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3*H*s Education: Examining hands-on, heads-on and hearts-on early childhood science education

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Active engagement has become the focus of many early childhood science education curricula and standards. However, active engagement usually emphasizes getting children engaged with science solely through hands-on activities. Active engagement by way of hands, heads, and hearts are kept separate and rarely discussed in terms of getting all to work together, although inquiry-based education and student interest have been accepted as important in science education. The current study is an inquiry-based research. It aims to describe and examine projects and activity stations for preschoolers in a Turkish preschool classroom bringing together the pieces of the puzzle of science education, called here 'Hands–Heads–Hearts-on Science Education'. The study, conducted from a qualitative-interpretivist paradigm, reveals that activity stations and projects create a context for hands-on (active engagement), heads-on (inquiry based or mental-engagement), and hearts-on (interest based) science education. It is found that activity stations and projects, when maintained by appropriate teacher-support, create a playful context in which children can be actively and happily engaged in science-related inquiry.

Keywords: *Hands-on (active engagement); Heads-on (inquiry based); Hearts-on (interest based); Science; Early childhood education*

Introduction

In recent years, early childhood science education has gotten more attention from researchers and educators in Turkey and around the world. The constructivist thinkers (such as Dewey, Piaget, Montessori, Malaguzzi, and Steiner) claim that children actively construct a coherent worldview and knowledge based upon their personal experiences. Being hands-on, being inquiry based, and being interest based are

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three qualities of science education that teachers should be aware of and take into consideration for curriculum planning in a constructivist way (Inan, 2007; National Association for the Education of Young Children [NAEYC] & The National Council for Accreditation of Teacher Education [NCATE], 2001; National Research Council [NRC], 2001). However, active engagement has usually emphasized by getting children to engage with science in a hands-on way only. Although inquiry-based education and the interests of children have been accepted as important in science education, active engagement by hands, heads, and hearts are kept separate and not much discussed in terms of how to get all three to work together.

The term *3H*s (*H*ands-on, *H*eads-on, *H*earts-on) science education used by Inan (2007) is new to science literacy, but the concept is not new to science educators. This perspective on the science education of young children discusses teaching and learning science in terms of the whole-child perspective considering children's cognitive (e.g. inquiring, reasoning, predicting, and hypothesizing), social (e.g. being a valuable part of a community, cooperating, sharing, negotiating, playing, and working in a group), language (e.g. communicating ideas in various ways including nonverbal, using science terms), physical (e.g. engaging with both small and large motor skills during science work), and affective skills (e.g. following their interests, working on love of subject matter related to science with others in a playful environment, caring about living things, and having fun) (Inan, 2007). It includes all the essential qualities of science education discussed above (i.e. being hands-on, being inquiry based, and being interest based).

The current study, which is an inquiry-based research, has adopted a qualitative-interpretivist paradigm aiming to describe and examine project works of preschoolers in a Turkish preschool classroom by bringing together the pieces of the puzzles of science education, called here 'Hands–Heads–Hearts-on Science Education'. In the current paper, the term 'Hands-on' stands for children's active engagement with science, 'Heads-on' stands for inquiry-based education, and 'Hearts-on' stands for interest-based education. These three qualities of science education, hands-on, heads-on, and hearts-on, will be discussed in detail in the following section. This study was designed to answer the following question:

- How can teachers accomplish hands-on, heads-on science education and get preschoolers interested in science at the same time?

Theoretical Framework

A Constructivist View in Science Education: Active learning and hands-on pedagogy

Active engagement has become the focus of many early childhood science education curricula and standards and has been used as an effective way of teaching science for a number of years (e.g. Duran, Ballone-Duran, Haney, & Beltyukova, 2009; Linn, 1987; Piscitelli, 2000; Rakow & Bell, 1998; Samuelsson & Carlsson, 2008). Even back in the late 1980s, Linn stated that there was widespread agreement at a meeting at Berkeley, with distinguished mathematicians, scientists, and curriculum technology experts, that learners actively construct a coherent worldview based upon their personal observation and experience, and respond to formal instruction in terms of their preexisting intuitive knowledge.

Piscitelli (2000) states that an active-learning approach can be traced back to Dewey (1859–1952), Piaget (1896–1980), and Montessori (1870–1952). Montessori gave attention to the importance of using hands in cognitive development, while Piaget focused on children being active in their own learning. They all indicated that children actively construct their own knowledge. Piscitelli also stresses that Montessori supported active and self-directed learning, development of materials specially created for young children, as along with interactive strategies for the tenets of active learning. According to Piscitelli (2000), the active-learning philosophy holds that learning is 'a process of engagement with resources and ideas; involves people solving problems and discovering new things; contributes to personal development and social change; occurs sometimes in isolation but more often in collaboration with others; ignites creativity' (p. 40). The active-learning strategy involves using materials/resources, manipulating, experimenting with them, working with others or alone, asking, thinking, answering, and so on—similar to NAEYC and NCATE's (2001) depiction of science education for young children.

