experiences are emphasized regarding their benefits. In this context, nature-based experiences have been linked to various positive outcomes, including reduced attention deficits (Faber Taylor & Kuo, 2009; Faber Taylor, Kuo & Sullivan, 2001; Kuo & Faber Taylor, 2004; Mårtensson, Boldemann, Söderström, Blennow, Englund & Grahn, 2009; Taylor, Kuo & Sullivan, 2001; Ulset, Vitaro, Brendgen, Bekkhus & Borge, 2017); cognitive development (Coates & Pimlott-Wilson, 2019); creativity (Wojciehowski & Ernst, 2018); physical health (Chawla, 2015; Dennis Jr, Wells & Bishop, 2014; Gill, 2014; McCurdy, Winterbottom, Mehta & Roberts, 2010); physical skills (Fjortoft, 2001; Li et al., 2019; O'Brien & Murray, 2007); social development (Coates & Pimlott-Wilson, 2019; Li, Larsen, Yang, Wang, Zhai & Sullivan, 2019; O'Brien & Murray, 2007); learning (Ballantyne & Uzzell, 1994; Dennis Jr, Wells & Bishop, 2014; O'Brien & Murray, 2007); mental health (McCurdy, Winterbottom, Mehta & Roberts, 2010); behavior (Dennis Jr, Wells & Bishop, 2014); self-discipline (Faber Taylor, Kuo & Sullivan, 2002); self-confidence (O'Brien & Murray, 2007); positive attitudes toward the environment (Ballantyne & Uzzell, 1994; Collado, Rosa & Corraliza, 2020; Gill, 2014); nature connection (Barrable & Booth, 2020); willingness to protect nature (Dopko, Capaldi & Zelenski, 2019); and emotional well-being (Chawla, 2015; Dennis Jr, Wells & Bishop, 2014; Li et al., 2019). Considering these findings, it can be expressed that nature-based experiences and learning processes support not only the cognitive development of children but also contribute to their emotional and social development. Progress in these areas is significant for children's future academic and social lives. Additionally, the gains achieved in the emotional domain can enhance life skills. Furthermore, the positive impact of nature interaction on reducing attention deficits inevitably contributes to the effectiveness of learning environments. In this context, it can be stated that nature-based learning represents an important model that contributes to children's holistic development. Establishing a connection with nature through nature-based learning experiences and developing positive attitudes towards nature, along with a growing desire to protect it, is particularly important. Indeed, individuals' perspectives on nature continue to cause harm to the environment today (Yusup, Istiqamah & Khairunnisa, 2021). For example, viewing nature as an inexhaustible resource (Frank, 1997) and activities such as urbanization, industrialization, and mining (Ukaogo, Ewuzie & Onwuka, 2020) are among the reasons for environmental degradation. Unfortunately, the damage inflicted on nature has led to an increase in ecological and environmental problems (Ye & Shih, 2020). In this context, increasing children's awareness of the environment can lay the groundwork for them to become individuals who exhibit environmentally conscious and responsible behaviors in the future. Indeed, Iozzi (1989) emphasizes that the development of attitudes and values toward the environment should begin during early childhood.

2. Theoretical Framework of Nature-based Learning

The nature-based learning approach encompasses the integration of natural elements, such as plants, animals, and water, into educational environments, facilitating the acquisition of knowledge and various attitudes, skills, values, and behaviors relevant to areas such as personal development, academic achievement and environmental responsibility (Jordan & Chawla, 2022). Although there has been a rapidly increasing interest in implementing education in nature, the notion of conducting education in natural settings has its roots in the philosophical approaches of Aristotle and Plato (Stonehouse, Allison & Carr, 2011; Yıldırım & Akamca, 2017). At this point, it is deemed important to address the theories influencing learning through nature experiences. Indeed, learning experiences in nature or outdoors are influenced by Bronfenbrenner's bioecological theory (Pope, Egan & Hilliard, 2021), experiential learning theory (Williams & Wainwright, 2016), and place-based learning theory (Rymanowicz, Hetherington & Larm, 2020).

Bronfenbrenner's bioecological theory emerged from the transformation of Bronfenbrenner's ecological systems theory across three stages over time

(Rosa & Tudge, 2013). This theory is one of the most well-known theoretical frameworks regarding human development in social sciences (Vélez-Agosto, Soto-Crespo, Vizcarrondo-Oppenheimer, Vega-Molina & García Coll, 2017). Bronfenbrenner and Morris (2006) state that the bioecological model composes of four defining properties termed as *process*, *person*, *context*, and *time*, as well as the dynamic interactions between these properties. They indicate that the *process*, which forms the core of the model, encompasses specific forms of interaction occurring between the organism and the environment. The ability of these proximal processes to influence human development varies depending on the other three defining properties. The second defining property, *person*, emphasizes the active role of individuals in influencing their developmental processes, particularly focusing on biological impacts (El Zaatari & Maalouf, 2022). Here, three types of person characteristics are identified that have the most significant impact on the progression of future development, indicating their potential to affect the direction and strength of proximal processes throughout life (Bronfenbrenner & Morris, 2006). These characteristics are described by Bronfenbrenner and Morris (2006) as follows: (1) dispositions can initiate proximal processes in a specific area of development and sustain their operation; (2) effective functioning requires bioecological resources related to experience, skills, abilities, and knowledge; (3) demand characteristics invite or hinder social environmental responses that can promote or disrupt this operation. The third defining property, *context*, refers to the multiple environments that modify proximal processes, including social, physical, and economic settings in which individuals are continuously interacting (Krishnan, 2010). The *time* property focuses on the large-scale changes created over time by developmental processes and outcomes in society, and the impact of these emerging changes on the future of society (Bronfenbrenner & Morris, 2006). When linking bioecological theory with children's learning processes through nature experiences, it is evident that this theory posits that children's development continues through various contexts and environments with which they interact continuously, associating these contexts with their biological predispositions (Krishnan, 2010).

Kolb (1984) associates the designation of experiential learning theory with two reasons. The first is the explicit connection to the intellectual roots found in the works of Piaget, Dewey, and Lewin. The second reason pertains to the central role of experience in learning processes. In this regard, experiential learning theory is presented as a holistic integrative perspective that combines the elements of experience, behavior, cognition, and perception related to learning. In other words, this theory emphasizes that experiential learning occurs through real experiences, facilitating effective learning beyond the information presented in classroom settings or textbooks (Chan, 2012). In this context, experiential learning theory asserts that effective learning processes require four abilities: concrete experience, reflective observation, abstract conceptualization, and active experimentation (Kolb, 1984). Concrete experience ability refers to students' full, open, and unbiased participation in new experiences; reflective observation ability enables the reflection and observation of experiences from various perspectives; abstract conceptualization ability facilitates the creation of concepts by logically integrating observations into sound theories; and active experimentation ability highlights the application of these theories in decision-making and problem-solving processes (Kolb, 1984). Within this framework of the four identified abilities, experiential learning theory presents a four-stage learning cycle (Kolb, 2014). This theory serves as an important foundation for nature-based experiences as it emphasizes real-life experiences. Indeed, when outdoor environments such as botanical gardens and nature reserves are integrated into the learning processes, they provide valuable opportunities (Dunkley, 2016).

Sobel (2004) emphasizes the necessity for students to integrate with their communities and local resources within the framework of place-based learning theory, asserting that this will support the learning process with concrete and real experiences while highlighting the need for experience. Place-based learning theory aims to create a learning process in which students are directly engaged with their environments and collaborate with their communities. At this point, it promotes participation in local projects such as designing school garden layouts, recycling and composting programs, and water quality testing, thereby facilitating opportunities for students to explore nature and generate solutions to local problems. In this context, place-based learning theory, which focuses on the values, resources, and problems of the local community, aims to enhance socialization and academic success alongside improving the environmental quality of the community through the development of various collaborations between schools and the community (Powers, 2014).

3. Nature-based Early Childhood Education

Educational institutions with curricula focused on nature experiences are referred to by various names such as nature-based preschools, nature kindergartens, forest kindergartens, outdoor preschools, and Waldkindergartens; however, the common feature of all these programs is that their educational philosophies and methods are shaped through nature

(Cordiano et al., 2019). Finch and Bailie (2015) note that there is no single correct framework for defining the key characteristics of preschool institutions centered around outdoor habitats, and they explain these institutions' distinguishing features through three main criteria. These criteria are as follows (Finch & Bailie, 2015):

1. Nature themes and daily nature explorations form the core of the programs in nature kindergartens. In this regard, researchers state that nature is not merely a topic within various subjects or activity centers; rather, they describe nature as a binding element that intentionally integrates the philosophy, methodologies, classroom designs, outdoor spaces, and public identity of these schools.
2. The entire curriculum of nature kindergartens must be equally committed to developmentally appropriate high standards of early childhood education and best practices in environmental education. This situation necessitates that teachers working in nature kindergartens are experts in both areas. Thus, the teaching staff in these institutions is expected to be dual experts with skills and experience in both early childhood education and environmental education.
3. Nature kindergartens support a dual objective for children, focusing on meeting child development goals and instilling conservation values.

Although the educational institutions providing nature-based learning experiences in early childhood vary in their philosophies, each aims to establish intense interactions with nature and, in line with this goal, ensures that children are exposed to nature by participating in outdoor activities for varying durations (Sobel, 2014). At this point, as previously mentioned, the expectation for teachers to be dual-field expert is significant, as well as the roles they assume in organizing outdoor activities for children. The behaviors and attitudes of teachers during the activity process have a considerable impact on achieving the goals and outcomes of the activities. Indeed, Jacobi-Wessels (2013) states that teacher participation in outdoor activities supports learning and that a teacher's positive attitude and curious behaviors serve as an encouraging force in guiding children to explore.

The teacher's interaction with the children and their supervision during the process is also significant from a safety perspective. This is because nature-based learning activities in early childhood raise the issue of risk. Indeed, modern societies are risk-averse, and many children are protected from situations involving risk that were experienced by previous generations (Harper & Obee, 2021). In this context, it is suggested that the teacher takes on a role that facilitates the process rather than simply ensuring safety (McClintic & Petty, 2015). For example, the teacher is expected to take necessary precautions by being knowledgeable about local vegetation and animals, as well as identifying needs arising from seasonal changes (such as clothing choices or sunscreen) and addressing them appropriately (Jacobi-Wessels, 2013).

Due to the diversity of nature-based educational institutions mentioned in this section, the following section introduces various approaches and examples of schools that incorporate the philosophy of nature experiences into their programs during early childhood.

4. Development of Nature-based Early Childhood Education

The nature-based education initiative that emerged in Scandinavia and Germany is widely implemented in the United Kingdom and Wales and has recently begun to gain increasing interest in the United States (Cordiano, Lee, Wilt, Elszasz, Damour, & Russ, 2019). However, the idea of organizing or supporting learning environments through nature in early childhood education is not a new strategy. Pestalozzi, Froebel, Montessori, and Dewey expressed that children's learning and development are significantly supported through direct interactions with nature and natural materials, as well as high-quality early childhood programs (Davis, 1998).

Friedrich Froebel, known for establishing the first kindergarten in Germany in 1837, believed that nature-based experiences led by children form the foundation of early childhood education and continues to influence the curriculum content of many countries today (Ashmann, 2018). As the founder of the kindergarten, Froebel (1903) advocated for the necessity of children experiencing nature in gardens, forests, or around their homes, proposing activities such as garden care (e.g., growing plants from seeds, tending to fruits and crops), caring for animals like pigeons, chickens, and ducks, and collecting natural objects.

The first Montessori school, Casa dei Bambini, opened in Rome in 1907 (Whitescarver & Cossentino, 2008). The Montessori method, developed by Maria Montessori, involves a stimulating and collaborative learning environment where the child can freely explore their imagination and the teacher assumes a guiding role, encompassing a holistic approach that includes emotional, ethical, and spiritual development, rather than focusing solely on academic achievement (Duckworth, 2006). In Montessori classrooms, children aged 3-6 are encouraged to choose their own activities, which supports the individualization of the learning process by providing comprehensive tools and self-directed learning materials (Miezitis, 1971). In this context, the emphasis of the Montessori method on fostering children's independence and freedom to act is particularly notable (Montessori, 1912). Montessori (2013) states that children are natural observers of the environment, leading to various activities such as plant cultivation and animal care within her school (Montessori, 2013). Today, a wide range of nature activities continues to be conducted in Montessori schools.

In 1919, the first Waldorf school, Freie Waldorfschule Uhlandshöhe, was opened in Germany by Emil Molt, with Rudolf Steiner serving as the pedagogical leader (Paull & Hennig, 2020). In Waldorf schools, which are based on the philosophy of Anthroposophy, art is a central element of education, and the approach is built on experiential learning through arts such as painting, music, and movement, with Eurythmy, a form of artistic expression that visualizes music through bodily movements, being particularly noteworthy (Uhrmacher, 1995). According to the Waldorf approach, teaching environments are not limited to enclosed spaces; learning processes are also supported through open areas, as Steiner's theoretical framework posits that children should be viewed as part of nature, allowing them to explore themselves through activities that promote interaction with the natural environment (Demirci & Arslan, 2019).

Following the end of World War II in 1945, the first Reggio Emilia school was established in the Reggio Emilia region of Italy under the leadership of Loris Malaguzzi (Smith, 2014). This school was built by parents using funds raised from the sale of a tank, several trucks, and a horse, with Loris Malaguzzi guiding parents and educators from that inception (Gandini, 1993). The Reggio Emilia approach fosters an interaction based on the exchange of ideas between parents and teachers within a community context that offers a rich culture (Gilman, 2007). Malaguzzi (1993) stated that they aimed to create a school that provides an environment for learning, reflection, and reassessment. In structuring the school organization, they designed a system that brings together the child, parent, and teacher as three main subjects, strengthening interactions among these subjects. Furthermore, the Reggio Emilia program includes various activities aimed at enhancing children's interactions with nature, ensuring exposure to the natural environment (Omidvar, Wright, Beazley & Seguin, 2019; Osgood & Odegard, 2022).

Established in Scandinavia during the 1950s, forest schools (Murray & O'Brien, 2005) involve educational outdoor experiences conducted in forested areas or open environments with trees (Tiplady & Menter, 2021).

Dean (2019) notes that studying the global history of forest schools is a complex topic, as these schools have evolved into new versions influenced by the cultures of the countries in which they were established. Researchers have indicated that the forest school approach developed in Scandinavian countries has spread to countries like the United Kingdom and the United States. Additionally, Knight (2018) mentions that countries such as Canada, South Korea, China, Australia, and New Zealand have adapted the forest school approach according to their geographical and cultural structures. Furthermore, the Waldkindergarten, first established by Ursula Suben in Germany in 1968, has continued to be developed and sustained by Petra Jäger and Kerstin Jebsen in Flensburg during the 1990s, expanding upon Suben's ideas (Ordon, 2019). This adaptation of the forest school approach in different countries can be seen as an indicator of these institutions' educational significance worldwide. In this context, the global proliferation of forest schools indicates that this approach, which integrates children's educational processes with nature, occupies a prominent place among contemporary educational approaches. The Forest School Association (FSA), established in the United Kingdom, defines forest schools as follows (FSA, 2024):

Forest School is a child-centred inspirational learning process, that offers opportunities for holistic growth through regular sessions. It is a long-term program that supports play, exploration and supported risk taking. It develops confidence and self-esteem through learner inspired, hands-on experiences in a natural setting.

Additionally, The Natural Start Alliance, a project of the North American Association for Environmental Education (NAAEE), states that nature preschools can have both outdoor and indoor facilities, and that these schools can conduct all their instructional processes in outdoor environments, categorizing them as forest preschools, forest kindergartens, or outdoor preschools (NAAEE, 2020). In this context, The Natural Start Alliance defines forest preschools through the concept of nature preschools as follows (NAAEE, 2017):

Nature preschools as schools that use nature as the organizing principle for their programs… A nature preschool program uses the natural world to support goals that address both child development (in all domains, including cognitive, physical, social, emotional, aesthetic, and spiritual) and the development of an ecological identity or environmental ethic. Nature preschools often allow the children's interests and curiosity to guide the day's activities and inform the curriculum. A significant portion of the school day in nature preschools is spent outside. Forest kindergartens are a type of nature preschool that takes place entirely outdoors.

Nature-based learning approaches organize learning environments by integrating nature into the development processes of children. These approaches, which have spread to many countries worldwide through various practical examples, encourage children to interact with their natural environments. The approaches and views of educators such as Froebel, Montessori, Steiner, and Malaguzzi emphasize the important role of nature in learning processes. Indeed, the diversity of benefits provided by nature-based learning experiences is striking. For instance, a two-phase evaluation project conducted by O'Brien and Murray (2007) between 2002 and 2005 examined the effects of forest schools on children in Wales and England. This research scrutinized the changes in 24 children over an eight-month period. According to the findings, the forest school had positive effects on six themes: confidence, social skills, communication and language, motivation and concentration, physical skills, and knowledge and understanding. From this perspective, the contributions of nature-based learning experiences to cognitive, social, and emotional development, as well as the development of connections to nature and positive attitudes toward the environment, can be regarded as critical learning process outcomes. Indeed, these outcomes can be seen as indicators that the nature-based learning approach is a model contributing to a sustainable future.

