Chapter 1

Astronomy Education in Preschool: Foundations of Early Scientific Thinking[1]

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Abstract

This section examines the role of astronomy education in the preschool period in establishing the foundations of scientific thinking within a theoretical and pedagogical framework. Astronomy education contributes to the development of scientific literacy by supporting children's curiosity, observation, and inquiry skills at an early age. The study presents a constructivist learning ground based on Piaget's cognitive development, Vygotsky's sociocultural, and Papert's constructivist approaches. In line with these theoretical foundations, astronomy education has been integrated with concrete materials, games, storytelling, drama, and design-oriented activities. The interdisciplinary application of astronomy themes through the STEAM approach supports the development of creativity, aesthetic awareness, and problem-solving skills in children. Within the context of the Turkey Century Education Model (TCEM), astronomy teaching is directly linked to the field of science; pedagogical practices consistent with discovery, observation, production, and value-based learning processes are proposed. The chapter also details observation-based assessment tools, family involvement strategies, and teacher guidance processes. In conclusion, astronomy education in early childhood is defined as an interdisciplinary and holistic learning area that contributes to children's scientific identity and curiosity development.

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1. Introduction

Astronomy is a field that nurtures children's fundamental curiosity about nature and the universe and holds strong potential for building scientific thinking in the early years. The preschool period is a critical stage of development when individuals form their first mental models of the phenomena around them. During this period, children develop explanations based on their own observations of concepts such as the sky, the Sun, the Moon, and the stars (Bryce & Blown, 2013; Jones et al., 1987). However, these explanations are often intuitive and may also involve misconceptions that conflict with scientific knowledge (Vosniadou & Brewer, 1992). Therefore, starting astronomy education at an early age is critically important for the development of children's scientific thinking, observation, and inquiry skills. Science education in early childhood has been promoted since the 1960s with the goal of scientific literacy, and especially since the 1990s, astronomy themes that support children's curiosity-based learning processes have begun to be included in education programs (Worth & Grollman, 2004; Lelliott & Rollnick, 2010).

Astronomy education in early childhood not only imparts knowledge but also supports children's curiosity, discovery, observation, cause-and-effect reasoning, and problem-solving skills (French, 2004). It also contributes to the holistic structuring of science and nature-based learning processes. In this context, astronomy education enables the integration of science, technology, engineering, art, and mathematics (STEAM) fields in the preschool period. While observing celestial movements, children can experience mathematical concepts such as time, direction, numbers, measurement, and spatial awareness; in activities such as telescope construction, they can experience engineering and design-oriented thinking processes (Patrick et al., 2009).

Furthermore, it has been determined that early astronomy education contributes to the development of scientific identity and epistemic curiosity in children (Cheryan et al., 2017). Small observation activities, sky models, storytelling, and game-based experiences in learning environments increase children's tendency to produce explanations for natural phenomena. When evaluated within the framework of Vygotsky's (1978) social interaction-based learning theory, this shows that children construct scientific meaning through social and linguistic tools.

Recent studies have shown that astronomy education in early childhood supports not only conceptual development but also emotional and aesthetic awareness (Lelliott & Rollnick, 2010; Trundle, 2010). Sky observations enable children to gain awareness of their place in the universe and develop a sense of wonder and conservation towards nature. This demonstrates that astronomy education has gained importance as a value-based learning area in the context of sustainability education.

The Science, Nature, and Environment area included in the Turkish Century Education Model (TCEM) aims to develop children's environmental awareness and love of nature in early childhood, and astronomy concepts are a direct part of this area. Therefore, astronomy education in preschool must be approached in a way that is both consistent with the national curriculum and integrated with contemporary learning approaches.

2. Theoretical Framework

The theoretical basis for astronomy education in early childhood is built on children's developmental characteristics, cognitive structures, and social learning processes. During this period, children produce intuitive explanations to make sense of the natural phenomena they observe in their environment; these explanations shape both their ways of thinking and their scientific understanding. Therefore, astronomy education requires the creation of constructivist learning environments based on children's existing mental models (Fleer, 2009).

2.1. Piaget and the Cognitive Development Approach

Piaget's cognitive development theory proposes that learning in early childhood occurs through children's active mental constructions. According to Piaget (1952), children between the ages of 2 and 7 are in the preoperational stage, and thinking at this stage is based on perceptual characteristics and intuition. In the context of astronomy, children tend to explain their observations, such as the Sun "moving across the sky" or the Moon "following them," through egocentric thinking (Vosniadou & Brewer, 1992). Therefore, teaching astronomy concepts should aim to discover children's existing mental models and reconstruct these models with scientific concepts.