NAEYC and NCATE (2001) report that young children's investigations may not be systematic and their ideas may be scientifically inaccurate. However, they indicate that even though their ideas may not be accurate, young children's intense curiosity, interest, and love of hands-on exploration lead them to engage with science like more mature scientists do, so they should be supported and encouraged in their active engagement with learning and doing science. Here are some of the science-related experiences suggested for young children by NAEYC and NCATE:

- Raise questions about objects and events around them
- Explore materials, objects, and events by acting upon them and noticing what happens
- Make careful observations of objects, organisms, and events using all their senses
- Describe, compare, sort, classify, and order in terms of observable characteristics and properties
- Use a variety of simple tools to extend their observations (e.g. hand lens, measuring tools, eye dropper)
- Engage in simple investigations, including making predictions, gathering and interpreting data, recognizing simple patterns, and drawing conclusions
- Record observations, explanations, and ideas through multiple forms of representation
- Work collaboratively with others, share and discuss ideas, and listen to new perspectives. (2001, p. 22)

In their chapter 'A constructivist perspective on teaching and learning science', Julyan and Duckworth (2005) indicate the way that children construct their understanding of how things work is similar to the way that adults build their own understanding. They state, 'our beliefs about how the world works are formed around the meanings we construe from the data of our experiences' (p. 63). Accordingly, active engagement gives children much in common with more mature scientists (NAEYC & NCATE, 2001). The work of children involves a similar *process of making meaning*, and they construct their own understanding from their own experiences and from those meaning-making processes (Julyan & Duckworth, 2005).

Inquiry is the essential core of active learning. Results of the research conducted on inquiry-based education show, 'inquiry-based teaching requires doing hands-on activities, increases student excitement about learning, helps students become more involved in the learning process, and challenges students to communicate what they already know' and also almost all the teachers who participated in the research agreed that 'inquiry-based teaching helps students enjoy science, builds upon students' prior knowledge, promotes cooperative learning, helps retain content knowledge, and develops higher order thinking skills' (Duran et al., 2009, p. 60). In inquiry-based classrooms, children are very active in their own learning: engaging in scientific questioning, searching for evidence to support ideas, hypothesizing possible explanations based on evidence, connecting those explanations to science understanding, and sharing findings and explanations with the larger classroom community (The National Research Council, cited by Gilbert, 2009). Gilbert, however, states that even the teachers aligned with inquiry-based, constructivist-based theories often abandoned those notions of constructivist, inquiry-based science in favor of a more traditional approach to science education. So, it is important to make sure teachers have professional confidence in terms of how to work with 'standards' and 'chaos' which were the main reasons for those teachers to abandon the constructivist approach.

Briefly, active learning theory in science education proposes children's active participation. Hoorn, Nourot, Scales, and Alward (1993) describe science processes as 'the ways children seek answers to their questions' (p. 101). Accordingly, the constructivist view of teaching and learning science implies that teachers should allow children to have some direct 'experiences' with science. The atmosphere of playfulness is also important in encouraging children to work on science and seek answers to their science questions.

A Developmentally Appropriate View in Early Childhood Science Education: Play

Play is defined as a pleasurable, enjoyable, spontaneous, choiceful, and voluntary activity for children (Garvey, 1990). Researchers indicate that young children cannot be taught with direct instruction methods, such as formal explanation in the traditional educational environment (Fleer, 2009; Wolfinger, 2000; Zoldosova & Prokop, 2006). Instead, teachers should create a context in which preschoolers can have worthwhile, meaningful, cooperative, and fun science experiences, and play is one of such contexts (Fromberg, 1999; NRC, 2001).

In *Science in the Play-Centered Curriculum,* Hoorn et al. (1993) state that children's inquiries and interests, which are relevant to science, occur in play naturally.

According to Hoorn et al., children have a natural curiosity about concepts that are milestones in the evolution of science itself, such as the laws of floating, the relationship of time, and distance and velocity. They indicate that play creates a context in which children can engage with science as they work with and explore varied materials and pursue individual interests. Besides science content, a play-centered curriculum also provides children opportunities to get involved in *science processes*. In short, a play-centered curriculum is one way for teachers to include the natural sciences in classrooms, so that children can engage with the natural sciences through play, which is natural for them and makes science interest based.