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Chapter 13

Mental Models of Aquatic and Terrestrial Ecosystems in Preschool Children[1]

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Abstract

The main purpose of this study is to identify preschool children's awareness of aquatic and terrestrial ecosystems, describe the living and non-living components they recognize within these ecosystems, and evaluate the relationships they establish between these components. The sample consists of 60 children aged 60-72 months attending a public preschool in Van, Turkey, during the 2021-2022 academic year. The study group was formed using a convenience sampling method. The children's drawings related to aquatic and terrestrial ecosystems, created on blank A4 paper, were analyzed using the *Draw An Environment Test-Rubric* (DAET-R, DAME-R) adapted from an Environmental Drawing Test Rubric. Descriptive analysis was conducted to categorize the drawings into themes. Findings revealed that the most frequently depicted elements in aquatic ecosystem drawings were human figures (f=35), octopus (f=47), seaweed (f=27), shark (f=16), sun (f=37), and clouds (f=15), while in terrestrial ecosystem drawings, the most common elements were trees (f=40), grass (f=37), flowers (f=23), and butterflies (f=14). The analysis of both aquatic and terrestrial ecosystem drawings showed that although children included both biotic and abiotic components, they struggled to establish interconnections between components from two or more groups within an ecological system.

1 This book chapter is based on the first author's master's thesis completed under the supervision of the second author.

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1. Introduction

It would be beneficial for the continuity of the ecosystem if children were encouraged to become individuals who know and love nature and living things, and thus try to protect the natural balance. Many scientists believe the growing disconnect between modern society and the natural world presents a significant challenge to achieving sustainability (Muhr, 2020). In this context, one of the reasons why children may have incomplete and inadequate knowledge about the environment, environmental diversity, ecosystems and their elements could be interpreted as a potentially weak or broken connection between nature and society (Snaddon et al., 2008). It is often said that childhood learning forms the foundation for our future lives. With this in mind, it seems valuable to approach these formative years with greater awareness and engagement. It would be constructive for children to have the opportunity to appreciate the full richness of nature rather than seeing it only as a picnic area. It would also be beneficial for children to understand the interactions between natural assets and to be informed about plant and animal species so that they can recognise endangered species in the future (Göka, 1993). While awareness alone does not necessarily guarantee conservation, a lack of awareness will likely make it more challenging to protect endangered environments and species (Balmford et al., 2002). It would be beneficial for the continued stability of our natural environment if we could find ways to address the various environmental issues we face. It is becoming increasingly clear that the right interventions can significantly impact our planet. It would be beneficial to create tiny sparks of awareness in children, which could potentially contribute to them becoming individuals equipped with the skills to find solutions to problems when they become adults in the future (Melis et al., 2020). Furthermore, an examination of how children's understanding of natural areas and the environment is shaped may potentially provide insights that could inform more effective teaching in this field (Bonnett 2007). Some of the studies conducted for this purpose provide information about children's perceptions of nature and the environment and the factors that can shape these perceptions (Wals 1994, Bonnett & Williams 1998, Payne 1998, Kahn 1999, Ahi, 2016; Ahi & Alisinanoğlu, 2016; Köşker, 2019).

It is reasonable to conclude that preschool children's comprehension of ecology is constrained and/or erroneous. The field of ecology, which encompasses the notion of an ecosystem, is replete with many intricate and multifaceted concepts, and numerous challenges are inherent to its pedagogical and didactic processes (Özkan, Tekkaya, & Geban, 2004). Earth boasts a vast array of habitats and a plethora of species that have adapted to these conditions. The intricate relationships between organisms and their environment are complex and challenging to comprehend. To grasp the underlying order within this diversity, the concept of an ecosystem has been developed with a system understanding (Warren, 2007). An ecosystem is comprised of two primary categories of elements: living (biotic) and non-living (abiotic). The biotic elements can be further classified as producers and consumers. The abiotic elements encompass a range of substances, including organic and inorganic materials, as well as the cycles and climate that shape their interactions (Odum, 1999).

Biriukova (2005) argues that teaching in the field of ecology in early childhood can be enriched enhanced through the integration of sensory activities, educational games, and an array of visual aids, including images, posters, videos, and other multimedia resources. The use of pictures, drawings and visuals, which we use to teach concepts in the beginning, to evaluate children's knowledge and attitudes at the end of the process is considered appropriate for the age group we are working with. When researches on early childhood environment are examined, it is seen that expressing the conceptual frameworks of the subject area by drawing pictures for children is both more useful and more instructive (Barraza, 1999; Moseley, et al. 2010; Halmatov et al., 2012; Özsoy, 2012; Ahi, 2016). The data collection method using children's drawings is frequently preferred in research due to its positive and applicable aspects. As it encompasses non-verbal elements such as painting, drama, and music, these art-based research methods allow participants to express their cognitive and affective connections with nature (Flowers et al., 2015; Muhr, 2020).

This study aimed to ascertain the awareness of biotic and abiotic elements in aquatic and terrestrial ecosystems among children between the ages of 60 and 72 months. To this end, the drawings produced by the children and their accompanying verbal explanations were subjected to analysis. This analysis aimed to ascertain the concept of elements in ecosystems, the diversity of elements (e.g., biotic, abiotic, human-made, etc.), and their thoughts about the relationships between elements.

In this context, the current research is expected to provide insights that will assist researchers and educators in shaping the educational processes of young children. Specifically, it will offer insights into preschool children's understanding of biotic and abiotic elements in ecosystems and the relationships among them.

2. Method

2.1. Research Design

The research model of the study is phenomenological design. This research method is used to examine in depth how participants make sense of, feel and experience a particular experience or phenomenon. In this design, researchers focus on the experiences of participants through direct observation or interviews and try to understand these experiences from their subjective perspectives. Phenomenological design aims to reveal how "reality" is seen through the eyes of individuals by focusing on their life experiences, perceptions and meanings shaped by these perceptions (Larsson & Holmström, 2007).

2.3. Working Group

In the formation of the study group, the convenience sampling method was selected from the non-random sampling methods. Accordingly, the study group consisted of 60 children aged 60-72 months attending a state kindergarten in the central İpekyolu district of Van province. Approximately 75% of the families of the participant children had undergraduate or graduate degrees.

2.2. Data Collection and Analysis

The children in the study group were given blank sheets of paper consisting of a single page and were asked to draw 'a sea' to represent the aquatic ecosystem and 'a forest' to represent the terrestrial ecosystem, taking into account their cognitive levels. Explanations were given to the children for both drawings to encourage them to think and to help them elaborate their drawings.

"'You have started a journey in the sea...What do you think exists in the sea? Can you draw the living and non-living beings you encounter on this journey and how they are affected by each other and how they feed?

"You have started a walk in the forest...What do you think is in the forest? Can you draw the living and non-living things you encounter during this walk and how they are affected by each other and how they feed?

The drawings completed by the children were interviewed one-on-one with the children within the scope of the draw-and-tell technique, focusing on the human, biotic and abiotic beings and human-constructed elements in their drawings and their expressions of the relationships between these elements. To be sure of the results, the coding of the drawings was created together with the students. Children were asked to describe their drawings with sentences such as 'My Environmental Drawing....'. After the drawings, each student was interviewed for about 10 minutes to explain their drawings and coding was done based on the figures they drew.

Terrestrial ecosystem drawings were evaluated with the DAET-R (Draw-An-Enviroment Test) 'Draw an Environment Test' rubric adapted by Moseley et al. (2010), and aquatic ecosystem drawings were evaluated with the DAME-R (Draw-An-Marine-Enviroment Test) 'Draw a Sea' rubric adapted by Atasoy et al. Although the evaluation rubric prepared by Moseley et al. (2010) was designed to reveal the existing mental states, personal beliefs and attitudes towards the environment of pre-service teachers, it was deemed appropriate to be used for preschool age group in various studies (Ahi and Balcı 2017; Ahi and Atasoy 2019). It consists of 4 factors: biotic elements, abiotic elements, human elements and human constructions (artificial environments) in children's drawings. Children who drew elements that could be classified under these factors were evaluated as 1 point, drawings that could show the relationship between the drawn elements were evaluated as 2 points, and drawings that showed these relationships with various symbols and expressed a system understanding were evaluated as 3 points. In the rubric, four factors are scored on this 3-point system. The rubric was designed over 12 full points. In order to ensure reliability, scoring was also done by a scorer other than the researcher. Expert opinion was taken on the differences in scoring and a common point was agreed upon.

3. Findings

The results of the analysis of the data obtained from children's drawings and narratives about their drawings are presented in two sections: aquatic and terrestrial ecosystems.

3.1. Findings Related to Children's Aquatic Ecosystem Drawings

The elements in children's drawings of aquatic ecosystems were analyzed and 79 codes were obtained. Table 1 shows the frequency of depiction of figures in their drawings under the categories of Human, Living Elements, Nonliving Elements, Designed Environment, Imaginary Elements and Other Elements that cannot be classified.

It is noteworthy that the elements in the students' drawings are detailed and numerous. While the most frequently used codes in the human category ($f=28$) were mostly depicted as swimming people, children themselves and their mothers, *the* most frequently repeated items in the living creature category were octopus (*f=47*), algae (*f=27*), and shark (*f=16*). The shapes that children drew most frequently to symbolize abiotic beings were sun (*f=37*) and cloud (*f=15*). In terms of code diversity, the biotic element (living thing) category stands out with 27 different codes. Especially the figures of animals living in the sea were more common. It was determined that students did not include marine mammals in their drawings.

Table 1. Codes in Aquatic Ecosystem Drawings and Frequency of Repetition

Category/Codes	f	%	Codes	f	%	Codes	F	%
Human	28	46,6	Live Elements	58	96,6	Abiotic Elements	42	70
A floating one	9		Octopus	47		Sun	37	
Himself	7		Moss	20		Cloud	15	
Anne	5		Fish	35		Rainbow	6	
Father	4		Shark	16		Stone	5	
Good person	3		Baby fish	5		Wave	4	
Ship passenger	2		Anchovy	3		Kaya	3	
Diver	2		Dolphin fish	4		Sky	3	
Big brother	2		Shoal of fish	2		Beach	3	
Brother	2		Eel	2		Sand	3	
Drowning human	1		Piranha	1		Ada	1	
Family	1		Hammerfish	1		Moon	1	
Bewildered human	1		Invisiblefish.	1		Soil	1	
Imaginary Elements	2	3,3	Clowningfish	1		Volcano	1	
Mermaid	3		Bird	4		Extinct Volcano	1	
Imaginary Characters	2		Scorpion	1		Rain	1	
			Crab	1		Lightning	1	
			Snail	1		Star	1	
Other Elements	25	41,6	Frog	1				
			Crocodile	1		Artificial Environment	20	33,3
			Seagull	1		Ship	6	
			Seahorse	1		Submarine	5	
			Tree	1		Crate	5	
			Grass	1		Kayak	1	
			Flower	1		Tank	1	
						Home	1	
						Watchtower	1	
						Undersea Camera	1	
						Aquarium	1	

After the coding of children's drawings of aquatic ecosystems, the relationships between the figures in the drawings were scored with the DAME-R rubric and these data are presented in Table 2.

Table 2. Scoring of Children's Drawings of Aquatic Ecosystems

	0 Points		1 point		2 Points		3 Points	
	N	%	N	%	N	%	N	%
Biotic element	4	6,6	9	15	41	68,3	6	10
Abiotic element	11	18,3	38	63,3	8	13,3	3	5
Human	34	56,6	2	3,3	23	38,3	1	1,6
Artificial Env.	45	75	5	8,3	7	11,6	3	5

It is seen that children focus more on biotic and abiotic elements in their drawings and less on elements such as human beings and human structure.

Biotic Element: 68.3% of the children scored 2 points for living things, indicating that they perceived living things as a part of the aquatic ecosystem. It is understood that they mostly made drawings with moderate level of detail.

Abiotic Element: 63.3% of the children scored 1 point for abiotic elements. This shows that children were able to identify non-living elements in the aquatic ecosystem in limited number and detail, but they were able to recognize them clearly.

Human and Human Structure: Human and human structure elements are rare in children's drawings (56.6% and 75% scored 0, respectively). This shows that children tend to perceive the aquatic ecosystem as a more natural area and do not consider the human factor as a part of the ecosystem.

Table 3. Children's Total Score Obtained from DAME-R with Aquatic Ecosystem Drawings

Total Score	N	%
0-4 points	36	60
5-8 points	24	40
9-12 points	0	0
Total	60	100

When the data obtained are analyzed, it can be stated that 60% of the children's drawings included the elements one by one. This shows that children have a basic perception of the aquatic ecosystem, but this perception is not detailed. The 40% in the 5-8 point range shows that they were able to identify more elements. However, the fact that there were no participants in the 9-12 score range indicates that children have difficulty in comprehending the aquatic ecosystem in detail.

3.1.1.Children's Aquatic Ecosystem Drawing Examples

In this section, examples of drawings of aquatic ecosystems are given and information about the scoring system and students' perspectives are presented.

Figure 1. DAME-R total score=2 (drawing without relationship between categories)

Chid:47: "*There is a huge starfish in the sea, it feeds on things that fall into the sea.*" The student only pictured an item belonging to the category of living things and could not express it clearly enough.

Figure 2. DAME-R total score= 5 (drawing with relationship between categories)

Child:59: "*There are living things in the sea, and living things feed by eating each other. The shark eats the octopus, the octopus eats the fish, the fish eat the shrimp, and the shrimp eat the vitamins in the sea sand*." Although the student expressed the food chain by establishing more than one living creature-living binary relations in this picture, he could not clearly express his understanding of the system because he could not establish the third connection.

Figure 3. DAME-R total score= 7 (drawing with relationship between categories)

Child:36: "*There is a magic volcano, but it is extinct, this volcano gives oxygen to the sea, so it feeds both the fish and the sea. I watched it in a documentary*." The student made only one three-connected relationship, that is, the volcano, which is an abiotic element, affects both the fish, which is a living being, and the sea, which is an abiotic entity; but since the picture did not include any human figure or designed environmental element, it remained at the limit score in the rubric scoring.

Figure 4. DAME-R total score= 8 (drawing with relationship between categories)

Q:36: "*I drew a sea, people threw away the food left on their plates. The fish were fed with what people threw away, but the bad waste damaged the octopuses and killed them, only one of them is alive. Also, the cruise ship coming to the sea always causes pollution*." This is a sample of drawings with all code groups. Since it did not include a drawing of a human element, it was not included in the 9-12 point category.

Table 4. Children's Mental Themes towards Aquatic Ecosystem

Categories	Frequency (f)	Percentage (%)
Natural area where people and living things benefit together	27	45
Where sea creatures live	25	41,9
Natural area where flying animals benefit	2	3,3
Natural space for people to enjoy	2	3,3
Place of war	2	3,3
Unrelated image	1	1,6
The area where human and human-made elements are present	1	1,6
Total	60	100

When the children's narratives about their drawings were thematically classified, their understanding of the aquatic ecosystem was tried to be described in Table 4. It was observed that students who included cartoon characters in their drawings were in the unrelated drawing category. In some drawings, it was determined that the students established relationships between the elements; however, it was noteworthy that the relationships they established were incorrect. For example; expressing that the creatures in the sea are fed with the bait thrown by humans or that a "magical extinct volcano" gives oxygen to the sea, thus feeding both the fish and the sea. It is seen that children have alternative theories about nutritional relationships and the function of abiotic elements in the ecosystem.

3.2. Findings Related to Children's Terrestrial Ecosystem Drawings

Table 5 shows 78 different codes obtained from children's terrestrial ecosystem drawings. The most frequently used codes are human figure (*f=25*), tree (*f=40*), grass (*f=37*), flower (*f=23*), butterfly (*f=14*) and sun (*f=42*) from the category of living things.

The table shows how many children depicted the figures in their drawings under the categories of Human, Living Elements, Nonliving Elements, Designed Environment, Imaginary Elements and Other Elements that cannot be classified.

In terms of code diversity, the biotic element category stands out with 35 different codes. It was determined that all children in the study group included a living element in their drawings. The fact that forests are more accessible and observable for children increased the accuracy of the relationships established.

Table 5. Terrestrial Ecosystem Codes Codes and Frequency of Repetition

Codes	f	%	Codes	f	%	Codes	f	%
Human	25	41,6	Kaplan	3		Artificial Environment	10	16,6
Himself	8		Bee	3		Cycling	3	
Child	8		Sapling	3		Home	2	
Father	3		Snake	2		Road	1	
Brother	2		Hedgehog	1		Water machine	1	
Anne	2		Mole	1		Water fountain	1	
Picnicking Human	1		Kangaroo	1		Fence	1	
Friend	1		Panda	1		Tent	1	
Biotic Elements	60	100	Dog	1		Imaginary Elements	4	6,6
Tree	40		Cow	1		Cartoon character	1	
Sycamore tree	4		Sheep	1		Bad guy	1	
Apple tree	7		Fly	1		Talking tree	1	
Apricot tree	1		Insect	1		Magician tree	1	
Cherry tree	1		Poppy flower	1		Flying tree	1	
Poplar tree	1		Squirrel	1		Other Elements	6	10
Pine tree	1		Abiotic Elements	48	80			
Grass	37		Sun	42				
Flower	23		Sky	23				
Butterfly	14		Cloud	17				
Cat	9		Soil	16				
Giraffe	8		Rainbow	5				
Bird	7		Tree hollow	3				
Rabbit	7		Fruit	3				
Bear	6		Rain	2				
Turtle	6		Moon	2				
Seed	5		Stone	1				
Spider	4		Star	1				
Ant	4		Water	1				
Worm	3		River	1				
			Volcano	1				

After the coding of children's drawings of terrestrial ecosystems, the relationships between the figures in the drawings were scored with DAET-R and these data are presented in Table 6.