The Piagetian approach argues that early learning should be supported through concrete experiences, manipulative materials, and experimental activities. For example, scaled models of planets or sky simulations can help children transform abstract astronomy concepts into concrete experiences (Piaget, 1970).

2.2. Vygotsky and the Sociocultural Approach to Learning

Vygotsky's (1978) sociocultural theory emphasizes that learning occurs through social interaction and language. According to this perspective, the learning of astronomy concepts takes place within children's zone of proximal development; that is, children can understand complex sky events with the guidance of adults or peers.

For example, a teacher observing the night sky with a child and asking guiding questions ("Where do you think the Sun went?", "Why might the Moon change shape?") triggers cognitive discovery in the child. Such social interactions support meaning construction through language. Therefore, astronomy education in early childhood is not only a cognitive process but also a linguistic, social, and cultural process (Fleer, 2022).

Vygotsky's theory emphasizes the guiding role of teachers while also placing children's active participation at the center. During astronomy activities, methods such as group discussions, storytelling, or drama encourage children to develop scientific discourse and share their thoughts.

2.3 Papert and Constructionism

Papert's (1980) constructionism approach is based on Piaget's constructivist theory but defines learning as "learning by creating concrete products." This approach directly links early childhood astronomy education with STEAM environments. Children can integrate both engineering and science concepts by designing their own telescopes, rocket models, or planetary systems.

The constructionist approach enables children to "think by touching" and supports them in understanding abstract scientific concepts through doing and experiencing. For example, a child who designs the Solar System with simple cardboard models also learns concepts such as scale, rotation, and orbit experientially. This directly corresponds to design-oriented thinking in STEM-based early childhood education (Resnick, 2017).

2.4 Inquiry and STEM/STREAM Approaches

Astronomy education is naturally compatible with the inquiry-based learning approach. When children make observations about the sky, they ask questions such as "why," "how," and "when," which form the basis of scientific thinking (Trundle, 2010). The inquiry- e approach allows children to generate their own hypotheses, make observations, and develop explanations.

Furthermore, the STEAM approach brings astronomy education into an interdisciplinary context. For example, the "Phases of the Moon" activity integrates science, mathematics, art, and literacy, while the "Designing My Own Telescope" activity offers a learning experience that incorporates engineering and technology dimensions (Doğanay et al., 2024).

The STEAM approach also supports language development and creative thinking processes in early childhood. Children's verbal expression of their observations and narration of their sky experiences through stories or poetry enriches learning on both cognitive and affective levels (Brenneman et al., 2019).

2.5 Theoretical Approach in the Context of the Turkey Century Education Model (TCEM)

The Turkey Century Education Model (TCEM) aims to develop children's awareness and sensitivity to natural phenomena by focusing on science learning in early childhood (MONE, 2024). TCEM's constructivist and integrative philosophy links astronomy teaching to children's curiosity and observation skills.

The model centers on the processes of "discovering, observing, questioning, and creating," anticipating the laying of the foundations of scientific literacy at an early age. In this context, astronomy education helps children perceive celestial events not only as information but as life experiences. Furthermore, since TCEM emphasizes the emotional, value, and aesthetic dimensions in learning processes, astronomy-based activities have the potential to foster respect for nature, curiosity, responsibility, and awareness of the universe in children.

During early childhood, children develop a natural curiosity about astronomical concepts because they observe celestial events directly. However, this curiosity, when combined with intuitive thinking processes, often leads to the emergence of mental models that differ from scientific explanations (Vosniadou & Brewer, 1992). Therefore, astronomy education in preschool should aim to bridge the gap between children's existing cognitive structures and scientific concepts.

3. Children's Approach to Astronomy Concepts

Children interpret the sky according to their own experiences. For example, explanations such as the Sun "following them," the Moon "appearing at night," the Earth being "flat," or stars being "small stones that emit light" are concept patterns frequently observed at an early age (Sharp, 1996). These explanations arise from children's observational experiences but stem from their inability to fully grasp abstract spatial relationships (e.g., the spherical shape of the Earth or orbital movements) due to their cognitive development level (Blown & Bryce, 2010; Hayati & Asbi, 2025).