While play creates an engaging context for children to work on science, teachers' role in the learning process remains important. Teachers can support children's science play in various ways, such as: organizing a rich environment for exploration and social interaction, introducing age-appropriate science activities related to children's current play (Hoorn et al., 1993), and by modeling, which helps young children (Fromberg, 1999). From the social-constructivist view of learning, teachers' scaffolding children in play serves an important role in their constructing knowledge in the field. Similarly, Samuelsson and Carlsson (2008) state,

> The teacher's role is equally important for learning and play. It is important for giving support and inspiration, for challenging and encouraging the child's willingness and desire to continue the process of making sense of the world. This means that the focus should be on the process of communication and interaction. (p. 638)

An Ideal Early Childhood Science Education Integrating Constructivism, Social Constructivism, and Play: Hands-on, heads-on, and hearts-on science education

Many researchers agree that science should be taught in early childhood (Eshach & Fried, 2005; French, 2004; Gelman & Brenneman, 2004; Inan, 2007), and one of the most effective types of teaching occurs when learning happens when children are engaged *kinesthetically*, *cognitively*, and *emotionally* (Csikszentmihalyi & Hermanson, 1995, cited in Sinker & Russell, 1998; Inan, 2007). Similarly, Easton (1997) states, 'the aim of the Waldorf model is to educate the child toward a holistic thinking that integrates knowledge gained from thinking, feeling, and doing' (p. 88) and continues, 'by educating "head, heart, and hands," Waldorf education seeks to nurture a self-esteem that encompasses aesthetic and moral sensibilities as well as intellectual competence' (p. 94). Minds, hands, and hearts, which make a human being whole, are connected to each other, so they all should be considered for effective science education (Russell, 1997) alongside the notion of 'whole child' within the larger physical and social environment in which children have a constant interaction (New, 1999). Bredekamp (2013) states, 'Pestalozzi promoted what came to be called the "whole child" point of view—that children's physical, emotional, social, moral, and intellectual development are integrated. He called these "the hand, heart, and head"' (pp. 44–45). Inan (2007) states that, in the *3H*s, the child is considered to be both an individual entity working alone and a social entity interacting with others.

The importance of hands-on, heads-on, and hearts-on experiences for effective science education is often emphasized under various practices, such as hands-on and head-on experiences in the active-learning theory (French, 2004; Grieshaber & Diezmann, 2000; Hoorn et al., 1993; Krall, Straley, Shafer, & Osborn, 2009; Randler, 2009; Russell, 1997). Based on Bredekamp's developmentally appropriate approach, it can be said that hands-on science activities are developmentally appropriate for preschool children because hands-on activities allow children to construct their own knowledge at their own cognitive and knowledge levels, as well as engaging their individual interests (hearts-on).

While minds-on refers mostly to children's innate curiosity, wonder, and inquiries about the world (Russell, 1997), hearts-on refers to children's feelings and attitudes, including their interests, enjoyment, and love of science experiences (e.g. Cummings, 2003; French, 2004; Hoorn et al., 1993; Prokop & Tunnicliffe, 2008). Ginsburg and Golbeck (2004) state that although emotions cannot be separated from science learning, they are not emphasized as much as hands-on and heads-on experiences. *Heartless science* might suffer just as *handless* and *headless* science might suffer (Russell, 1997). Russell states, 'We are body, mind and spirit.' Accordingly, any pedagogy should target all those components for effective science teaching.

The NRC (2001) points out Katz's concept of four dimensions of growth, namely *knowledge, skills, feelings,* and *dispositions,* which constitute the whole child and cannot be separated from each other. The council report stresses the importance of supporting all those dimensions in creating effective strategies for children's science education. It indicates that knowledge and skills, which refer to science content and scientific processes, can be gained through effective instruction, but positive feelings and dispositions can be constructed only through positive relationships between the teacher/caregiver and children during the instruction.

Even though there is some early childhood science literature which emphasizes importance of hands-on, heads-on, hearts-on education in young children's learning of science, getting children to engage with science hands-on is usually the most emphasized and practiced in the field of early childhood education in Turkey. The reason for this might be a lack of research about how to accomplish the 3Hs, and thus a lack of understanding on how to apply them. Accordingly, it is essential to figure out how to get active engagement by hands, by heads, and by hearts work together. The current study aims to show how project approach with activity stations can work well to get hands-on, heads-on, and hearts-on experiences work altogether.