Table 6. Scoring of Children's Terrestrial Ecosystem Drawings

	0 Points		1 Point		2 Points		3 Points	
	n	%	n	%	n	%	n	%
Bioticelement	1	1,6	20	33,3	31	51,6	8	13,3
Abiotic element	2	3,2	48	80	9	15	1	1,6
Human	53	88,3	2	3,2	31	51,6	4	6,6
Artificial Env.	21	35	6	10	3	5	0	0

When the distribution of points regarding the elements of terrestrial ecosystems in children's drawings is analyzed, it is seen that living and non-living elements are focused on more, while elements such as humans and human structures are drawn less frequently.

Biotic Elements: 51.6% of the children scored 2 points for living things, indicating that they developed a moderate level of awareness in identifying living things in the terrestrial ecosystem. 13.3% of the children scored 3 points and made more detailed drawings, while 33.3% of the children scored 1 point and made more superficial drawings.

Abiotic Element: 80% of the children scored 1 for non-living elements, indicating that most of the children clearly identified non-living elements but did not provide detailed information. This implies that non-living elements are recognized as part of the terrestrial ecosystem, but not elaborated.

Human and Artificial Environment: 88.3% of the drawings did not include human elements (0 points), indicating that children perceive the terrestrial ecosystem more as a natural environment and do not see human elements as part of the ecosystem. Man-made elements were not drawn at all by 35% of the students.

Table.7 Total score obtained by children from DAET-R with terrestrial ecosystem drawings

Total Score	n	%
0-4 points	35	58,3
5-8 points	25	41,7
9-12 points	0	0
Total	60	100

When the total score distribution of children's terrestrial ecosystem drawings is evaluated, 58.3% of the children scored between 0-4 points, while 41.7% scored between 5-8 points. However, there were no participants in the 9-12 point range. This shows that children have a basic awareness of the terrestrial ecosystem, but this perception is not deep and comprehensive. The fact that the children's drawings did not establish a connection between two or more elements within a system understanding reveals that the students in the study group were not aware of the system understanding in the terrestrial environment.

Examples of drawings of terrestrial ecosystems are given below and information about the scoring system and students' perspectives on the drawings is presented.

Figure 5. DAET-R total score= 6 (drawing with relationship between categories)

Child 1: "*Animals are very happy in the forest because people have never polluted it. Also, all animals have food. The giraffe eats tree leaves, the turtle hides in a tree stump, and the bear loves honey.*" In the verbal expression of the picture, the student included every figure except the designed element and made binary connections.

Figure 6. DAET-R total score= 5 (drawing with relationship between categories)

Child 42: "*Animals are fed from the feed prepared by people. Other people come and plant seeds, trees and flowers grow. The growing trees became a home for squirrels*." In the picture, binary connections between human and biotic elements are expressed; however, there is no understanding of a system.

Figure 7. DAET-R total score= 5 (drawing with relationship between categories)

Child 20: "*We went for a walk in the forest and I saw a flock of butterflies there. Butterflies feed on the pollen of flowers.*" The student established a one-way relationship between biotic and abiotic elements in his/her drawing.

Figure 8. DAET-R total score= 3 (drawing without relationship between categories)

Child 15: "*Butterflies are flying in the forest.*" The student depicted biotic and abiotic elements but did not establish any relationship between them.

Figure 9. DAET-R total score= 2 (drawing without relationship between categories)

Child 38: "*Animals are just waiting for people to give them food.*" There are human and animal figures in the drawing, but no relationship is established.

Figure 10. DAET-R total score= 8 (drawing with relationship between categories)

Child 31: "*I go to the forest on my bicycle, the fountain of water from the ground makes the flowers and trees grow. The fences were built to protect the forests from people, so that they don't come here.*" The student included all the elements in his drawing and made more than one binary connection; however, there was no expression of a three-stage system understanding.

Table 8. Children's Mental Themes towards Terrestrial Ecosystem

Categories	f	%
Natural area where animals live	6	10
Natural space for people to enjoy	6	10
Natural area with plant life	1	1,6
An area where plants and animals live together	17	28,3
An area where plants and humans co-exist	7	11,8
The area where humans and animals live together	6	10
An area where humans, animals and plants live together	15	25
Unrelated	2	3,3
Total	60	100

Students' verbal expressions about forest drawings were interpreted according to the factors they included and categorized as shown in the Table 8. The highest value belongs to the idea that forests are the habitat of plants and animals with a rate of 28.3%. In the biotic category, the plant population was elaborated with the diversification of tree species, seeds and flower species. Although there were children who included animal-human and plant drawings in their drawings and made drawings from all elements, it was determined that they could not express an understanding of a system in their verbal expressions and that they usually included the elements one by one. The drawings of two students consisted entirely of imaginary elements and did not include any of the elements in the rubric.

4.Conclusion and Discussion

4.1. Conclusion and Discussions Regarding the Codes Children Included in Their Drawings

The drawings were used to determine children's awareness of the elements in aquatic and terrestrial ecosystems and their ability to identify the relationships between the elements. As a general evaluation of the research, it should be said that the children in the study group were aware of the biotic and abiotic elements in the ecosystem, as well as distinguishing human and human structures or the designed environment among these elements. Apart from this, it is also seen that the children attributed magical or imaginary properties to the elements in all three categories with imaginary elements in their drawings. This is a normal situation for the cognitive level of the age group. Similar to the current study, studies conducted with preschool children have reported that the elements in children's drawings of the environment are distinguished into categories called biotic, abiotic, and anthropic (Carretón Sanchis et al., 2021; Alaçam, 2024). Moreover, the analysis of combinations of different categories revealed that due to the variety of possible combinations of drawn items, almost half of the subjects added many different categories as well as items with a high level of complexity (Carretón Sanchis et al., 202 1) .

In the present study, it was observed that less than half of the children's drawings contained elements of different categories together. However, it should be noted that the relationships between the elements belonging to different categories were reflected in the drawings and children's narratives about their drawings in a very limited way.

Regarding the drawings of aquatic ecosystems, it can be stated that the majority of the children depicted the marine ecosystem in a rich and varied way due to their imagination about the sea, their interest in underwater life and the influence of the cartoons they watched. However, it can be said that children have some alternative conceptions about the marine environment chosen as an aquatic ecosystem. While describing their drawings, the children generally likened the marine life to an aquarium and stated that people feed the fish with food. This may have been due to the fact that the aquarium was an aquatic environment that they could observe more closely and was more familiar to them in daily life.

Students portrayed aquatic environments as natural areas where humans and living things benefit together. The common idea in the drawings was that people usually prefer them for swimming. Braund and Reiss (2006) state that technological tools such as the internet and television enable students to access a wide range of information and may have an impact on students' naming skills. It can be said that some children included biotic and abiotic elements with characteristics other than the reality of the aquatic environment in their drawings under the influence of the cartoons they watched and the computer games they played. Louv (2010) calls the emerging separation between children and nature a 'nature-deficit disorder', in other words, he emphasizes the distance between children and nature. According to Louv (2010), this separation can lead to negative consequences for children, such as underutilization of the senses and difficulties with attention. If we consider this situation together with the development of science process skills, it can be said that spending time in natural environments has a positive effect on the development of these skills.

As a result of the coding of children's drawings of the aquatic ecosystem, it was observed that there were drawings for all categories in the rubric (human, biotic elements, abiotic elements and artificial environment) and the category that children included the most was biotic elements. Almost all of the students depicted a living creature living in the sea in their drawings. Yörek et al. (2009), as a result of their research, it was stated that the situation that most expresses the state of being alive is thought to be the concept of mobility by the students, and therefore, when it comes to living things, relationships are established first with human life, then with animals and then with plants. In the present study, the same situation was also the case, and the students gave very little space to plant drawings and expressed only the existence of mosses. Children have difficulty in classifying plants as living things due to the inability to observe their developmental differences and immobility (Öztürk & Tulum, 2021). Nyberg et al. (2019) argue that children's perceptions of plants are often based on pre-existing experiences with plants in early childhood, rather than an 'inability' or 'plant blindness' to see plants or perceive plants as important. Consistent with this claim, it can be argued that students' mental schemas of plants in aquatic ecosystems are incomplete and that their opportunities to observe plants in aquatic environments are limited.

The most frequently depicted animal elements in the drawings were octopuses and fish. Animals as biotic elements are the group with the most diversity. In the findings of the study conducted by Atasoy et al. (2020) to reveal primary school students' mental models of the marine ecosystem, it was observed that students mostly included biotic elements and there were similarities in terms of code diversity. The diversification of fish species in some pictures (anchovy, shark, hammerfish, etc.) attracted attention. The fact that the students included fish species that they could not observe live and established correct relationships suggests that they may have been influenced by the drawings in storybooks and science magazines.

Of the total number of the study group, 47% were human figures, 70% were abiotic objects, and 33.3% of the children who drew human structure designs. The human elements drawn in the drawings were generally depicted as swimming in the sea or feeding animals. In addition, some children depicted human figures as individuals who help sea creatures by collecting waste. Although it was observed that drawings of the sun and clouds were made as abiotic elements, it was noted that these drawings did not express any relationship in verbal expressions and were included in the drawings as a single factor. Drawings of ships, submarines, tanks, watchtowers and treasure chests, which were made for man-made elements (designed environment), were rarely included, but did not reflect the realism in the ecosystem in children's verbal expressions. Some elements that were not included in the rubric but were included in the children's drawings were categorized into different codes. Children drew cartoon figures that do not exist in reality (nup, stiff, mermaid) or abiotic objects that do not exist spontaneously in nature (ice cream, flag, heart, waste). Since these items did not belong to any category in the rubric, these drawings could not be scored. In the interview phase, they did not make any connection with other elements of the ecosystem in their verbal expressions about these elements. A similar situation was observed in other studies. For a sustainable early childhood program, preschool students were asked to draw pictures showing the human-environment relationship, and evaluations were made based on repeated drawings and interviews with students after the program. It was observed that children conceptualized the environment with fantastic elements out of the ordinary (Cengizoğlu et al., 2020). It was thought that children's use of technology could cause these views.

One of the important findings of the terrestrial ecosystem drawings is that almost all of the students had a lived experience with the forest, which provided richness in terms of drawing diversity and led them to depict it as a place that hosts living things that represent green in general. However, it was observed that they had some alternative concepts about the terrestrial environment. The idea that living creatures in the forest feed only on the water and food left by humans emerged. It is thought that children see the forest as an entity that interferes with other beings from the outside without involving people in forest life. The research conducted by C. Sanchis et al. (2022) also supports this view. In the research conducted to reveal the belonging images of the current students of the kindergarten located in a wetland park area in Spain towards their natural environment, the students were asked to draw a place they liked and their environmental perceptions were analyzed according to various categories. It was observed that children had difficulty in perceiving this natural area, which they visit every day and with which they have close relationships, as a valuable part of their environment and often drew other areas. As a result of their study, Ergazaki and Adriotou (2009) found that young children can accurately express how living creatures in nutrition relationships in the forest ecosystem affect the flow in the forest if the right learning environment is created.

Students depicted terrestrial environments as natural areas where humans and plants benefit together. The common idea in the drawings was that people generally prefer to go to the forest for picnics. It should be stated that the fact that a small number of students were influenced by the cartoons they watched and the computer games they played and reflected this situation in their drawings (talking tree, magician tree, etc.) is an expected situation in terms of the cognitive development level of the age group.

As a result of the examination of children's drawings of terrestrial ecosystems, it was observed that there were figures for all categories in the rubric (human, living thing, non-living thing and human structure) and all of the children depicted a figure representing a living thing living in the forest in their drawings. The most frequently depicted living element in the drawings was coded as a tree. In the concept maps created by Ahi and Balcı (2017) in their study on forest and deforestation with children in the same period, students similarly defined the forest as a place with many trees. There are pictures in which tree species are expressed in detail (sycamore, apple, apricot, etc.). Emphasizing the presence of herbaceous plants, 37% of the children included grass in their pictures. This shows that children think that green is common in terrestrial ecosystems. Various animal figures were also preferred as living elements, with butterflies being the most preferred animal (f=14). The diversity and similarity of the codes obtained from the environmental drawings of preschool students by Günindi (2012) were found to be highly compatible with the results of the study. While figures such as cat, giraffe, bird and bear were included in animal drawings, no child mentioned insects.

This situation showed that although the students included drawings of living things, they could not reflect biodiversity sufficiently. van Heel et al. (2022) reached similar results in terms of living diversity in their study. In order to have information about the daily nature experiences of urbanized children, they had 1532 children draw their favorite areas. In addition to the low number of drawings of natural areas, it was observed that artificial playgrounds that do not reflect biodiversity are generally preferred. Against this risk, it was revealed that areas should be opened where children's daily nature experiences can be increased without the need for adult supervision.

In the study group, the human figure represented 42%, abiotic objects 80%, and children who drew human-made design products 10%. The human elements drawn in the drawings were generally depicted as people planting seeds or playing games in the forest. It is considered important for sustainability that children think of enriching the soil by planting seeds. Although it was observed that (f=42) drawings of the sun and (f=23) drawings of the sky were made as abiotic elements, it was noted that these drawings did not express any relationship in verbal expressions and were included in the drawings as a single factor. Although bicycles, roads, water fountains, fences and tents were rarely included in the drawings of man-made elements (designed environment), they did not reflect children's connections with the ecosystem in their verbal expressions.

4.2 Conclusions and Discussions Regarding the Mental Themes Children Construct in Their Verbal Expressions about Ecosystems

As a result of the scoring of the drawings made by the students for both ecosystems with test rubrics, quantitative data of the research result were obtained and evaluations were made.

As a result of the scoring of children's drawings of aquatic ecosystems with DAME-R and their verbal expressions, the schemas formed in their minds by the drawings were grouped under certain subheadings and interpreted in the context of the relationships established. As a result of the analysis of the drawings, it was observed that the participant children did not draw all the elements (human, living, non-living and designed elements) and even if they drew the elements, sometimes they did not establish any relationship. Considering the rubric total scores of the drawings, the drawings of the children who scored between 0-4 (f=36) were single-factor; in other words, only drawings were made without establishing a relationship with any element. On the other hand, the children who scored between 5-8 points (f=24) established bilateral relationships in their drawings and stated that the factors in nature affect each other. By establishing the most relationship between the human and living factor (f=27), the verbal expression that people in the aquatic ecosystem are important for the nutrition of living creatures living in the sea and that pollution of the sea affects living creatures were frequently used. On the other hand, 40% of the students depicted the sea as an area where only living creatures live. Although very rare, there were also children who described the seas as a place where water needs are met for flying animals, a natural area where only people have fun, and an area where designed elements are used. There were no pictures that scored between 9 and 12, which is the highest evaluation criterion of DAME-R. In other words, although the students established bilateral relationships, they could not express this in a system understanding, and they could not adequately express that the elements belonging to all entity groups in the aquatic ecosystem affect each other.

As a result of the scoring of children's terrestrial ecosystem drawings with DAET-R and verbal expressions of their drawings, the schemas formed in their minds by the drawings were grouped under certain subheadings and interpreted in the context of the established relationships.

As a result of the analysis of the drawings, it was observed that the participant children did not draw all the elements (human, biotic, abiotic and designed elements) and even if they drew the elements, sometimes they did not establish any relationship. Considering the rubric total scores of the drawings, the drawings of the children who scored between 0-4 (f=35) were single-factor; in other words, only drawings were made without establishing a relationship with any element. On the other hand, the children who scored between 5-8 points (f=25) established bilateral relationships in their drawings and stated that the factors in nature affected each other. The most common relationship was established with the association of plant and animal population (living-living) between the living factor with a rate of 28.3%. The verbal expressions that the terrestrial ecosystem is important for the nutrition of the creatures living in the forest and that people go there for picnics were frequently used. Another 25% of the students depicted forests as a living habitat where people, animals and plants live together. Two drawings received 0 points because they did not contain any real elements and relationships. No drawing received a score between 9 and 12, which is the highest evaluation criterion of the rubric. In other words, although the students established bilateral relationships, they could not express this in a system understanding and could not adequately express that the existence of all elements in the terrestrial ecosystem affects each other.

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Chapter 14

Sustainability and Citizen Science in Early Childhood Education in the 21st Century

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Abstract

This study examines the individual and societal impacts of integrating sustainability and citizen science into early childhood education. While sustainability aims to preserve natural resources and promote social equity, citizen science encourages individuals' active participation in scientific processes. Early childhood is a critical period for fostering environmental awareness and introducing scientific methods. In this context, sustainability and citizen science enable children to develop critical thinking, problem-solving, and social responsibility skills. The first section explores the theoretical foundations of sustainability and citizen science, detailing their environmental, economic, and social dimensions. The second section focuses on sustainability approaches applicable in early childhood, such as nature-based learning, recycling education, and technology-enhanced projects. The third section investigates the integration of citizen science into children's learning processes and its contributions to societal awareness, highlighting examples of projects where children acquire skills like data collection and analysis. The fourth section emphasizes the effectiveness of educational methods, including project-based learning, game-based learning, and storytelling, in fostering these concepts. The final section presents recommendations for expanding

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the role of sustainability and citizen science in education. Key suggestions include restructuring curricula, strengthening teacher training, enhancing family involvement, and integrating technology. The study concludes that instilling these concepts at an early age significantly contributes to individual development and societal sustainability.