Research shows that children aged 4–7 typically perceive the relationship between the Sun, Moon, and Earth in a geocentric (Earth-centered) manner, meaning they believe the Sun revolves around the Earth (Plummer & Krajcik, 2010). This is a typical reflection of the "intuitive thinking" stage defined by Piaget (1952). When explaining their observations, children rely on their direct perceptual experiences rather than logical reasoning.

The Sun, Moon, and Earth form the core of children's conceptual system of astronomy. Children's understanding of the relationships between these concepts is fundamental to their ability to perceive the universe systematically. Sun: Children generally think that the Sun moves, "rises," and "sets." These observations are not sufficient to explain that the Sun's changing position in the sky is caused by the Earth's rotation (Hannust & Kikas, 2007; Nobes et al., 2003).

Moon: The phases of the Moon are a complex concept for children. Most children think that the Moon "changes shape" or "appears in different places in the sky." The understanding that the Moon becomes visible due to the light it receives from the Sun requires a level of abstract thinking and is not fully established in the preschool period.

Earth: Children generally perceive the Earth as "flat"; knowledge that it is round remains an abstract statement unless based on experiential foundations. Concrete materials, balls, or sphere analogies are quite effective in teaching the global model (Vosniadou, 2013).

3.1 Conceptual Misconceptions and Conceptual Change

The misconceptions observed in children's astronomical concepts stem not only from a lack of knowledge but also from the nature of cognitive models. Vosniadou and Brewer (1992) state that children develop "hybrid models" about the Earth; for example, they produce explanations such as "it is round, but there is a flat area on which we live." Such explanations show that scientific and intuitive knowledge coexist in the child's cognitive system.

Therefore, the goal in the teaching process is not to directly correct children's misconceptions, but to understand why they produce these explanations and to help them develop alternative, more consistent models (Land & Jonassen, 2012). Conceptual change is possible when children reorganize new information without creating conflict with their existing cognitive structures (Posner et al., 1982).

3.2 Teaching Strategies and Supporting Conceptual Development

Astronomy instruction in early childhood should be conducted using discovery-based and play-based strategies rather than direct instruction. Teachers should create environments that maintain children's curiosity and encourage observation. Effective teaching strategies are summarized below:

- Learning with concrete models: Models of the Solar System made from materials such as cardboard, clay, and light sources help children grasp spatial relationships more easily.
- Storytelling and dramatization: Stories such as "The Journey of the Moon and the Sun" help children internalize concepts in an emotional context.
- Observation-based learning: Observing changes in shadow length during the day or the Moon's position in the sky provides children with direct experience.
- Inquiry-based activities: Open-ended questions such as "Why does night fall?" and "Why is the Sun hot?" develop children's hypothesis-generating skills (Siry et al., 2023).

3.3 Family Participation and Environmental Interaction in Conceptual Learning

Families play a significant role in children's lasting learning of astronomy concepts. Experiences such as observing the sky at home, reading simple astronomy books, or visiting museums support conceptual development (Patrick & Mantzicopoulos, 2016). Furthermore, teacher-family collaboration facilitates children's transfer of what they learn at school to their daily lives.

Family involvement not only reinforces learning but also strengthens children's scientific self-efficacy and epistemic curiosity (Siry et al., 2023; Vosniadou, 2008). Thus, astronomy education not only transfers knowledge but also lays the foundations for the development of scientific identity in children.

3.4 The Instructional Position of Astronomy Concepts in TCEM

The Turkey Century Education Model (TCEM) aims to develop children's observation and inquiry skills regarding natural phenomena in the "Science, Nature, and Environment" field in preschool (MONE, 2024). In this model, astronomy themes are included under subheadings such as "day-night difference," "weather events," "seasons," and "sky observation." TCEM's value-based learning approach requires that astronomy concepts be addressed not only cognitively but also emotionally and aesthetically.

In this context, a teaching approach that makes children aware of their place in the universe, nurtures their curiosity and sense of wonder, and integrates observation and inquiry processes should be adopted. Astronomy education enables children to connect with nature, develop observations-based thinking, and gain an open-minded attitude toward scientific explanations.

4. Pedagogical Approaches and Teaching Practices

The effectiveness of astronomy education in the preschool period depends on selecting pedagogical approaches that are appropriate for children's cognitive levels, curiosity, and play-based learning tendencies. During this period, learning is shaped around play, observation, experience, and interaction. Therefore, instead of traditional knowledge transfer, active, integrated, and constructivist teaching strategies that encourage children's active participation should be adopted in astronomy education (Fleer, 2022; O'Connor et al., 2021).