1. Introduction

1.1. The Changing Role of Education in the 21st Century

The 21st century is characterized by rapid technological, environmental, economic, and social transformations, which have reshaped the priorities of education. In today's world, it is not enough for individuals to possess academic knowledge; they must also demonstrate environmental awareness, critical thinking skills, and a sense of social responsibility (UNESCO, 2019). Within this context, sustainability and citizen science emerge as two fundamental concepts that respond to these needs.

Sustainability emphasizes the preservation of environmental resources and the achievement of social equity (WCED, 1987), while citizen science encourages individuals to actively contribute to scientific research processes (Bonney et al., 2016a; Yanarateş & Yılmaz, 2022; Yılmaz, 2021a; Yılmaz, 2021b; Yılmaz, 2023). Integrating these concepts into education, especially at an early age, can significantly contribute to raising more conscious and engaged future generations.

1.2. The Relationship Between Sustainability and Education

Sustainability encompasses principles such as the conservation of natural resources, the prevention of environmental degradation, and the promotion of economic development in harmony with social equity (Sterling, 2010a). Education serves as a powerful tool to instill these principles in individuals. Goal 4 of the United Nations Sustainable Development Goals (SDGs), which aims to "ensure inclusive and equitable quality education," emphasizes the integration of sustainability into curricula (UN, 2015).

Education for sustainability equips individuals with the ability to recognize environmental problems, devise solutions, and adopt sustainable living habits. Research indicates that introducing environmental awareness at an early age increases the likelihood of individuals adopting sustainable behaviors in adulthood (Davis, 2015).

1.3. The Importance of Sustainability Education in Early Childhood

The early childhood period is a critical phase in which cognitive, emotional, and social development occurs rapidly. Education during this stage plays a pivotal role in shaping an individual's future behaviors and values (Elliott & Davis, 2018). Early childhood education offers unique opportunities to foster environmental awareness and sustainability consciousness.

Integrating activities such as nature exploration, recycling projects, and eco-friendly practices into early childhood curricula enables children to connect with their environment. For instance, hands-on experiences like planting seeds or observing soil processes help children understand ecological systems and develop empathy toward the environment (Wilson, 2020).

1.4. The Role of Citizen Science in Education

Citizen science is an innovative approach that facilitates public participation in scientific research (Hecker et al., 2018). By encouraging community involvement in data collection and analysis, it makes science more accessible and participatory. Projects focused on environmental monitoring, nature observations, and data collection can nurture children's scientific curiosity while fostering a deeper connection with nature (Bonney et al., 2016b; Öztürk & Demiroğlu Çiçek, 2024).

Implementing citizen science projects in early childhood education enhances children's engagement in scientific processes and improves their understanding of environmental challenges. Activities such as birdwatching in a local park or monitoring air pollution levels can help children develop both scientific skills and environmental responsibility (Cochrane et al., 2017).

1.5. The Role of Technology in 21st-Century Education

Technology plays a critical role in integrating sustainability and citizen science into education. Child-friendly mobile applications and digital platforms make it easier for young learners to actively participate in environmental processes. For example, applications that allow children to collect and share local environmental data foster both individual and collective problem-solving skills (UNESCO, 2018).

Moreover, technologies such as virtual reality (VR) and augmented reality (AR) enable children to understand environmental processes more effectively. For instance, a virtual forest tour can teach children about ecosystem functions while simultaneously enhancing their environmental consciousness.

1.6. Research Problem and Rationale

The primary aim of this study is to highlight the significance of sustainability and citizen science in early childhood education in the 21st century. It explores how environmental awareness and scientific thinking skills acquired at an early age influence lifelong behaviors. Additionally, the study discusses how citizen science can be integrated into children's learning processes and aligned with sustainability goals.

2. Sustainability Approaches in Early Childhood Education

2.1. The Importance of Sustainability Education in Early Childhood

Early childhood represents a critical period during which children develop awareness about their environment and begin forming their value systems. Introducing sustainability education at this stage plays a significant role in fostering environmental awareness, social responsibility, and resource consciousness (Davis, 2015). During this process, teaching children about environmental challenges and possible solutions contributes to raising individuals who are more conscious in adulthood (Elliott & Davis, 2018).

Sustainability education for children is not merely about transferring knowledge; it also allows them to develop skills such as problem-solving, creativity, and empathy through hands-on activities (Öztürk, 2023; Tilbury, 2011). This type of education enhances children's connection with the environment while empowering them to propose local solutions to global challenges.

2.2. Core Principles of Sustainability Education

The success of sustainability education relies on addressing its three primary dimensions holistically: environmental, economic, and social sustainability (Sterling, 2010a).

1. **Environmental Sustainability:** Focuses on preserving natural resources and promoting eco-friendly practices. For preschool-aged children, this approach enables understanding of concepts such as pollution, recycling, and ecosystem cycles.

2. **Economic Sustainability:** Involves efficient use of resources, waste prevention, and fostering economic awareness. Practices like conserving energy or water can fall under this category.
3. **Social Sustainability:** Emphasizes social justice, cultural diversity, and community engagement. Encouraging children to participate in community activities, develop empathy, and learn teamwork are central goals.

2.3. Nature-Based Learning Approaches

Nature-based learning promotes children's participation in educational processes within natural environments. Research shows that interacting with nature improves children's emotional well-being, enhances their attention spans, and develops problem-solving skills (Chawla, 2015). This type of learning not only increases children's knowledge of environmental issues but also strengthens their connection to the natural world.

Examples of nature-based learning activities include:

- **Playing with Soil:** Interacting with soil and plants teaches children the importance of ecosystems.
- **Observing Animals:** Studying animals in their natural habitats helps children understand biodiversity and habitats.
- **Nature Walks:** Enable children to explore and observe environmental processes.

2.4. Recycling and Waste Management Education

Recycling is an indispensable part of sustainability education. Teaching children about waste segregation and the importance of recycling can enhance their contributions to the environment (Tilbury, 2011). Hands-on recycling projects in preschool classrooms effectively support children's learning processes in an engaging way.

For instance, placing bins for plastic, paper, and glass in the classroom can help children understand the recycling process. Such activities also foster problem-solving skills and a sense of responsibility toward the environment.

2.5. Energy and Water Conservation Education

Energy and water conservation are other crucial dimensions of sustainability education. Helping children understand that energy resources are limited and teaching them to use these resources efficiently is vital for long-term environmental impact (Wilson, 2020). Activities such as energy conservation games or storytelling about water usage can effectively teach these concepts to children.

2.6. Examples of Sustainability Projects

Some exemplary projects that can be integrated into early childhood education curricula include:

- **Gardening Projects:** Children can learn about natural cycles by observing plant growth and caring for them.
- **Nature Journals:** Encourage children to record their daily observations about the environment.
- **Community Participation:** Engaging children in local environmental events fosters their sense of social responsibility.

2.7. The Role of Teachers

The success of sustainability education is closely linked to teachers' knowledge and pedagogical approaches. Teachers should serve as role models to foster positive attitudes toward nature and the environment among children. Actively participating in environmental projects can motivate children and enrich the learning process (Küçük-Demir, 2023).

2.8. Family Involvement

Families play a crucial role in effectively implementing sustainability education. At-home practices such as recycling projects or adopting energy-saving habits help reinforce children's learning (Davis, 2015). Actively involving families in the process enables children to internalize sustainability concepts more effectively.

3. Integration of Citizen Science into Early Childhood Education

3.1. Definition and Scope of Citizen Science

Citizen science refers to an approach that encourages individuals to engage in scientific processes, aiming to make science accessible and understandable to all members of society (Haklay, 2015; Yılmaz & Salman, 2022; Yılmaz, Şahin-Atılgan & Güzel-Sekecek, 2024). This process includes observing the environment, collecting data, and contributing to scientific analyses. Integrating citizen science into early childhood education offers an opportunity to introduce children to scientific processes and develop their sensitivity toward environmental challenges at an early age (Bonney et al., 2016b).

3.2. The Role of Citizen Science in Education

Citizen science not only teaches children the basic steps of scientific methods but also enhances their societal awareness (Ayyıldız & Yılmaz, 2021; Ayyıldız, Yılmaz & Baltacı, 2021; Elliott & Davis, 2018). Implementing citizen science projects in early childhood education enables children to develop skills in scientific observation, data collection, and analysis. For instance, observing and recording bird species in a park helps children understand environmental issues while fostering their scientific curiosity (Gray et al., 2012; Sevgi & Yılmaz, 2023).

3.3. Applications of Citizen Science Projects for Young Children

1. **Local Environmental Monitoring Projects:** Children can observe and record air, water, or soil pollution in their surroundings using simple methods. These projects enhance children's awareness of environmental issues while encouraging their participation in scientific processes (Shirk et al., 2012).
2. **Nature Observation Journals:** Documenting daily observations of natural changes, such as seasonal transitions or plant growth, helps children improve their observational skills.
3. **Tracking Animal Species:** Counting local animal species and observing their behaviors may foster children's understanding of biodiversity.

3.4. Technology in Citizen Science

Technological tools play a crucial role in the implementation of citizen science. Child-friendly mobile applications, digital maps, and simple data analysis tools allow children to actively engage in scientific processes (Cochrane et al., 2017). For instance, identifying plant species via a mobile app or measuring air pollution in a specific area enables children to participate more effectively in scientific activities.

3.5. Cognitive and Social Contributions of Citizen Science

Citizen science projects contribute to children's development of scientific thinking and social responsibility (Dickinson et al., 2012). Collaborating with community members to address local environmental challenges strengthens children's empathy and sense of societal responsibility.

3.6. Role of Educators

Teachers play a guiding role in the implementation of citizen science. Their knowledge of scientific processes and ability to convey this knowledge to children are critical for the success of such projects (Trumbull et al., 2000). Additionally, educators' attitudes toward environmental issues and their enthusiasm significantly influence children's interest in these projects.

3.7. Parental Involvement

Parental involvement in citizen science projects enhances the benefits children derive from these activities. Parents engaging in nature observations with their children or supporting projects increase children's motivation to learn (Ballard et al., 2017). This process also provides an opportunity for quality family time.

3.8. Community and Citizen Science

Citizen science impacts not only individuals but also communities. Children's participation in local environmental projects develops their ability to address community issues and grow as informed and responsible citizens.

4. Educational Methods Supporting Sustainability and Citizen Science

Integrating sustainability and citizen science concepts into early childhood education requires not only curriculum development but also innovative teaching methods and pedagogical practices (Sterling, 2010b). Effective teaching strategies are essential for fostering children's environmental awareness, participation in scientific processes, and sense of social responsibility (Davis & Elliott, 2014; Sevgi, Ayyıldız & Yılmaz, 2023). This section provides a detailed exploration of educational methods that support sustainability and citizen science.

4.1. Project-Based Learning (PBL)

Project-based learning (PBL) allows students to acquire knowledge and skills by engaging in real-life scenarios centered on a problem or project. PBL is highly suitable for integrating sustainability and citizen science, as children work in teams, observe, and collect data to address environmental issues (Thomas, 2000).

Example Application:

- **Nature Conservation Project:** Children participate in activities such as tree planting, plant observation, or waste collection in a local park, fostering both a connection to nature and problem-solving skills.

PBL is an effective tool for developing critical thinking, problem-solving, and collaboration skills at an early age.

4.2. Game-Based Learning

In early childhood, play is a fundamental way of learning. Game-based learning simplifies abstract concepts like sustainability and citizen science for children (Fisher et al., 2011). Digital games, in particular, are a powerful medium for raising environmental awareness.

Example Application:

- **"Zero Waste Game":** A game designed to teach children about recycling and waste management, either digitally or physically.
- **Nature-Themed Role-Playing Games:** Simulating an ecosystem to help children understand animal life cycles.

Game-based learning engages children actively, making the learning process both enjoyable and effective.

4.3. Storytelling and Visual Learning

Stories are a powerful tool to help children understand complex concepts. Storytelling about sustainability and citizen science fosters empathy and emotional connections with the environment (Wright & Pullen, 2013; Yılmaz, Uysal & Nacar, 2024).

Example Application:

- **"Heroes of Nature" Storybook:** Designing a storybook or visual material to teach eco-friendly behaviors to children.
- **Animations and Short Films:** Addressing topics like pollution, recycling, or biodiversity through visual content.

Storytelling and visual learning methods make children more emotionally and cognitively sensitive to environmental issues.

4.4. Experiential Learning

Experiential learning enables children to acquire knowledge through direct experiences. It is an effective way for children to observe natural environments, solve problems, and explore their learning processes (Kolb, 1984).

Example Application:

- **On-Site Observation Activities:** Visiting an ecosystem to study living organisms in their natural habitats.
- **Gardening Activities:** Teaching children about basic ecosystem components like water, sunlight, and soil by growing plants.

Experiential learning enhances children's interaction with the environment and develops their analytical thinking skills.

4.5. Technology-Enhanced Learning

Technology serves as a crucial tool in integrating sustainability and citizen science into education. Digital platforms, mobile applications, and augmented reality (AR) technologies enhance children's participation in scientific processes (Hughes, 2005; Yılmaz, Gülgün, Çetinkaya & Doğanay, 2018).

Example Application:

- **"Nature Observation Apps":** Allowing children to identify plant species and digitally record their observations.
- **Virtual Reality (VR) Tours:** Enabling children to explore forests or coral reefs virtually.

Technology-enhanced learning strengthens children's scientific thinking skills and helps them better understand sustainability concepts.

Integrating sustainability and citizen science concepts into early childhood education is achievable through effective teaching methods. From project-based learning to technology-enhanced approaches, these strategies enable children to develop environmental awareness and scientific skills. These methods contribute not only to individual growth but also to societal progress.

5. Conclusion and Recommendations

5.1. Conclusion

This study has highlighted the importance of integrating sustainability and citizen science concepts into early childhood education. In a world increasingly affected by environmental and social crises, these concepts play a crucial role in fostering children's environmental awareness, scientific thinking skills, and social responsibility (Barron et al., 2015). Acquiring these skills at an early age helps individuals exhibit lifelong eco-friendly behaviors and contribute more effectively to society (Tilbury, 2011).

Technological advancements have further enhanced this process. Tools such as mobile applications, augmented reality (AR), and virtual reality (VR) enable children to learn about environmental data more effectively and participate actively in scientific processes (Bonney et al., 2016c). However, to ensure the success of this integration, educational policies, curricula, and teacher training programs must be aligned to support these concepts.

5.2. Recommendations

1. **Developing Educational Policies**
    - Comprehensive policy frameworks should be established to better integrate sustainability and citizen science into education systems (UNESCO, 2017).
    - Environmental education and citizen science-focused curricula should be widely implemented in early childhood education programs.
2. **Revising Curricula**
    - Activities that help children understand environmental issues and develop solutions should be incorporated into the curriculum. These activities may include nature observations, recycling projects, and sustainable living practices (Davis, 2015).
    - Greater emphasis should be placed on game-based and experiential learning methods in the curriculum.
3. **Investing in Teacher Training**
    - In-service training programs for teachers on sustainability and citizen science should be organized.
    - Training programs aimed at enhancing educators' digital skills should be developed to enable more effective use of technology in the classroom (Elliott & Davis, 2018).
4. **Engaging Families in the Process**
    - Sustainability and environmental education programs should be organized for families, encouraging parents to conduct hands-on projects with their children.

- Parents should be actively involved in school activities related to sustainability and citizen science.

5. **Leveraging Technology and Digital Tools**
   - Mobile applications and games should be developed to help children learn and analyze environmental data (Yılmaz, 2023; Yılmaz, 2024)
   - Virtual ecosystem simulations supported by VR and AR technologies can enable children to establish a more meaningful connection with the environment (Hecker et al., 2018).

6. **Raising Community Awareness**
   - Collaborations among local governments, NGOs, and schools should be encouraged to initiate environmental awareness projects.
   - Community events for children should promote social responsibility and environmental consciousness (Sterling, 2010a).

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Chapter 15

Bibliometric Analysis of Studies on Environmental Education in Early Childhood Education

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Abstract

The aim of this study is to conduct a bibliometric analysis of articles related to environmental education in early childhood (EEEC). The sub-objectives of the study were to determine the distribution of studies on EEEC by years, the most used keywords, the most cited articles, the most active researchers, the most cited journals and the most active collaborating countries. Bibliometric analysis methods were used in the research. Bibliometric mapping analysis was preferred to provide visual representations of the relationships between the main concepts. The data were obtained from the Web of Science (WoS) database and the 191 articles accessed because of filtering were analysed using VOSviewer software. As a result of the research, it was determined that studies on EEEC have increased over the years. Among the keywords, "early childhood education", "environmental education" and "sustainability" came to the fore respectively. The most cited study was "Beyond Stewardship: Common World Pedagogies for the Anthropocene". Prominent journals included "Australian Journal of Environmental Education" and "Sustainability", while the most influential authors were identified as "Alsina, A." and "Rodrigues-Silva, J.". Among the countries, "Australia", "Canada" and "Brazil" are at the forefront. Encouraging more co-operation and interdisciplinary studies in the field of EEEC will help deepen research in this field.