4.1. Play-Based Learning Approach

Play is the natural context for learning in the preschool period. Astronomy-themed games enable children to develop both scientific concepts and social-emotional skills. For example, in the "Space Adventure Game" activity, children take turns visiting "planet stations" on a simple planet course set up in the classroom. At each station, a task (e.g., "Find the planet closest to the Sun," "Model the shape of the Moon") is completed.

In such games, children learn scientific knowledge indirectly while also acquiring social skills such as waiting in line, teamwork, and communication (Brenneman et al., 2019). Furthermore, the game context provides internal motivation for learning by maintaining the child's curiosity.

Here, the teacher is not a "knowledge provider" but a "guide who facilitates the flow of the game." The symbols, gestures, and conversations children use during the game can be evaluated through observation; this provides important clues for understanding both the cognitive and affective dimensions of learning.

4.2. Storytelling and Astronomy with Language Development

Astronomy is an extremely suitable learning area for storytelling. Stories give children the opportunity to make sense of abstract concepts within concrete storylines (Kapsala & Mavrikaki, 2020). For example, a story titled "The Sun's Tired Day" can describe how the Sun rises every morning and goes to rest in the evening. This story helps children intuitively grasp the day-night cycle.

Storytelling activities support scientific thinking and awareness of causality along with language development. After the story, the teacher can ask questions such as:

"Why might the Sun be tired?"

"What else do you think changes when night falls?"

Such questions develop children's ability to produce explanations, establish cause-and-effect relationships, and verbally express their observations (French, 2004). In addition, astronomy activities supported by stories ensure the integration between the "language and cognitive development areas" of the Turkey Century Education Model (MONE, 2024).

4.3. Drama and Role-Playing Approaches

Drama supports learning through physical expression in early childhood. Astronomy-themed dramas allow children to discover abstract concepts through "thinking with the body" (Lobman, 2018).

For example, in an activity called "Sun, Moon, and Earth Dance," children are selected in groups of three: one is the Sun, one is the Earth, and one is the Moon. While the Sun remains stationary, the Earth revolves around it; the Moon revolves around the Earth. This dramatic enactment concretizes concepts such as the Earth's rotation and the Moon's orbit.

Drama activities develop children's scientific awareness and empathic thinking skills. They also support communication within the group, movement coordination, and emotional expression skills.

4.4. Integration of Art, Design, and Creativity

Art allows children to internalize the aesthetic aspects of astronomical concepts. Children can express their observations of the sky through drawing, painting, collage, or three-dimensional model design. These activities can develop children's observation skills, attention to detail, and creativity.

For example, in an activity called "My Galaxy," children are given black cardboard and glitter paints. Children draw their own galaxies, name their planets, and describe them. This develops both spatial awareness and original expression skills (Varelas et al., 2010; Walan & Enochsson, 2019).

From a STEAM perspective, art acts as a bridge connecting the disciplines of science and engineering. Children can experience both visual design and scientific modeling processes together.

4.5. STEAM-Based Applications

Astronomy is, by its very nature, an interdisciplinary field of science. Therefore, when integrated with the STEAM approach, it can produce powerful learning outcomes.

Below are examples of STEAM activities that can be implemented at the preschool level:

Activity 1. Finger Rocket **Objective:** To help children recognize that movement is created by air pressure. **Materials:** Pipette, A4 paper, tape, scissors, felt-tip pen. **Process:** 1. Children draw and cut out small rockets from A4 paper. (A ready-made rocket model can also be provided.) 2. The bottom of the rocket is sealed with tape, leaving enough space for the straw to fit through. 3. The rocket is placed on the pipette and blown to launch it. 4. A discussion is held: "Whose rocket went farther?" **Developed Skills:** Motor skills, measurement, establishing cause-and-effect relationships, observation. **Evaluation Questions:** 1. Why did the rocket move? 2. What could be changed to make it go farther? 3. What happened when you blew?	**Activity 2. Water Rocket** **Objective:** To experience the relationship between pressure and force. **Materials:** Plastic bottle, water, water rocket kit, pump. **Process:** 1. The bottle is shaped into a rocket and decorated as desired. 2. The bottle is filled halfway with water. 3. The bottle is placed on the rocket ramp and air is pumped into it. 4. When the pressure increases, the trigger is pulled and the rocket is launched upward. 5. The rocket flight is observed and the results are discussed. **Developed Skills:** Scientific process, cause and effect, attention, problem solving. **Assessment Questions:** 1. Why did the rocket take off? 2. What can be done to make it fly higher? 3. What would happen if there were no air?	**Activity 3. Astronaut Mask** **Objective:** To introduce astronauts and raise awareness about life in space. **Materials:** Paper plate, aluminum foil, string, paint, scissors. **Process:** 1. Cut the center of the cardboard plate to form a mask shape. 2. Cover it with foil and tie the string. 3. Children act out a drama themed "If I were an astronaut...". **Developed Skills:** Language skills, social-emotional development, creativity. **Assessment Questions:** 1. Why do astronauts wear special suits? 2. What might they encounter in space? 3. If you were an astronaut, what would you discover?