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1. Introduction

In today's rapidly growing demographic structure and globalization, various environmental problems and serious crises are being experienced more than ever before due to uncontrolled urbanization, industrialization, deforestation, and the loss of valuable agricultural lands. These issues, regardless of perspective, cause significant harm to humans and other living beings (Liu, Hussein & Bin Mat Noor, 2024; Pimentel et al., 2004). In fact, nearly one-tenth of diseases and deaths worldwide are caused by environmental problems (Singh & Singh, 2017). To tackle these problems, education and participation are among the primary elements. On one hand, humans are damaging the environment, while on the other hand, efforts are being made towards environmental education and education for sustainable development to eliminate this damage and leave a better world for future generations. Consequently, these areas are becoming increasingly important (Acosta Castellanos & Queiruga-Dios, 2022; Güzelyurt & Özkan, 2019).

Environmental education is a strategic approach that promotes collaborative environments, allowing individuals to share their local knowledge, experiences, beliefs, and practices, and aims to develop environmental awareness, attitudes, behaviors, skills, and actions through education. This educational model aims to create an environmentally conscious and aware society by bringing together the contributions of various individuals (Ardoin, Bowers & Gaillard, 2020). Thus, environmental education is seen as one of the important steps in eliminating human-induced environmental problems (Özdemir, 2016). Environmental education is an effort to increase individuals" awareness levels by providing them with knowledge and experience related to the environment. In this way, individuals" beliefs, attitudes, and most importantly, behaviors towards the environment will develop in an environment-centered manner (Frantz & Mayer, 2014). At this point, environmental education serves as a bridge between the individual and nature. Environmental education is critical for developing environmentally friendly behaviors, adapting to the natural environment, and mitigating global environmental problems. Recycling waste, using energy-efficient devices, and avoiding unnecessary energy consumption play an important role in reducing the carbon footprint (Gómez-Prado et al., 2022; Schönfelder & Bogner, 2020). Conserving water resources by saving water, using natural products free of chemicals, and opting for environmentally friendly transportation methods such as public transport or bicycles minimize environmental damage. Additionally, planting trees reduces carbon emissions and increases biodiversity. Such behaviors enhance people's environmental sensitivity and encourage active participation in solving environmental problems (Gude, 2017). Effective environmental education equips individuals or communities with various skills to collaborate on positive environmental actions, allowing them to be more dynamic in addressing environmental issues and solutions (Ardoin, Bowers, & Gaillard, 2020; Hungerford & Volk, 1990).

Considering that environmental education is a way of thinking and behaving, the greatest responsibility of societies in terms of sustainability should be to ensure that children develop a positive attitude towards the environment and to provide them with the necessary values, knowledge, and skills (Trott & Weinberg, 2020). In terms of the gains provided by environmental education, it is accepted that the best period to start environmental education is the preschool years when a person's personality begins to form. At this point, it is critically important to start environmental education at an early age to ensure that children develop a positive attitude towards the environment and are raised as responsible individuals in the later stages of their lives (Barrable, 2019; Kotaman, Karaboğa, Bilgin & Tuğrul, 2022; Yalçın, Yalçın, Bozan & Gecikli, 2016). Early childhood education covers the 0-6 age groups, and the foundation of children's cognitive, social, and emotional development is laid during this period. During this period, children absorb all information like a sponge and gain basic ideas about their surroundings and the world around them (Wilson, 1996). Environmental education given to children in this age group has a lasting positive impact on various aspects of their development. Thus, children will develop positive attitudes towards the environment and be raised as responsible individuals (Poje, Marinić, Stanisavljević & Rechner Dika, 2024).

Presenting different environmental problems and solutions in terms of sustainability is only possible through environmental education studies conducted in this field. Therefore, it is thought that environmental education studies will affect both the current generation and future generations. Considering the importance of environmental education in early childhood, it can be concluded that research in this area is vital. Studies emphasize that individuals who receive environmental education in early childhood are more sensitive to environmental problems and grow up as solution-oriented individuals, develop problem-solving skills, and are successful in solving environmental problems they encounter in later years, increase their environmental awareness and sustainability consciousness, and play an important role in developing positive attitudes towards the environment and acquiring skills to solve environmental problems (Adams & Savahl, 2017; Bascopé, Perasso & Reiss, 2019; Corraliza & Collado, 2019; Cutter-Mackenzie & Edwards, 2013; Wilson, 1996). In this context, when the relevant literature is examined, it is determined that there are various bibliometric analysis studies on environmental education (Arias-Chávez et al., 2022; Arya et al., 2024; Bozdoğan et al., 2023; Çelik, 2022a; Karakuş & Polat, 2021; Kurtulus & Tatar, 2021; Ok, 2022; Su et al., 2022; Wang & Lv, 2021) and bibliometric studies on bullying management strategy in early childhood education (Aisyah et al., 2023), technology use (Aktas, 2022), STEM (Bui et al., 2024; Nhi et al., 2024; Su & Yang, 2023; Xue, Keat, & Tarofder, 2024), mathematics education (Çelik, 2022b; Maharani, 2023), critical thinking skills (Ergin & Temel, 2023), parenting (Handayani, 2024), artificial intelligence (Yi, Liu & Lan, 2024), augmented reality use (Kayaduman & Sağlam, 2024), robotic coding (Kırksekiz & Kol, 2023), and teacher education (Tunç et al., 2023). Due to the inaccessibility of systematic review studies on early childhood education, the lack of a comprehensive study on which bibliometric analyses are available on environmental education in early childhood is noteworthy. This indicates a need for a review study on environmental education in early childhood.

In this context, bibliometric analyses of studies in the field of environmental education in early childhood will help identify current research gaps and assist future studies in this area. Given the critical role of environmental education in early childhood, bibliometric analyses in early childhood environmental education will shed light on solving environmental problems and environmental education. Environmental education studies in early childhood education are important for presenting relevant research trends as a whole and revealing gaps in knowledge in the field. Doing so can encourage researchers to fill research gaps and address issues that have not been fully explored or supported by evidence.

In this way, the bibliometric analysis of Early Childhood Environmental Education (EEEC) will also support the development of the curriculum in this field. Therefore, this study aims to present a bibliometric mapping analysis of studies on early childhood environmental education conducted in the Web of Science. It aims to examine the studies in this field to reveal current research trends, priorities, and research gaps. By providing a general evaluation of early childhood environmental education studies, it will help see the big picture and guide researchers, decision-makers, and policymakers. Therefore, the purpose of this study is to conduct a bibliometric analysis of articles related to EEEC. For this purpose, the research questions are listed below:

1. What is the distribution of the number and citations of studies related to EEEC over the years?

2. What is the distribution of the most used keywords in studies related to EEEC?
3. What is the distribution of the top 10 most cited articles related to EEEC?
4. Who are the most influential researchers in EEEC (citation and co-citation)?
5. What are the most cited journals related to EEEC (citation and co-citation)?
6. Which countries are the most influential and collaborative in EEEC?

2. Method

Bibliometric analysis methods were applied to evaluate research on environmental education in early childhood. Bibliometric mapping analysis was preferred because it provides visual representations of the relationships between key concepts. Bibliometric analysis is a method of analysing data published in various journals over a specific period and includes the examination of keywords, citations, and authors (Rusly et al., 2019). This method reveals the relationships between disciplines, fields, specializations, and individual articles through mapping and visualization. Bibliometric methods are easily accessible sources of citation data (Passas, 2024).

2.1. Data Source and Collection

With the development of online databases such as Web of Science (WoS), Scopus, PubMed, and Google Scholar, and software for conducting bibliometric analyses, these methods have become more widespread. Among these databases, WoS stands out globally and is frequently used in bibliometric analyses (Wu, Li, Tong, Wang & Sun, 2021; Zupic & Čater, 2015). In this research, WoS and Scopus databases, which are commonly used in bibliometric analyses, were used as sources. In the process of determining the studies to be included in the screening and research, the reporting steps for systematic reviews (Table 1 and Figure 1) were used as a guide (Moher et al., 2009).

Table 1. Keywords used in database searches

Early childhood search terms	Operator	Environmental education search terms
("pre-school" or "pre-school education" or "pre-school teaching" or "kindergarten" or "kindergarten class" or " kindergarten school" or "early childhood education" or "early childhood learning" or "early childhood")	AND	("environment education" OR "environmental education")

The screening was concluded on November 7, 2024. As a result of the screening, 569 articles were identified. After selecting "article" as the document type, 360 articles were found. When "Education Educational Research" was selected as the Web of Science category, 282 articles were identified. After selecting "Web of Science Core Collection" as the database, 195 articles were found. Finally, after removing duplicates and irrelevant studies, 191 articles were included. The data collection for the study was completed on November 7, 2024.

2.1. Data Analysis

VOSviewer, a widely used bibliometric software, will be used to facilitate bibliometric analysis. This programme helps to identify salient themes and influences by visualising co-citation networks and identifying bibliometric clusters. The data analysed in accordance with the objectives of the study are presented with visuals. In addition, descriptive statistics such as frequency were used in the study (Lasino, Rukmana, Mokodenseho, & Aziz, 2023; Van-Eck & Waltman, 2010).

3 Findings

3.1. Trends of annual publications and cites

The research data was conducted between the years 1980-2024 and 191 articles were found as a result of filtering. A total of 1821 citations related to EEEC The average number of citations per study is 12.23 The H-Index of the studies is 27

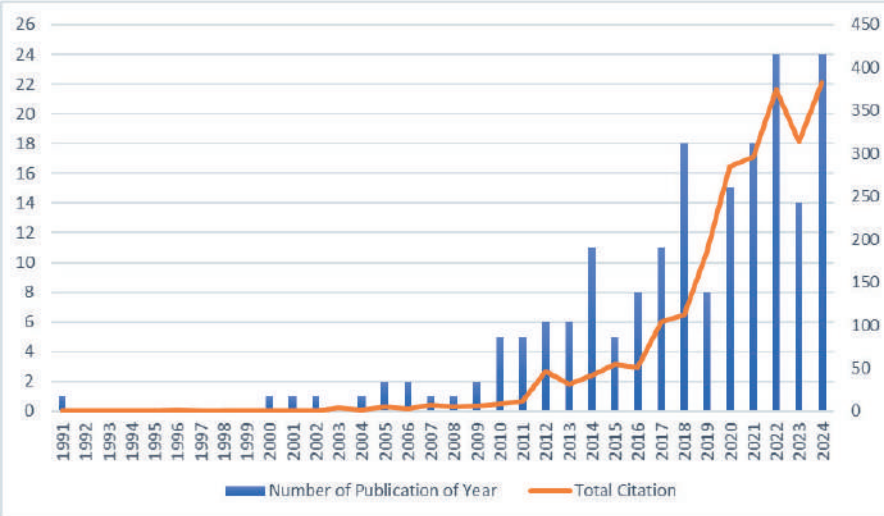

Figure 1. Number of publications and citations according to scientific studies published on EEEC

Figure 1 shows the annual number of publications and citations related to environmental education in early childhood between 1991 and 2024. These indicators can be divided into two periods: 1991-2009 and 2010-2024. Between 1991-2009, a total of 13 publications and 36 citations were made. Between 2010-2024, 178 publications and 2300 citations were made. It was determined that the number of articles in the first period increased approximately 14 times in the second period. Similarly, the number of citations increased many times more than the first period. These values show that the subject of EEEC has attracted the attention of researchers since 2010 and studies continue to be added.

3.2. Analysis of keywords

Keywords represent the main topics and related subtopics of published scientific studies (Wu et al., 2022). The co-occurrence and network analysis of keywords related to EEEC can help researchers to comprehensively understand the relationship between keywords and analyse the relationship between various conversations in this field.

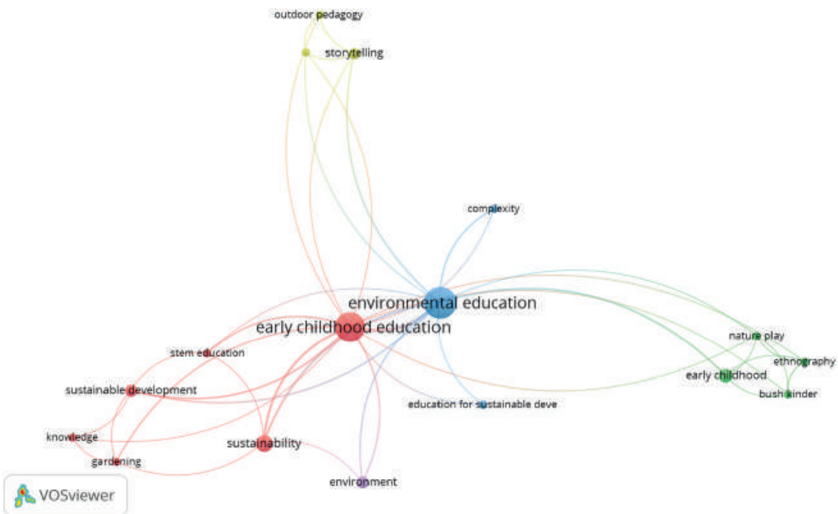

Figure 2. Keyword network analysis of scientific studies on EEEC

The prominent keywords related to scientific studies on EEEC are "early childhood education (occurrence 22, total link strength 366)", "environmental education (occurrence 24, total link strength 32)", "sustainability (occurrence 7, total link strength 12)", "sustainable development (occurrence 4, total link strength 8)" and "early childhood (occurrence 5, total link strength 6)". In addition, the words "bush kinder", "environment", "ethnography" and "gardening" are among the most frequently used keywords.

3.3. The most influential scientific studies on EEEC

The top 10 most cited scientific studies on EEEC are presented in Table 2.

When Table 2 is analysed, it is seen that the 3 most cited studies are "Beyond stewardship: common world pedagogies for the Anthropocene", "Revealing the research "hole" of early childhood education for sustainability: a preliminary survey of the literature", and "Education for sustainable development in early childhood education: a review of the research literature". The most cited study on EEEC belongs to the author "Taylor, A" and the study was published in the journal "Environmental Education Research".

Table 2. Top 10 most effective scientific studies on EEEC according to the level of citation

Name of article	Authour(s)	PY	Journal	TC
1- Beyond stewardship: common world pedagogies for the Anthropocene	Taylor, A	2017	Environmental Education Research	154
2-Revealing the research "hole" of early childhood education for sustainability: a preliminary survey of the literature	Davis, J	2009	Environmental Education Research	146
3-Education for sustainable development in early childhood education: a review of the research literature	Hedefalk, M. et al.	2015	Environmental Education Research	96
4-Early childhood environmental education: A systematic review of the research literature	Ardoin, NM & Bowers, AW	2020	Educational Research Review	94
5-Children in nature: sensory engagement and the experience of biodiversity	Beery, T. & Jorgensen, KA	2018	Environmental Education Research	77
6-Envisioning Black space in environmental education for young children	Nxumalo, F & Ross, KM	2019	Race Ethnicity and Education	69
7-Toward a model for early childhood 8-environmental education: foregrounding, developing, and connecting knowledge through play-based learning	Cutter-Mackenzie, A & Edwards, S	2013	Journal of Environmental Education	61
8-Sustainability education in early childhood: An updated review of research in the field	Somerville, M & Williams, C	2015	Contemporary Issues in Early Childhood	53
9-Environmentalising early childhood education, curriculum through pedagogies of play	Edwards, S & Cutter-Mackenzie, A	2011	Australasian Journal of Early Childhood	53
10-Curriculum analysis and education for sustainable development in Iceland	Jóhannesson, et al.	2011	Environmental Education Research	49

3.4. Analysis of Sources

The most active journals related to scientific studies on EEEC are presented in Table 3 and the source network analysis is presented in Figure 3.

Table 3. The top 10 most influential scientific journals according to the level of citations related to EEEC

Source	NP	TC	TL	C	CQ	PYS
Australian Journal of Environmental Education	7	14	2	ESCI	Q2	1984
Environmental Education Research	3	4	2	SSCI	Q1	1995
Sustainability	6	16	2	SSCI	Q2	2009
International Journal of Early Years Education	1	7	1	ESCI	Q2	1993
International Journal of Technology and Design Education	1	13	1	SSCI	Q2	1990
Contemporary Issues in Early Childhood	1	0	0	ESCI	Q2	1990
Curriculum Journal	1	0	0	ESCI	Q2	1990
Early Childhood Education Journal	1	2	0	SSCI	Q1	1973
Education 3-13	1	1	0	ESCI	Q3	1973
Education Sciences	1	0	0	ESCI	Q1	2011

Figure 3. Citation network analysis of journals published within the scope of scientific studies related to EEEC

When the journals in which scientific studies on EEEC were published were examined, it was determined that the most effective journals were "Australian Journal of Environmental Education", "Environmental Education Research", "Sustainability, "International Journal of Early Years Education" and "International Journal of Technology and Design Education". When the citation network analysis is analysed, the journals "Sustainability", "International Journal of Early Years Education" and "International Journal of Technology and Design Education" come to the fore.