Activity 4. Planet Necklace **Objective:** To learn about the solar system and develop sequencing skills. **Materials:** Beads, string, planet images. **Process:** 1. Each bead represents a planet. 2. Children string them in order on the string to create "planets moving away from the Sun." 3. The necklace is worn, and the names of the planets are said aloud. **Developed Skills:** Sequencing, visual matching, color–size awareness. **Assessment Questions:** 1. Which planet is closest to the Sun? 2. Which was the largest planet? 3. If you were an alien, which planet would you want to live on?	**Activity 5. My Own Telescope** **Objective:** To learn about observation tools and understand the principles of a telescope. **Materials:** Cardboard or plastic tube, plastic lens, paint, tape, **Process:** 1. Children connect two cardboard tubes. 2. A thin-edged lens is placed on the front, and a thick-edged lens is placed on the back. 3. The telescope is painted and decorated. 4. A "Sky Observation Hour" is held, and children observe the sky from the window. **Developed Skills:** Observation, hand–eye coordination, creativity, science awareness. **Evaluation Questions:** 1. What did I see with my telescope? 2. What is a real telescope used for? 3. What did I notice while observing?	**Activity 6. Journey Through the Sky at the Planetarium** **Objective:** For children to observe stars, planets, and the sky in a professional planetarium environment in three dimensions **Materials:** Planetarium **Process:** 1. The teacher explains to the children what a planetarium is. 2. They spark curiosity by saying, "There is a place where we can observe the sky even during the day." 3. Concepts such as stars, planets, and the Moon are introduced to the children with pictures. 4. The children are taken to the planetarium. 5. A related film is watched. **Developed Skills:** Cognitive: Observation, attention, establishing cause-and-effect relationships. **Evaluation Questions:** 1. What did you see in the planetarium? 2. How did the stars appear to you? 3. Which planet interested you the most? 4. What would you like to do if you were in space?

Activity 7. Moon Phases with Biscuits	Activity 8. Star Hunt	Activity 9. Observing the Sun with a Telescope
Objective: To identify and sequence the phases of the moon. **Materials:** Chocolate-filled cookies (e.g., Oreos), plastic knife, cardboard, pen. **Process:** 1. The cookies are split in half, and the cream is carved into different shapes to form the phases of the moon (New Moon, Crescent, First Quarter, Full Moon, etc.). 2. Children arrange the phases in the correct order and glue them onto the cardboard. 3. The teacher identifies which phase it is at each stage. **Developed Skills:** Fine motor skills, Sequencing, Science awareness, Attention development **Assessment Questions:** 1. Which cookie represents the Full Moon? 2. What shape is the crescent moon? 3. What do we call it when we see the entire moon?	**Objective:** To introduce the concept of constellations. **Materials:** Black cardboard, needle, flashlight. Process: 1. Punch holes in the cardboard and create a star pattern. 2. The flashlight is held from behind, and the stars are projected. 3. Each child names their own constellation. **Developed Skills:** Visual perception, pattern recognition, creativity. **Evaluation Questions:** 1. How do the stars appear? 2. Do the stars move? 3. What name did you give your own constellation?	**Objective:** To help children understand the structure of the Sun, its ability to emit light, and its importance in the sky. **Materials:** A telescope with a safe solar filter for observing the Sun (special solar filter) **Process:** 1. The teacher explains to the children that the Sun is a star and a source of light. 2. It is emphasized that one should never look directly at the Sun for the sake of eye health. 3. The children take turns approaching and observing the reflected sunspots and the corona. **Developed Skills:** Science awareness: Concepts of light, heat, and stars. **Assessment Questions:** 1. What did you see through the telescope? 2. How did the Sun appear to you? 3. Why was the Sun so bright? 4. Why is it dangerous to look at the Sun with the naked eye?

Such activities develop children's scientific thinking, creative problem-solving, and interdisciplinary connection skills (Doğanay et al., 2024).

4.6. Teacher Role and Learning Environment Organization

Astronomy education is based on the teacher's guiding role. The teacher should be a "learning designer" who guides children's questions, helps them make sense of their observations, and continuously enriches the learning environment (Broström, 2015; Ravanis, 2017).

An effective astronomy learning environment:

- Includes experimental materials (globe, flashlight, mirrors, posters) in different corners,
- Encourages documenting learning with reflective tools such as observation journals and sketchbooks,
- Deepens children's thinking through open-ended questions,
- Includes group activities that support collaboration among students.

4.7. Family Participation and Astronomy Activities at Home

Families can support astronomy learning at home with reinforcing activities. For example, in a "Sky Observation Night" activity, families observe the evening sky with their children, draw the shape of the Moon, and bring it to school the next day. This activity strengthens both home-school collaboration and the child's sense of ownership of learning (Blanco-Chamborro et al., 2023).

Families can also read simple space-themed books with their children, organize trips to science centers, or use sky mobile applications together. In this process, teachers' guidance to families ensures the continuity of learning.

4.8. The Benefits and Applicability of Astronomy Activities in Special Education

Astronomy-themed STEM activities in early childhood provide rich learning environments that keep children's scientific curiosity alive and integrate learning with hands-on experience. These activities not only serve science education but also support children's cognitive, affective, social, and motor development domains. Particularly for children with special educational needs, astronomy themes offer multisensory, constructivist, and interactive learning processes that facilitate participation and meaning-making (Çakabay & Mete, 2025; Kaplan & Tekinarslan, 2020).

According to constructivist learning theory, children do not acquire knowledge directly but construct it through experience. Astronomy themes concretize this process of construction through observation, modeling, experimentation, and drama. The Türkiye Yüzyılı Maarif Model (MoNE, 2024) emphasizes the importance of holistic and inclusive learning environments that foster scientific inquiry in early childhood. In line with this approach, the astronomy activities developed within the "Overcoming Barriers with STEM" project have emerged as exemplary practices ensuring equal participation of children with special needs in learning processes.

The most significant contribution of astronomy-themed activities to special education is their ability to make abstract concepts tangible through multisensory experiences. Regardless of visual, auditory, attentional, or intellectual impairments, each child can actively participate in learning by engaging their most effective sensory channels. For example, the "Finger Rocket" and "Water Rocket" activities teach the relationship between air pressure and force while enhancing cause-and-effect reasoning. Children with visual impairments can feel different rocket surface textures, while those with hearing impairments can be guided through color cards. Such adaptations strengthen attention and motor coordination skills (Trundle, 2010).

The "Phases of the Moon" and "Moon Phases with Biscuits" activities support sequencing and classification skills. Children with visual impairments perceive the cream patterns on biscuits through touch, while those with intellectual disabilities engage with a simplified version of the model with fewer phases. For children on the autism spectrum, the phases are linked to daily life routines ("when the sun rises – when evening comes"), making learning more predictable, safe, and meaningful (Brenneman et al., 2019).

Activities such as the "Astronaut Mask" and drama-based practices significantly contribute to children's social and emotional development. By embodying a scientific role, children enhance empathy and identification skills. Children with visual impairments decorate their masks through touch, while those with hearing impairments express themselves through gestures, facial expressions, or sign language. For children on the autism spectrum, short and structured dramatic roles increase focus and communication skills (Lobman, 2018; Carr & Lee, 2012).

Art- and design-based activities also hold high potential in the context of special education. In "Planet Necklace" or "My Galaxy" activities, children develop awareness of color, size, and order. Children with visual impairments distinguish bead sizes by touch, while those with attention difficulties benefit from high-contrast colors. Through these processes, children's creative thinking, expression, and planning skills are strengthened (Varelas et al., 2010; Walan & Enochsson, 2019).

The "Journey Through the Sky in the Planetarium" activity provides children with a three-dimensional observational experience that brings abstract astronomical concepts to life. Children with visual impairments benefit from audio descriptions; those with hearing impairments are supported by subtitles and visual content. Light and sound levels can be adjusted for children on the autism spectrum. This activity not only conveys scientific knowledge but also fosters curiosity, attention, and emotional security (Blanco-Chamborro et al., 2023).