3.5. Analysis of Authors

The citation network analysis of the authors who published on EEEC is presented in Figure 4. Considering the network analysis of the authors publishing within the scope of EEEC, it was determined that "Alsina, A.", "Rodrigues-Silva, J.", "Campbell, C.", "Ebrahim, N.A.", Jamali, F., Jamali, S.M., "Speldeinde, C.".

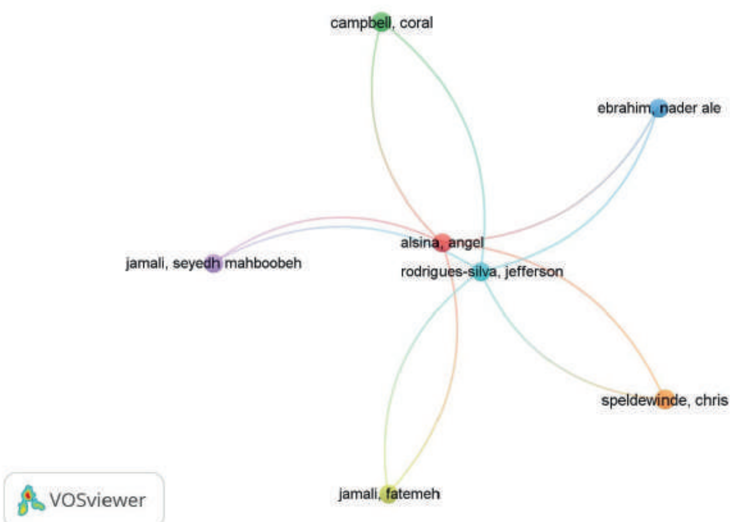

Figure 4. Network analysis of authors publishing within the scope of scientific studies related to EEEC-related publication

3.6. Analysis of Countries

Scientific studies published within the scope of EEEC have been analysed and the most active cooperating countries and the publication network are presented in Figure 5.

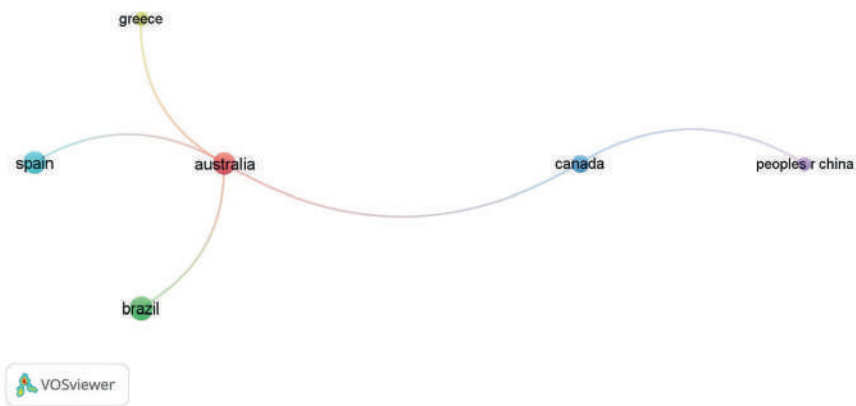

Figure 5. The countries with the highest number of active collaborators in scientific studies related to EEEC

Australia, Canada, Brazil, Brazil, Greece, China and Spain are the countries that are most active in scientific studies related to EEEC.

4. Conclusion and Discussion

In this study, a bibliometric analysis was conducted on the studies on EEEC in the WoS database. The research data was conducted between 1980 and November 2024 and 191 articles on EEEC from 97 different journals were analysed in terms of publication year and number of citations, keywords of published articles, most effective article, journal, author and country collaborations.

When the number and attribution of the studies by years were analysed, it was determined that there was a leap in the studies in 2010 and the number of studies with EEEC increased after 2010. Although there has been an increase in the number of articles in the last 5 years, a noticeable decrease in the number of EEEC studies was observed in 2019 after 2018. After 2019, although the number of articles increased, it took until 2021 to recover. This may indicate that the article production performance of researchers is under the influence of COVID-19 (Fauzi & Khusuma, 2020; Sari, Purnomo, & Hariyono, 2023). Apart from this, it is another striking result that the most studies and citations are in 2022 and 2024. Considering that 2024 is not completed and some of the journals publish in December, it can be said that the most publications and citations will be in 2024. This finding is in parallel with the finding of Ardoin and Bowers (2020) in their systematic analysis of early childhood environmental education (ECE) that more studies were conducted with ECE in the last 5 years compared to previous years. This increase shows that the subject of ECE has attracted more attention in recent years and has been addressed more by researchers. Similar studies are found in the literature that the number and attribution of environmental education studies increase as the years increase (Arias-Chávez, et al., 2022; Arya et al., 2024; Kurtulus & Tatar, 2021; Liu et al., 2024; Onopriienko et al., 2021).

Keyword analysis is an important tool for understanding the main topics of studies related to EEEC and the relationships between these topics. In our study, keywords such as "early childhood education", "environmental education", "sustainability" and "sustainable development" were prominent. Wu et al. (2022) state that the co-occurrence of keywords and network analysis can help researchers to comprehensively understand the relationship between keywords. In the analysis of Arias-Chávez, et all's (2022) bibliometric study on environmental education, it was determined that the most used keywords were "environmental education, sustainability and sustainable development". Studies on environmental education in the literature support the findings of the keyword analysis of the research (Arya et al., 2024; Lasino, Rukmana, Mokodenseho, & Aziz, 2023; Lima Ho et al., 2023; Liu et al., 2024; Sari, Purnomo, & Hariyono, 2023).

The analysis of the most cited studies shows which studies are the most influential in the field of EEEC and in which journals these studies are published. It was determined that the top ten most cited studies were between 2011-2020 and the most cited study was "Beyond stewardship: common world pedagogies for the Anthropocene" in 2017. After this study, "Revealing the research "hole" of early childhood education for sustainability: a preliminary survey of the literature" in 2009, "Education for sustainable development in early childhood education: a review of the research literature" in 2015 and "Early childhood environmental education: A systematic review of the research literature" in 2020.

Journal and author analyses help to identify the most influential journals and researchers in the field of EEEC. In our study, journals such as "Australian Journal of Environmental Education" and "Environmental Education Research" stand out. Similarly, authors such as "Alsina, A." and "Rodrigues-Silva, J." are among the authors who contribute the most to the field of EEEC. The studies of these authors make important contributions to environmental education and sustainability in early childhood. Karakuş and Polat (2021) identified "Environmental Education Research", "Journal of Environmental Education", "Sustainability", "Australian

Journal of Environmental Education" among the most effective journals in environmental education. Similar findings are found in terms of the most effective journals in bibliometric studies on environmental education (Arias-Chávez, et al., 2022; Arya et al., 2024; Kurtulus & Tatar, 2021; Liu et al., 2024; Ok, 2022).

Analyses of cooperation between countries identify the countries that cooperate the most and are the most effective in the field of EEEC. In our study, countries such as "Australia", "Canada" and "Brazil" stand out. Karakuş and Polat (2021) determined that Brazil and USA are the most active countries in the bibliometric analysis of environmental education. In a study conducted by Sivasamy and Vivekanandhan (2015) based on the Scopus database, it was determined that the most publications in the field of environmental education came from the United States, followed by Brazil. In the bibliometric analysis study conducted by Kurtulus & Tatar (2021) on environmental education, it was determined that USA, United Kingdom, Brazil, Australia and Canada were among the most collaborating countries, respectively. In the study conducted by Arias-Chávez, et al. (2022) on environmental education, it was determined that the most effective countries and the countries that cooperate the most are USA and Australia. Ok (2022), in his bibliometric analysis of nature and environmental education, determined that USA, England, Australia and Canada were the most collaborating countries. When evaluated with the findings of the study, it shows that USA has a limited number of studies in environmental education in early childhood compared to other top-ranked countries. On the other hand, Australia and Canada are among the effective countries in terms of environmental education in early childhood. Here, it is determined that there are imbalances in the studies of the countries. Especially with the development of technology, individuals" interactions with nature are decreasing day by day. To increase the interaction of individuals with nature, countries should carry out more studies with EEEC in more cooperation (Arts, Van der Wal, & Adams, 2015; Hajj-Hassan, Chaker, & Cederqvist, 2024; Liu et al., 2024).

This study comprehensively analysed the trends of scientific publications and citations in the field of early childhood environmental education (ECE) over time. It shows that ECE has attracted a great deal of attention especially since 2010 and the number of publications and citations in this field has increased significantly. It can be said that although the number of environmental education in early childhood and citations have increased over the years, it is still not at the desired level. At this point, more studies are recommended. Keyword, author, journal and country analyses revealed which topics, researchers and publication organs are prominent in the field of ECE. These findings, which are generally consistent with other studies in the literature, emphasise that EEEC has an increasing importance in the academic field and that research in this field will continue in the future. This study demonstrates once again the importance and impact of EEEC and shows that research in this field plays a critical role in terms of sustainability and raising environmental awareness.

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Section 4:

Research and Specialized Topics

Chapter 16

Biology Education in Preschool Period

Süleyman Sarıbıyık[1]

Abstract

This study addresses the importance of biology education in early childhood and explores effective teaching methods. Biology education plays a crucial role in developing children's understanding of the environment, connecting with nature, and enhancing scientific thinking skills. The fundamental teaching principles aim to help children comprehend biological concepts through concrete experiences and increase their environmental awareness. Play-based and inquiry-oriented learning methods engage children actively, making learning both fun and meaningful. The interdisciplinary teaching approach is a key method that enhances the effectiveness of biology education. When biology is integrated with fields like art, mathematics, and technology, children learn from a broader perspective and develop creative thinking skills. Art projects provide opportunities to explore biological diversity aesthetically, while mathematical activities strengthen numerical thinking and data analysis skills. The integration of technology allows children to experience biological processes in virtual environments and develop digital literacy. Conducting experiments and engaging in observation activities improve children's skills in forming hypotheses, collecting data, and analyzing information. Learning through observation deepens their understanding of ecosystems and those of the behavior of living organisms. Creative methods like storytelling and dramatization teach biological concepts through emotional connections and stimulate children's imagination. In conclusion, biology education promotes environmental awareness, healthy living habits, and scientific thinking. Interdisciplinary teaching and creative methods aim to foster curiosity and a desire for lifelong learning, preparing children to become lifelong learners.

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1. Introduction

Biology is a fundamental discipline that allows us to understand the principles of life, make sense of our interactions with the environment, and explain the workings of nature. Introducing biology education in the early childhood period is essential, as it nurtures children's innate curiosity about the natural world and fosters the development of scientific thinking skills from a young age (Piaget, 1952; Inhelder & Piaget, 1964). Awareness of biological concepts during early childhood enhances children's sensitivity to their environment and contributes to the formation of a conservation-oriented mindset in the future (Kellert, 2002). Children exhibit a strong desire to explore and understand the world around them during their early years.

This natural curiosity forms the foundation of learning, providing opportunities for them to question, discover, and make sense of their surroundings (Bruner, 1966). Biology education is crucial in supporting this curiosity, enabling children to acquire basic knowledge about plants, animals, and the environment. Knowledge gained through direct experiences helps children comprehend abstract concepts and fosters the development of scientific process skills (Lind, 1998).

One of the primary goals of early childhood biology education is to familiarize children with living organisms and ecosystems in their environment. Experiences in nature not only support cognitive, affective, and psychomotor development but also contribute to children's emotional well-being and foster a positive attitude toward the environment (Wilson, 1997). For example, activities such as nature walks, planting seeds, and observing animals help children develop an appreciation for nature and learn to live harmoniously with their surroundings (Sobel, 1996). Another crucial aspect of biology education in early childhood is the enhancement of children's scientific process skills. These skills include observing, hypothesizing, classifying, measuring, and drawing conclusions. Engaging in such activities allows children to develop analytical thinking and problem-solving abilities from an early age (Eshach & Fried, 2005).

Acquiring these skills is beneficial not only in scientific endeavors but also in everyday life, significantly impacting children's academic success in later years (Gelman & Brenneman, 2004). Moreover, biology education aims to instill a sense of environmental responsibility in children. Cultivating environmentally conscious individuals from a young age is crucial for a sustainable future. When this awareness is developed early, children become more sensitive to issues like pollution, climate change, and biodiversity conservation (Palmer, 1995). In this context, biology education teaches children to respect and protect natural resources and understand the importance of minimizing their ecological footprint (Chawla, 1999).

The methods and techniques employed in teaching are pivotal in determining how well children grasp biological concepts. Constructivist approaches emphasize active engagement and experiential learning, which are crucial for meaningful understanding (Vygotsky, 1978). In this sense, hands-on experiences, where children learn through exploration and interaction, can be more effective than traditional teaching methods. Interactive and play-based learning environments make biology concepts memorable and enjoyable for children (Fleer, 2009). Biology education also encourages children to develop an inquisitive mindset. By asking "Why?" and "How?" questions, children engage in cognitive processes that support their intellectual growth and understanding of scientific inquiry (Kuhn, 2000). This type of education helps children embrace scientific thinking as a way of life. In addition, involving children in scientific thinking processes boosts their self-confidence and nurtures a lifelong interest in learning (Tunnicliffe, 2001).

In conclusion, biology education in early childhood is a vital component that allows children to explore the natural world, develop scientific process skills, and grow into environmentally conscious individuals. The biology knowledge and appreciation instilled during this period have long-lasting effects, shaping children's attitudes toward the environment throughout their lives. Thus, integrating biology topics into early childhood curricula is a crucial step in supporting both the scientific and emotional development of young children (Monroe, 2003).

2. The Fundamental Principles of Biology Education

2.1 Age-Appropriate Biological Concepts

When planning biology education for early childhood, it is essential to consider the children's age and cognitive development level. According to Piaget's cognitive development theory, preschool children are in the concrete operational stage, meaning they struggle with abstract concepts (Piaget, 1969). Therefore, biology teaching should be enriched with concrete materials and real-life experiences. For instance, observing the growth of seeds or witnessing the metamorphosis of a caterpillar into a butterfly provides children with valuable insights into biological processes (Tardif & Doudin, 2011). These types of activities nurture children's sense of curiosity and increase their interest in nature.

When introducing biological concepts to young children, it is crucial to engage their senses actively. Research has shown that children learn biological knowledge more effectively through multisensory experiences, such as touch, sight, and smell (Baldwin, 2012). For example, a child who touches and examines a plant or smells the soil finds the experience more meaningful. Such tangible interactions help children better understand abstract concepts and support their cognitive development.

2.2 Play-Based and Inquiry-Oriented Learning

Play-based learning is a highly effective approach to helping children grasp biological concepts. According to Vygotsky's (1978) social interaction theory, play is a powerful tool for developing children's cognitive and social skills. When biology education is integrated with play-based activities, children are more likely to engage with complex biological ideas in a meaningful way. For instance, role-playing games that mimic animals or gardening projects enable children to connect with the natural world (Wood, 2013; Yılmaz, Uysal & Nacar, 2024).

Inquiry-oriented learning encourages children to ask questions, make observations, and draw conclusions, fostering scientific thinking skills and promoting independent exploration (Chaille & Britain, 2003). For example, allowing children to study the life cycle of an insect firsthand enhances their observation and analytical skills. In this learning approach, teachers act as facilitators, guiding and supporting children's inquiries and discoveries (Siry, 2014). This hands-on, inquiry-based approach cultivates a deeper understanding of biological concepts and helps children develop problem-solving abilities.

2.3 Relating Biological Concepts to Daily Life

Connecting biological topics to children's everyday experiences makes learning more meaningful and memorable. When children relate what they learn in biology to real-world events they observe, they are more likely to internalize the information (Gelman, 2004). For example, learning about why plants need water while watering a plant helps children understand and remember the concept better. By fostering awareness of the living things in their surroundings, biology education also promotes environmental consciousness from an early age (Chawla, 1998).

Biology education can also raise awareness about healthy living and nutrition. For instance, teaching children about the nutritional value of fruits and vegetables can help them develop healthier eating habits (Story, 2002).

Such activities make biology relevant to children's daily lives and ensure that knowledge is integrated into their routines and decision-making processes.

2.4 Effective Teaching Methods for Biology Education

Experiments, observations, and interactive activities are essential methods for developing children's scientific process skills in biology education. When children learn biological concepts through hands-on experiences, they are more likely to understand and retain the information (DeVries, 2001). For example, using a simple microscope to observe plant cells or setting up an aquarium to study fish behavior can spark a lifelong interest in biology. Besides experiments, storytelling and art activities can be effective teaching tools. For instance, a story about the life cycle of plants can improve children's listening and comprehension skills (Reifel, 2004).

Technology integration is another important strategy for enriching biology education. Digital resources can make biological processes more understandable and engaging. For example, virtual lab simulations or educational apps that explore animal habitats can capture children's attention and make learning exciting (Plowman & McPake, 2013). However, it is crucial to use technology in a balanced and thoughtful way. Combining traditional and digital teaching methods often yields the best outcomes in early childhood biology education, creating a well-rounded and engaging learning experience.

3. Relating Biological Concepts to Daily Life

3.1 Utilizing Children's Daily Experiences

Children constantly observe biological phenomena in their environment, which provides significant learning opportunities. For instance, a child playing in the garden might watch plants grow or observe insects, gaining a better understanding of biodiversity and natural interactions (Chawla, 2006). Teachers can make these observations more meaningful by incorporating them into classroom activities. Involving families in this process further expands learning opportunities. For example, parents can take children to parks to observe different species or engage them in plant-growing activities at home (Kirkby, 2003; Öztürk, 2023).

Leveraging children's daily experiences makes abstract concepts in biology more tangible. For instance, watering a plant at home or in the schoolyard can be an effective way for children to learn about the life cycle of plants (Wilson, 1997). When children understand that plants need moisture, light, and soil to grow, they can apply this knowledge to their everyday life. These hands-on experiences facilitate the comprehension of abstract biological concepts.

3.2 Integrating Biological Knowledge into Lifestyle

Integrating biological knowledge into daily life can help children become healthier and more environmentally conscious. For instance, connecting healthy eating habits to biology enables children to understand how their bodies function and how different foods affect their health (Story & Stang, 2005). Teaching children that fruits and vegetables are rich in vitamins and minerals can encourage healthier eating habits. Similarly, linking biological knowledge to hygiene practices helps children grasp the importance of actions like handwashing (Curtis & Cairncross, 2003).

Recycling and environmental awareness are also critical components of biology education. Teaching children about the benefits of recycling and the environmental impact of waste can promote a sustainable lifestyle (Palmer, 1995). For example, when children learn that plastic waste remains in nature for hundreds of years if not recycled, they become more environmentally responsible. This kind of education fosters a more conscientious relationship with nature.

3.3 Nature Walks and Field Trips

Direct experiences in nature enhance children's understanding of biological concepts. Nature walks and field trips offer opportunities to observe nature, recognize different plant and animal species, and understand how ecosystems function (Fleener, 2000). For example, during a forest walk, children can observe the photosynthesis process in trees and the habitats of various animals. Such activities help children connect with nature and increase their interest in biology (Louv, 2008).

Out-of-classroom learning environments provide excellent opportunities for children to reinforce what they have learned in the classroom. During nature trips, children can observe plants and animals under the guidance of teachers. For example, a field trip to a riverbank allows children to study the impact of water on the ecosystem and examine aquatic life (Ayyıldız & Yılmaz, 2021; Bebbington, 2005). These activities make learning fun and unforgettable.

3.4 Supporting Biological Concepts with Art and Play

Incorporating art and play into biology education makes learning more engaging for children. They can learn biological concepts by drawing, singing songs, or acting out scenarios. For example, in a drama activity, children can act out how flowers grow, learning about the plant life cycle through role-play (Eckhoff, 2008). Such creative activities contribute to children's cognitive and emotional development (Öztürk & Demiroğlu Çiçek, 2024).

Art projects are effective tools for sparking children's interest in biology. For example, during a drawing activity, children can illustrate different animal species and discuss their habitats (Thompson, 2005). These projects allow children to blend biological knowledge with their imagination. Moreover, when biology education is supported by games, children's participation increases, and they retain the information more effectively (Fisher, 2002).

4. Effective Teaching Methods for Biology Education

4.1 Conducting Experiments and Observation Activities

Biology education should be enriched with experiments and observation activities to develop children's scientific process skills. These methods encourage active learning and help children better understand scientific concepts. For example, using a microscope to examine plant cells or observing the photosynthesis process of a leaf allows children to explore biological processes (Driver et al., 1994; Yılmaz, 2023). Research shows that inquiry-based learning enhances children's analytical thinking skills and helps them approach information more critically (Harlen, 2000).

Experiments help children develop hypotheses, collect data, and draw conclusions. For instance, children can conduct a plant growth experiment using control groups to learn that seeds need water and light to grow (Sampson & Grooms, 2009; Yılmaz, 2024). Teachers should guide and inspire curiosity while promoting independent thinking. Additionally, observation activities in biology education help children better understand nature and discover the behaviors of living organisms (Hodson, 1996).

4.2 Storytelling and Dramatization

Storytelling and dramatization can be effective teaching methods in biology education. Children comprehend biological concepts better through stories and reinforce their understanding by dramatizing what they have learned (Egan, 1986). For example, after listening to a story about the life cycle of a flower, children can dramatize this process as a group. Such activities enhance both cognitive and social skills, making learning enjoyable (Ayyıldız, Yılmaz & Baltacı, 2021; Cornett, 1999).

Storytelling helps children learn by forming emotional connections. A story about the life of a plant or an animal can foster environmental awareness and empathy in children. Moreover, stories stimulate children's imagination and make abstract biological concepts more concrete (Wright, 1995). Dramatization, on the other hand, enables children to enact biological events and supports their collaboration skills.

4.3 Use of Technology

The use of technology in biology education significantly enriches children's learning experiences. Interactive educational software, simulations, and digital games allow children to explore biological processes virtually (Plowman & Stephen, 2003). For instance, watching a simulation of cell division on a tablet can help children understand this complex concept better. Technology increases children's engagement in learning and appeals to various learning styles (Buckingham, 2007; Yılmaz, Gülgün, Çetinkaya & Doğanay, 2018).

Digital tools used in biology education also foster independent learning skills. For example, an interactive microscope app can allow children to examine plant cells in detail. Additionally, teachers can make use of videos and animations to explain biological processes more effectively (Levin & Wadmany, 2006). However, it is important to use technology thoughtfully and in moderation. Combining traditional methods with technological tools often provides the most effective learning experiences.

4.4 Collaborative Learning and Group Projects

Biology education can be more effective when supported by collaborative learning and group work. Children can explore biological topics together in group projects and learn from one another (Johnson & Johnson, 1999). For example, in a group activity, children can research how an ecosystem functions and share this information with their classmates. Collaborative learning develops children's communication, problem-solving, and critical thinking skills (Slavin, 1996; Yılmaz, Şahin-Atılgan & Güzel-Sekecek, 2024).

Group work allows children to gain a deeper understanding of biological concepts. For instance, in a project, children can investigate the habitats of different animals and present their findings to the class. Teachers should support and guide children's learning processes throughout these activities.

Collaborative learning also teaches children responsibility and the value of working together.

5. Interdisciplinary Teaching Approach

5.1 Definition and Importance of Interdisciplinary Teaching

Interdisciplinary teaching is an educational approach that integrates knowledge and skills from different disciplines. This method allows students to examine topics from a broader perspective and enhances their ability to solve real-world problems (Beane, 1997). In the context of biology education, interdisciplinary teaching enables students to connect biological knowledge with fields such as mathematics, art, history, or technology, providing a more comprehensive learning experience (Drake, 2007).

Integrating interdisciplinary teaching into early childhood education fosters children's natural curiosity and supports their active engagement in the learning process. This approach helps make abstract concepts, such as those in biology, more meaningful (Fogarty, 1991). For example, in a project-based learning activity, children might analyze the factors affecting plant growth using mathematical measurements or express the life cycle of a plant through art projects. Such activities encourage creative thinking and help children synthesize knowledge from different disciplines (Jacobs, 1989).

5.2 Integration of Biology and Mathematics

The integration of biology and mathematics helps children understand biological processes while developing their mathematical skills. For example, children can measure the weekly growth of a plant and create graphs to represent this data (Caine & Caine, 1994; Yanarateş & Yılmaz, 2022). These activities enhance children's comprehension of both biological and mathematical concepts. Additionally, children can develop numerical thinking skills by analyzing biological data (Schmidt et al., 1997).

Combining mathematical skills with biology education improves children's problem-solving abilities and strengthens their scientific thinking processes. For instance, in a class project, children might measure the germination rate of seeds and analyze the results statistically. Such interdisciplinary activities teach children essential skills like data collection, analysis, and inference (National Research Council, 2000).

5.3 Integration of Biology and Art

Art serves as an effective tool to make abstract concepts in biology more tangible. Children can better grasp biological topics by expressing them through art forms like painting, sculpture, drama, or music (Eisner, 2002; Sevgi & Yılmaz, 2023). For example, illustrating animal habitats through drawing can make biological concepts more meaningful for a child. Drama activities can also help children understand biological processes by acting out the behaviors of animals (Bresler, 1995).

The combination of biology and art also fosters children's creativity. Art projects enable children to explore biological diversity and the aesthetic aspects of nature. For instance, children might study the structure of a leaf and then create a three-dimensional project using clay or paint. These interdisciplinary activities offer deeper learning experiences in both art and science (Marshall, 2014).

5.4 Integration of Biology and Technology

Technology plays a crucial role in making biology education more effective and engaging. Digital tools facilitate children's observation, analysis, and creative project development in biological studies (Jonassen, 2000; Sevgi, Ayyıldız & Yılmaz, 2023). For instance, after observing cells under a microscope, a child can use digital drawing software to illustrate their findings. Children can also use tablets or computers for data collection and analysis during biological experiments (Bers, 2008).

The integration of biology and technology helps children develop digital literacy skills. They learn to use the internet safely for research and create innovative projects using technology. For example, children might produce short documentaries about biodiversity as a video project, effectively combining technology and biological knowledge (Resnick, 2006).

5.5 Advantages of Interdisciplinary Teaching

Interdisciplinary teaching enriches children's learning experiences and enhances their critical thinking skills. This approach allows children to evaluate information from various perspectives and encourages lifelong learning (Beane, 1997). In the context of biology education, interdisciplinary teaching fosters children's interest in nature and supports their creative thinking skills. Moreover, interdisciplinary activities teach children the value of collaboration and integrating knowledge from different fields (Drake, 2007).

6. Conclusion

Biology education plays a crucial role in helping children understand their environment, connect with nature, and develop scientific thinking skills. In early childhood, the fundamental principles of biology education focus on helping children comprehend biological concepts through concrete experiences and increasing their sensitivity to the environment (Yılmaz, 2021a; Yılmaz, 2021b). Play-based and inquiry-oriented learning methods encourage active participation, while integrating biological concepts with disciplines like art, mathematics, and technology makes learning more meaningful.

Interdisciplinary teaching significantly enhances the impact of biology education. By combining biology with mathematics, art, and technology, children gain a broader understanding of biological concepts and develop creative thinking skills. For instance, using mathematical measurements and graphs to study plant growth not only reinforces numerical thinking but also allows children to learn biological concepts through hands-on activities. Similarly, art projects enable children to explore biological diversity and the aesthetic aspects of nature (Yılmaz & Salman, 2022.

The integration of technology into biology education enriches children's learning experiences by allowing them to explore biological processes in virtual environments. Digital tools and interactive applications help children develop independent learning skills and increase their interest in biology. However, the use of technology should be balanced and thoughtful; combining traditional teaching methods with digital tools often yields the best learning outcomes (Küçük-Demir, 2023).

Experiments and observation activities are among the most effective methods for developing children's scientific process skills in biology education. These activities strengthen children's abilities to form hypotheses, collect data, and draw conclusions. Additionally, learning through observation helps children understand the behaviors of living organisms and ecosystems more deeply. Creative methods like storytelling and dramatization enable children to learn biological concepts by forming emotional connections.

In conclusion, biology education is essential for fostering environmental awareness, healthy living habits, and scientific thinking skills in children. Relating biological concepts to different disciplines deepens children's learning and enhances their critical thinking abilities. Interdisciplinary teaching and creative learning methods instill a lifelong curiosity and a desire to learn. Therefore, carefully planned and well-supported biology education in early childhood greatly contributes to children's overall development.

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Chapter 17

An Investigation of Postgraduate Theses on Scientific Process Skills in Preschool Education in Turkey

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Abstract

Scientific process skills (SPS), which are the thought and behavior processes used for science, are skills that facilitate learning in science education. To raise scientifically literate individuals, gaining scientific thinking skills in early childhood is important. This research paper examined scientific process skills in postgraduate theses covering preschool education in Turkish literature. According to the convenience sampling method, 53 graduate theses, the full text of which was accessed from the national thesis center, were evaluated according to the thesis review form. According to the results of the analysis, more than half of the graduate theses related to scientific process skills are master's theses. More than half of the theses are of quantitative research type. When analyzed in terms of the research methods preferred in the theses, the majority of them included experimental research method. According to the sampling method used in the theses, about half used random sampling. Looking at the sample group in the theses, the sample group of most theses consisted of preschool students. It was seen that more than half of the theses included a scale of science process skills.

1. Introduction

Science and technology are changing rapidly in our age. These changes affect individuals and societies. Changes lead individuals to be able to produce knowledge, use it functionally in life, solve problems, think critically, be entrepreneurial, and determined, have communication skills, empathize, contribute to society and culture, etc. At the same time, it forces societies to catch up with changes in science and technology to take their place in

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international competition (MEB, 2018). Science education is an important area to access to current science and technology (Akman et al., 2017). In other words, science education is a tool for understanding and exploring the world. In other words, science education is the education of the food eaten, the water drunk, the car driven, and the electricity used (Gürdal, 1988). Science education contributes to the individual's creative thinking skills, effective communication with teachers, family, and friends, language development, reasoning skills, and the ability to easily solve daily problems (Hancer et al., 2003). The aim of teaching science in schools, which is the process of thinking about the nature of knowledge, understanding existing knowledge, and producing new knowledge, contributes to raising scientifically literate individuals (Çepni et al., 1997; Korkmaz, 2002; MEB, 2018). A scientifically literate individual can comprehend the relationship between science, technology, and society, and can use his/her knowledge in the field of science in solving problems encountered in daily life (Ayvacı & Özbek, 2017). Science literacy plays an important role in developing an individual's ability to maintain meaningful and productive jobs in the future and in enabling societies to keep up with the times (NRC, 1996). Science literacy includes understanding basic science concepts, the nature of science, and the interrelationship between science-technology-society-individual (Liu, 2009). The American Science Association states that a scientifically literate individual uses scientific thought processes to understand scientific concepts and principles and the natural world (AAAS, 1989). Scientific process skills, which facilitate learning to raise scientifically literate individuals, have an important role in science education (Akman et al., 2003).

Scientific process skills are the processes of thought and behavior used for science (MEB, 2018). Scientific process skills are to enable students to gain research methods, be active, and develop a sense of responsibility in learning (Çepni et al., 1997). In the education process, it is important to answer the question of when and at what level these skills should be acquired. Children begin to access information at an early age with a sense of curiosity and research (Tan & Temiz, 2003). From this point of view, scientific process skills should be taught to children from an early age to provide them with a scientific perspective (Kandemir, 2012). The early childhood period, when development and learning are the fastest, is the period when learning takes place actively in interaction with the child's environment. Experiences and gains acquired at an early age contribute to the development of cognitive-affective-social skills and later life skills (Kesicioğlu, 2019). One of the early childhood education is the pre-school education period (Babaroğlu, 2017). Educational activities in the preschool term have short and long-term benefits for the child's cognitive, affective and social development (Barnett, 1992). Today, the changes and developments of information and technological advances are based on a child-centered approach to education and offer a learning experience that takes into account the learner's interests and abilities. This new approach states that the learner is responsible for his/her learning and that learning takes place as a whole. Thus, early childhood education should be supported with child-centered activities (Ekici, 2015). Science education, which includes child-centered activities in this period, is the basic step in the development of creative thinking skills. Preschool science education provides the opportunity to see how children can use information from daily life (MEB, 2013). Scientific process skills, one of the important steps of science education, enable children to raise as scientifically literate individuals (Saraçoğlu, 2012). Therefore, it is important to train children in scientific process skills in preschool education.

2. Scientific Process Skills

Scientific process skills (scientific thinking skills) are the skills of thinking about the scientific problem and presenting the results. Scientific process skills, which are the most powerful tool in producing knowledge about the world, contribute to the student's knowledge structuring, being active, taking responsibility, gaining research methods, and permanence in learning (Arslan & Tertemiz, 2004). Scientific process skills, which include actions such as making scientific predictions by observing the physical and social world, explaining, questioning, and hypothesizing, are thinking skills used in the production of scientific knowledge. Scientific process skills facilitate science learning, allow students to be active and responsible in their learning, and contribute to retention in learning (Çepni et al., 1997). It is known that scientific process skills have a significant effect on attitude towards scientific research (Bahtiyar & Can, 2016), scientific creativity (Aktamış & Ergin, 2007), academic achievement (Mutlu, 2012), and attitude towards science (Yamak et al., 2014). There are some classifications of science process skills in the literature (e.g. Arslan, 1998). In the classification of scientific process skills, it is seen that a step is followed from simple skills to complex skills (Ergin et al, 2005). It is important that teaching from basic to integrated skills is well organized according to the grade level. Some of the skills categorized in the literature are described below (e.g. Akman et al., 2017; Barman, 1992; Çepni et al., 1997; Padilla, 1990; Rezba et al., 2003):

2.1. Basic Skills

2.1.1. Observation

The most basic skill is the ability to observe. However, observation is the most complex skill. The skill of observation, which forms the basis for other skills, is to examine objects directly with the sense organs or indirectly with tools such as telescopes, microscopes, etc. that increase the sensitivity of the sense organs. One or more of the sense organs can be put to work. In other words, the ability to observe is to look, smell or feel carefully and systematically. In science activities, color, size, shape, etc. properties of objects can be observed.

2.1.2. Classification

Classification is the ability to group objects according to certain characteristics. The ability to classify involves grouping objects according to similarities or differences. The ability to classify is related to the ability to observe. By making a good observation, information about objects can be collected and the information collected can be organized with classification skills. Concepts can also be organized with classification skills. In science activities, binary or multiple classifications can be made according to any feature of objects such as color, size, etc.