One observation-based activity, "Observing the Sun Through a Telescope," helps children develop scientific awareness. Using safe observational tools, children experience and understand the concepts of light and heat. For children with visual impairments, temperature differences are introduced through tactile experiences; for those with hearing impairments, explanatory subtitles accompany the video demonstrations.

When implemented under teacher guidance in individualized and multisensory ways, all these activities create inclusive learning environments for children with special educational needs. Family involvement further reinforces learning permanence. Small home tasks such as "Sky Diary" or "My Star" can extend curiosity beyond the classroom (Siry et al., 2023).

In conclusion, astronomy-based STEM activities in early childhood special education serve not only science teaching but also the development of social participation, communication, self-confidence, and creativity. Findings from the "Overcoming Barriers with STEM" project demonstrate that such activities enable each child to participate in scientific processes according to their capacities, making learning genuinely inclusive. In this sense, astronomy themes act as a strong educational bridge that embodies the idea of "science for every child" in early childhood education.

5. Assessment and Observation Processes

For astronomy education to be effective at the preschool level, it depends not only on children's participation but also on the systematic observation and evaluation of learning processes. In early childhood, evaluation focuses more on understanding how children's thinking, observation, questioning, and curiosity behaviors develop rather than measuring cognitive gains (Shepard et al., 2018).

Therefore, the assessment process in astronomy education should be conducted using an observation-based, qualitative, child-centered, and process-oriented approach. This approach provides a holistic picture of the child's learning process and strengthens the teacher's pedagogical guidance (Worth & Grollman, 2003).

5.1. The Philosophy of Assessment Approaches

Astronomy education in preschool focuses on the process of discovery, curiosity, and explanation as much as on conceptual accuracy. Therefore, assessment should aim to understand "how the child thinks and learns" rather than "what the child knows" (Fleer, 2009).

In this context, three fundamental assessment approaches come to the fore:

Observation-Based Assessment: Systematic observation of the child's behavior during play, drama, storytelling, or activities.

Performance-Based Assessment: Examining the child's process of creating a product (e.g., making their own telescope, creating a model of the phases of the moon).

Reflective Assessment: Providing the child with the opportunity to express their own thoughts verbally, through drawings, or dramatically.

These approaches reflect not only the extent to which children understand astronomy concepts, but also how they develop scientific awareness in their learning processes (Trundle, 2010).

5.2. Key Components of the Observation Process

In early childhood astronomy education, observation is both a learning tool and an assessment strategy. The teacher systematically records how children make their observations, what clues they pay attention to, and how they construct their explanations.

An effective observation process includes the following steps:

Planning: Pre-determining the behaviors, concepts, and learning objectives to be observed.

Observation: Recording the child's behavior in their natural learning environment (during play, drama, storytelling).

Interpretation: Comparing observations with children's cognitive development level and teaching goals.

Reflection: Reorganizing teaching strategies based on the observations.

This process is consistent with the formative assessment approach; it provides continuous feedback throughout the learning process (Black & Wiliam, 2009).

Some key behavior categories that can be observed in astronomy-themed learning processes are as follows:

Table 1. Observation categories

Category	Examples of Behaviors to Observe	Assessment Indicator
Curiosity and Exploration	Asking questions about the sky, wanting to observe	Asks cause-and-effect questions such as "Why does night fall?"
Observation Skills	Carefully examining objects, noticing changes	Notices that the length of shadows changes over time
Questioning and Prediction	Formulating hypotheses, proposing explanations	Provides logical explanations to questions such as "What would happen if there were no sun?"
Communication and Sharing	Expresses observations verbally, through drawings, or dramatically	Can explain the results of their observations to their friends
Creativity and Production	Creating astronomy-themed products	Defines the characteristics of their own "planet" by designing it
Scientific Attitude	Patience, attention, open-mindedness, cooperation	Behaves carefully while observing, respects others' ideas

This table enables teachers to systematically monitor children's astronomy-themed learning processes through qualitative indicators.

The tools used to assess astronomy learning in preschool are tools that reflect the child's active participation and document the observation and production processes. The tools highlighted in the literature are as follows:

Observation Forms: Short notes or checklists where the teacher systematically records their observations during the activity.

Anecdotal Records: Short, descriptive notes taken by the teacher when the child exhibits a specific behavior.

Portfolios: Personal development files that bring together the child's drawings, models, stories, and observation records.

Video/Photographic Evidence: Visual documentation of the observation process facilitates subsequent analysis by teachers.

Child Journals or "Sky Journals": Tools in which children record their own observations through drawings and brief explanations (Patrick & Mantzicopoulos, 2015).