2.1.3. Inference

Inference skills are possible opinions about an observed situation. It is the evaluation of the information emerging from observations together with experiences. Here, an idea is made about the causes of the situation. On the way to the correct inference, it is important to collect data with good observation and to interpret the observed event well with the collected data. In science activities, children's observations can be questioned.

2.1.4. Prediction

The ability to predict is the ability to anticipate the outcome of an event and/or a situation or to make judgments about the outcome based on experience. In other words, it predicts what the outcome of the event will be. Prediction is achieved through good observation and sensitive measurement. It is achieved by collecting and analyzing appropriate data to support and refute the prediction. The reliability of prediction is related to the accuracy of past observations. In science activities, children can be supported to make predictions about the outcome before the activity.

2.1.5. Measuring

Measure skill is to evaluate the properties of objects numerically. Measurement can take place through direct comparison or with a standard unit. In measure skill, which is the process of comparing an unknown quantity with a known quantity, the object is evaluated quantitatively, its properties are determined or expressed in numbers. In science activities, children can measure changes in the properties of objects such as weight and lightness by observing them and use simple measuring tools.

2.1.6. Communication

The communication is to communicate data obtained through observation in a way that others can understand. In the ability to communicate, it is important to record data to control and present the organization of information. Recording data can be done verbally as well as with representative visuals such as pictures, graphs, etc. In science activities, children can share their work by drawing and using body language.

2.2. Integrated Skills

2.2.1. Interpreting Data

The ability to interpret data is a communication skill to answer the question asked in the problem. Data interpretation involves presenting the results of the analysis. Using representative visual tools such as tables and graphs and statistical skills used in data analysis facilitates interpretation. In science activities, children can interpret the data obtained by comparing it with previously thought data.

2.2.2. Hyphotheses

Questions, predictions and inferences are important in hypothesizing. The ability to form hypotheses are propositions that can test the truth of the problem. A hypothesis is useful when it is tested by observation or experiment. Therefore, a hypothesis based on observations and scientific principles is a good proposition when it is clear, specific, and testable. In hypothesis formulation, there are steps of determining the problem to be investigated well, then collecting and testing data about the problem. The hypothesis should be designed so that its truth or falsity can be proven. In science activities, children can create testable statements based on hypotheses.

2.2.3. Experimentation

The ability to conduct experiments is the ability to design processes of collecting data, testing data, changing variables, controlling variables, and recording data. An experiment can also be based on an observation. Even if it is an observational process, the experiment is based on a plan. Experimentation involves testing hypotheses by collecting empirical evidence. In science activities, children can design experiments to answer the questions they pose.

In addition to these skills from simple to complex, some skills cannot be mentioned such as changing variables and evaluation in this paper. Although the classifications of scientific process skills generally differ according to researchers, it is known that there are more limited skills (such as observation, classification, and measurement) that preschool children should have (AAAS, 1993).

3. Scientific Process Skills in Preschool Education Postgraduate Theses

There are many theses written on scientific process skills in Turkey. Theses are published in the library system of universities and the National Thesis Center of the Council of Higher Education (YOK), where all theses are archived from a common point. The abstract and/or, depending on open access, the full text of the theses produced in Turkish universities can be accessed from the electronic environment of the YOK National Thesis Center (https://tez.yok.gov.tr/UlusalTezMerkezi/). Postgraduate theses related to scientific process skills written within the scope of the preschool period were searched by YOK National Thesis Center. The terms "*preschool education*", "*early childhood education*", and "*scientific process skills* (SPS)" were used for the search on the relevant web. According to the appropriate sampling method, within the framework of these concepts, 53 theses were accessed as open-access full text from the YOK National Thesis Center (Attachment 1). The theses were examined in terms of masthead (year, program) and method (research type, research method, sampling method, sampling group, measurement tool, statistical method) by using the thesis review form developed by Sarı (2011). The SPSS 27 (Statistical Package for the Social Sciences) program was used to analyze the data obtained from theses using the thesis review form. According to the thesis review form, coding compatibility was considered to ensure reliability in theses. In this respect, Miles and Huberman's (2015) formula (Reliability = Consensus/(Consensus + Disagreement)) was used to check the reliability of the researcher's coding and another researcher's coding. The coding agreement rate was calculated as 92%. Analysis results, frequency (N), and percentage (%) values are given. This analysis's result is important in determining the tendency related to scientific process skills in postgraduate theses related to preschool period and guiding future studies.

3.1. Distribution of theses according to years

The distribution of postgraduate theses related to scientific process skills, which can be accessed open access from YOK National Thesis Center, according to years is shown in Table 1.

Table 1. Distribution of theses according to years

Year	N	%
2010	1	1.9
2012	1	1.9
2014	2	3.8
2015	3	5.7
2016	5	9.4
2017	2	3.8
2018	3	5.7
2019	13	24.5
2020	3	5.7
2021	4	7.5
2022	4	7.5
2023	10	18.8
2024	2	3.8
Total	53	100.0

When Table 1 is examined, it is seen that scientific process skills in postgraduate theses written in preschool education were published in 2019 (24.5%), followed by 2023 (18.9%). According to the years, 2 or more theses on scientific process skills were published as of 2014.

3.2. Distribution of theses according to postgraduate program

The distribution of postgraduate theses related to scientific process skills, which can be accessed openly from the National Thesis Center, according to the postgraduate program is shown in Table

Table 2. Distribution of theses according to postgraduate program

Program	N	%
Master	38	71.7
PhD	15	28.3
Total	53	100.0

According to Table 2, 71.7% of the postgraduate theses on science process skills were master's theses, while 28.3% were doctoral theses.

3.3. Distribution of theses according to research type

The distribution of postgraduate theses related to scientific process skills, which can be accessed open access from the National Thesis Center, according to the type of research is shown in Table 3.

Table 3. Distribution of theses according to research type

Research Type	N	%
Mixed Model*	9	17.0
Qualitative	5	9.5
Quantative	35	66.0
Quantitative * Qualitative	4	7.5
Total	53	100.0

** It is quoted as expressed in the theses.*

According to Table 3, 66% of the postgraduate theses on science process skills were quantitative, 9.5% were qualitative and approximately 25% were multiple research types.

3.4. Distribution of theses according to research method

The distribution of postgraduate theses related to scientific process skills, which can be accessed open access from the National Thesis Center, according to the type of research is shown in Table 4.

Table 4. Distribution of theses according to research method

Research Method	N	%
Action Research	3	5.7
Case Study	1	1.9
Correlational Method	1	1.9
Descriptive Method	9	17.0
Descriptive Method, Case Study	1	1.9
Embedding Mixed	1	1.9
Experimental Method	33	62.3
Experimental Method, Case Study	1	1.9
Mixed Method	3	5.7
Total	53	100.0

According to Table 4, among the research methods in postgraduate theses on science process skills, the experimental method (62.3%) was used the most; the survey method (17.0%) was used the second; the action research method (5.7%) and the mixed method (5.7%) were used the third. In the theses, 1.9% used case study, 1.9% used the relational method, and 1.9% used the grounded theory method. When Table 4 is examined, 1.9% of the theses used the survey method and case study method and 1.9% used the experimental method and case study method together.

3.5. Distribution of theses according to the sampling method

The distribution of postgraduate theses related to scientific process skills, which can be accessed open access from the National Thesis Center, according to the sampling type is shown in Table 5.

Table 5. Distribution of theses according to sampling method

Sampling Method	N	%
Cluster Sampling	5	9.4
Purposive Sampling	17	32.1
Random Sampling	23	43.4
Random Sampling, Cluster Sampling	1	1.9
Random Sampling, Purposive Sampling	1	1.9
Missing	6	11.3
Total	53	100.0

When Table 5 is examined, random sampling (43.4%), purposive sampling (32.1%), and cluster sampling (9.4%) methods were used in the postgraduate theses on science process skills. While 3.8% of the theses used more than one sampling method, 11.3% did not indicate the sampling method used.

3.6. Distribution of theses according to sample group

The distribution of postgraduate theses related to scientific process skills, which can be accessed open access from the National Thesis Center, according to the sample group is shown in Table 6.

Table 6. Distribution of theses according to sample group

Sampling Group	N	%
48-60-month-old Children	1	1.9
48-66-month-old Children	1	1.9
48-66 month-old Children, Preschool Teacher	1	1.9
48-66-moth-old Children, 60-66 month-old Children	1	1.9
48-72-month-old Children	2	3.8
5-year-old Children	5	9.4
5-year-old Children, First-grade Children	1	1.9
55-72-month-old Children	1	1.9
6-year-old Children	3	5.7
60-66-month-old Children	1	1.9
60-72-month-old Children	20	37.8
60-72-month-old Children, Parent	1	1.9
60-72-month-old Children, Preschool Teacher	2	3.8
60-72-month-old Children, Preschool Teacher, Academician, Parent	1	1.9
60-72-month-old Children, Preschool Teacher, Science-based Children Book	1	1.9
Preschool Children, Preschool Teacher	1	1.9
Preschool Children	4	7.5
Preschool Teacher	3	5.7
Preschool Teacher Candidate	2	3.8
Missing	1	1.9
Total	53	100.0

According to Table 6, the majority of the sample group in the graduate theses on science process skills consisted of preschool children (90.6%). In the theses, 60-72-month-old children (37.8%), 5-year-old preschool children (9.4%), and preschool children (7.5%) were the most common sample groups. While 9.4% of the theses included more than one sample group, 9.4% included only adults.

3.7. Distribution of theses according to data collection tool

The distribution of postgraduate theses related to scientific process skills (SPS), which can be accessed open access from the National Thesis Center, according to the data collection tool is shown in Table 7.

Table 7. Distribution of theses according to data collection tool

Tools	N	%	Tools	N	%
SPS Scale	5	9.4	SPS Test	3	5.7
SPS form / Observation Form	1	1.9	SPS Scale /* Game-Based Activity	1	1.9
SPS Scale / Science Activity	2	3.8	SPS Test / STEM Activity	1	1.9
SPS Scale / STEM Activity Interview Form	1	1.9	SPS Test / STEM Activity Interview Form	1	1.9
SPS Scale Basic Skills of Preschool Children Scale	1	1.9	SPS Scale Environment Scale For Children	1	1.9
SPS Scale Critical Thinking Skill Rubric	1	1.9	SPS Scale Frostig Visual Perception Scale	1	1.9
SPS Scale / Learning Styles Scale	1	1.9	SPS Scale / Nature Education Program	1	1.9
SPS Scale / Montessori's Activity	1	1.9	SPS Scale / STEM Activity	1	1.9
SPS Scale / Observation Form	1	1.9	SPS Scale / Interview Form	2	3.8
SPS Scale / Science Literacy Scale	1	1.9	SPS Scale / Science Efficacy Form	1	1.9
SPS Scale / Block Code Program	1	1.9	SPS Scale / Primary Program	1	1.9
SPS Scale / Drama-Based STEM Program Torrance creative thinking	1	1.9	Bracken Basic Concept Scale Observation Form	1	1.9
SPS Scale / Diary / Video Science Concepts	1	1.9	SPS Scale / STEM Teaching Scale Awareness Scale of STEM	1	1.9
SPS Scale / Observation Form Scale of Preschool Teachers' Competency	1	1.9	SPS Test / Interview Form Stem Activity	1	1.9
SPS Test Observation Form / Interview Form	1	1.9	SPS Interview Form Course Plan / Observation Form	1	1.9

SPS Test Decision-Making Test Problem Solving Skill Test	1	1.9	SPS Scale Evaluation of Critical Thinking Through The Philosophical Inquiry Scale	1	1.9
SPS Scale STEM Program	1	1.9	SPS Scale / Stem Activity Cognitive Field Development Form	1	1.9
SPS Scale / Science Attitude Scale Science Self-Efficacy Scale Mathematics Attitude Scale	1	1.9	SPS Form / Interview Form Problem-Solving Scale Science Self-Efficacy Belief Scale	1	1.9
SPS Scale Bracken Basic Concept Scale Inquiry-Based Science Education Program	1	1.9	SPS Scale Scale for The Tendency to Play Games Game Skills Assessment Scale	1	1.9
SPS Test / Interview Form Boehm Test of Basic Concepts Science Activity Based on Reggio Emilia	1	1.9	SPS Scale / Risk Factors List Early Childhood Resilience Scale Mathematic Content Standards Scale	1	1.9
SPS Scale Observation Form Interview Form / Document	1	1.9	SPS Scale / Observation Form Early Learning Skills Scale Interview Form / Document	1	1.9
SPS Test / Diary Early Schildhood Creativity Scale Problem-Solving Skills Scale Observation Form	1	1.9	SPS Scale Torrance Creative Thinking Photos / Observation Form 5w Form / Interview Form	1	1.9
Total	N= 53	%100			

** "/" sign is used for comma purposes.*

When Table 7 is examined, it is seen that the science process skills scale was used in the majority of the theses. The SPS (Scientific Process Skills) scale (60.8%) was used frequently in the theses, SPS test (13.2%) was used second frequently, and the SPS form (5.7%) was used third frequently. While 15.2% of the theses used a single measurement tool, the others frequently used more than one measurement tool

3.8. Distribution of theses according to statistical methods used in the research

The distribution of postgraduate theses related to scientific process skills, which can be accessed open access from the National Thesis Center, according to the data collection tool is shown in Table 8.

Table 8. Distribution of theses according to statistical method

Statical Method	**N**	**%**
Content analysis	2	3.8
Descriptive analysis	1	1.9
DFA, one-way ANOVA	1	1.9
Mann Whitney U test	2	3.8
Mann Whitney U test, Kruskal Wallis H Test	2	3.8
Mann Whitney U test, Kruskal Wallis H Test, Wilcoxon Signed Rank test	2	3.8
Mann Whitney U test, Wilcoxon Signed Rank test	10	18.9
Mann Whitney U test, Wilcoxon Signed Rank test, ANCOVA	2	3.8
Mann Whitney U test, Wilcoxon Signed Rank test, Content Analysis	2	3.8
Mann Whitney U test, Wilcoxon Signed Rank test, Spearman Correlation	1	1.9
One-way ANOVA, Two-way ANOVA, Hierarchical Multiple Regression	1	1.9
Rasch Model, Content Analysis	1	1.9
Reliability, Validity	1	1.9
T-test	4	7.5
T-test, Content Analysis	2	3.8
T-test, Mann Whitney U test, Wilcoxon Signed Rank test, Kruskal Wallis H test, one-way ANOVA	1	1.9
T-test, Mann Whitney U test, Kruskal Wallis H test, one-way ANOVA	1	1.9
T-test, Mann Whitney U test, Content Analysis	1	1.9
T-test, Mann Whitney U test	1	1.9
T-test, one-way ANCOVA, two-way ANOVA	1	1.9
T-test, one-way ANOVA	6	11.3
T test, one-way ANOVA, Kruskal Wallis H test	1	1.9
T-test, Wilcoxon Signed Rank test	2	3.8
Wilcoxon Signed Rank test	1	1.9
Wilcoxon Signed Rank test, Content Analysis	2	3.8
Wilcoxon Signed Rank test, Kruskal Wallis H test	2	3.8
Total	53	100.0

According to Table 8, the Mann Whitney U test and the Wilcoxon Signed Rank test (18.9%), the T-test, the one-way ANOVA (11.3%), and the T-test (7.5%) were the most common statistical methods used in theses on science process skills. When Table 8 is examined, 3.8% of the theses used content analysis; 3.8% used the Mann Whitney U test; 1.9% used descriptive analysis; and 1.9% used the Wilcoxon Signed Rank test. 81.1% of the theses stated that they used more than one statistical method.

4. Conclusion

Preschool children's experiences with the environment they observe are among the subjects of science teaching. The goal of science teaching is to raise science literate individuals (MEB, 2018). To achieve this goal, scientific process skills have an important place in science teaching (Akman et al., 2017). For science literacy, preschool children need to acquire scientific process skills through activities. To improve the quality of preschool science education for children aged 36-72 months in Turkey, the preschool curriculum is organized in light of scientific developments (e.g. MEB Preschool Teaching Curriculum, 2013, 2018). These programs are based on teaching scientific process skills to preschool students to teach them scientific thinking and research methods. Accordingly, in this article, "Scientific process skills in preschool graduate theses in Turkey were examined. We accessed 53 open-access theses from the database of the YOK National Thesis Center. While more than half of the theses written within the scope of scientific process skills are master's theses; less than half of them are doctoral theses. Postgraduate theses on scientific process skills were most frequently produced in 2019, followed by 2023. In theses, quantitative research was the most common research type, followed by multiple research types. As a research method, more than half of the theses used experimental research methods. In postgraduate theses, the random sampling method was most frequently used as the sampling method, and the purposive sampling method was preferred secondly. The sample group of almost all of the theses consisted of children aged 48 months and above, while very few of them consisted of only adults or children with adults. Although differences were observed in terms of the variety of data collection tools in the theses, it was observed that more than half of them used the science process skills scale. It was observed that most of the theses used parametric and nonparametric tests based on comparison analysis as statistical methods. Since it is important to support and improve the scientific process skills of preschool children in line with the goal of science literacy, it is recommended that research methods, sampling methods, and diversity of sampling groups should be included in future studies.

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