These tools can be used not only for assessment purposes but also to help children develop self-assessment and reflective awareness (Carr & Lee, 2012).

Table 2. Sample Observation Form: "Exploring the Sky"

Observation Area	Behavioral Indicator	Observation Note / Example Situation
Curiosity and Exploration	Asks questions about celestial objects	Asks, "Why do stars twinkle?"
Observation Skills	Notices changes in the sky	Shares the observation, "The moon was bigger yesterday."
Communication	Shares his observations with his peers	Tells about their own observation drawing in the story corner.
Creativity	He creates original drawings related to the sky.	"There are purple clouds on my planet," he says.
Scientific Attitude	He observes patiently and carefully.	He watches the sky for 5 minutes, observing quietly.

This form visualizes both the teacher's individual observation notes and the child's progress in the learning process.

The collected observation data should be interpreted not only for quantitative scoring purposes but also to help the teacher reorganize the learning environment. For example, if the majority of children think that shadows are fixed, the teacher can reinforce this concept with a new experimental activity.

Thus, assessment functions not as an "outcome" but as a "process that guides learning" (Worth & Grollman, 2003). This approach is also directly aligned with the TCEM values of "discovering, observing, and creating."

The Turkey Century Education Model (TCEM) emphasizes that assessment in preschool should be a process that documents and supports the child's development, not one that ranks them (MONE, 2024). This understanding shifts teachers in astronomy education into the role of "observer-researcher."

According to TCEM, the teacher:

- Personalizes each child's observation process,
- Organizes learning environments based on observation data,
- Designs differentiated learning paths that support children's curiosity.

This approach enables children who develop scientific awareness at an early age to acquire lifelong learning skills.

6. Conclusions and Recommendations

Early childhood is a critical developmental stage where the foundations of children's perceptions of their environment, curiosity, and thinking patterns are laid. Astronomy education provided during this period not only helps children acquire knowledge about the sky, but also supports the development of fundamental cognitive skills such as scientific thinking, observation, questioning, and explanation (Plummer, 2015). Astronomy enables children to view the natural phenomena they observe in their environment through a scientific lens, which forms the cornerstone of scientific literacy at an early age.

The theoretical and practical framework presented in this book chapter demonstrates that astronomy education in early childhood is shaped around four fundamental axes: (1) developmental appropriateness, (2) constructivist learning, (3) interdisciplinary integration, and (4) pedagogical creativity.

Astronomy stimulates children's natural curiosity and makes learning meaningful. Children encounter phenomena such as the Sun, Moon, and stars at an early age. These observations trigger questions of "why" and "how" in them. Therefore, astronomy themes provide an ideal context for preschool science education (Ampartzaki & Kalogiannakis, 2016; French, 2004).

Conceptual development requires concrete experiences as well as abstract thinking. Children may struggle to grasp concepts such as the shape of the Earth, the phases of the Moon, or the day-night cycle in the abstract. At this point, modeling, observation, storytelling, and play-based activities are effective tools that support conceptual change (Vosniadou & Brewer, 1992; Trundle, 2010).

Integration plays a key role in pedagogical approaches. The STREAM approach (Science, Technology, Reading, Engineering, Arts, Mathematics) enriches astronomy education not only with science learning but also with dimensions of art, language, and engineering. Thus, children develop both creative and analytical thinking skills (Doğanay et al., 2024).

The assessment process is part of learning. In astronomy-based activities, the use of observation, portfolio, and story-based assessment tools are important elements that document the child's learning process and provide pedagogical feedback to the teacher (Black & Wiliam, 2009).

TCEM provides a strong national framework for astronomy education. The Turkey Century Education Model (MONE, 2024) centers curiosity, observation, production, and value-based learning in science, nature, and the environment in early childhood. This philosophy supports both the scientific and aesthetic aspects of astronomy themes.

Consequently, astronomy education in the preschool period contributes not only to children learning scientific concepts but also to them becoming individuals who discover, observe, and question themselves. The cognitive and emotional bond established with the sky at an early age nourishes children's awareness of nature, their power of curiosity, and their creativity.

Therefore, astronomy education is a learning area that directly aligns with the principles of the Turkish Century Education Model: "scientific curiosity, aesthetic sensitivity, and value-based learning." Early childhood astronomy education, which combines interdisciplinary approaches (STEAM) with pedagogical creativity, will lay the foundation for raising future scientifically literate generations.

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