Methodology

Context and Participants

To choose the research site, the researchers relied on what Patton (1990) calls the 'Purposeful Sampling' method, which involves selecting information-rich cases for an in-depth research. The site was information rich for the researchers to pursue their inquiries and a convenient place to access and conduct their research. In this study, confidentiality of all participants in the preschool was accomplished through concealing the real names, and no identifying information has been included.

This qualitative study involved a Turkish private preschool in Kütahya, which included 70 preschoolers, 6 teachers, 3 assistant teachers/assistant researchers, and classroom helpers. Assistant researchers were undergraduate students studying early childhood education; they were present to receive training from the teachers and conduct some projects with the preschoolers. While one teacher was present in the classroom almost all the time, there were one or two assistant researchers at any time to serve as additional support staff.

The teachers in the preschool developed their daily plans in a more creative and interesting way by creating activity stations and projects even though they need to consider the National Ministry of Turkish Education (MEB) program for preschoolers. The school had 6 classrooms for different age levels, namely 3–4-year olds, 4–5-year olds, and 5–6-year olds. Each assistant researcher was responsible for two different classrooms shifting from one classroom to another during extracurricular activities, such as chess and gymnastics.

Data Collection

This is an interpretivist qualitative research. In order to triangulate findings of the research in a more holistic way, the current research utilized various sources of evidence, namely informal interviews done with teachers, observations of the children, documents and artifacts of children's works, and field notes taken by assistant researchers; all of which are commonly used in qualitative study research. Three assistant teachers in the preschool, who are also assistant researchers, helped the researchers while collecting data.

The data collection process continued for about two and a half months and the researchers had a meeting with the assistant researcher/teachers every week to discuss children's experiences in science and the projects emerging in the preschool. Observation of the children by assistant researcher/teachers lasted six hours each week during the two-and-a-half-month period. Informal interviews with the teachers were done randomly during observations, as needed by the assistant researcher/teachers; during this time they took field notes, and collected documents and artifacts (i.e. children's work, photos, and activity station plans). Each week the assistant researcher/teachers and the researchers had a two-hour meeting to discuss the ongoing data.

Data Analysis

The data analysis was conducted throughout the study as it also shaped how the study proceeded (Glesne, 1999). So there was an ongoing data analysis during two and a half months. Some of the data were transformed into computer documents in various ways.

Spradley's ethnographic analysis method was utilized to interpret the data. That is, data analysis occurred from having a general perspective to a more detailed example event analysis to have a deeper understanding on the topic of interest. Under the section 'First Steps toward Teaching the Hands–Heads–Hearts-on Way', Table 1 represents the general perspective of the classroom. On the other hand, *Earthworms Project* represents a deeper example related to the topic of interest.

The central concept of an ethnographic perspective is culture, 'the notion that a group of people in prolonged interaction within a particular setting will construct a patterned way of conducting life together' (Fernie & Kantor, 2003, p. 6). By working with the assistant teacher/researchers for two and a half months, the researchers aimed to accomplish such prolonged interaction.

Two lenses were used while interpreting the data: Hands–Heads–Hearts-on Science Education and NAEYC & NCATE's criteria. In short, the current study aimed to understand and interpret 3Hs Science Education, which is the patterned way of conducting science education in the researched preschool.

Findings

First Steps toward Teaching the Hands–Heads–Hearts-on Way

In the current study, the teachers offered the preschoolers classroom experiences that are project based and multidisciplinary to engage the children in science. These are

Table 1. Examining science experiences of preschoolers at a Turkish preschool

	Depiction	Sources	Examples from the school
Hands-on	>Actively working on science >Using science process skills (e.g. observing)	>Teacher prepared activity stations and the environment which gives children freedom to choose and work on science actively	>Experiment stations, t-shirt coloring station, wall coloring station, cooking station, creative activities station (e.g. creating noise-making devices), etc.
Heads-on	>Asking questions, inquiring about science	>Questions asked by teachers >Provocations for conflicts and contradictions prepared by teachers	>Does a bag of water burn? >Does a paper, which covers a glass of water, get wet when the glass is upside-down? >What is there inside an apple?
Hearts-on	>Love of subject matter, related to science and being interested in science	>Playful contexts/materials provided by teachers and time given to children to play >Alternatives created by teachers for children to choose from >Activities planned by teachers based on children's previous/continuing interests or possible interests foreseen by teachers	>Playful/interesting activity tables >Children bringing science books related to their own interests >Pretending animals/cats growling in free play time >Listening to sounds of animals on playground >Creative drama (pretending to be a snowman, who melts inside)

called 'Activity Stations'. The preschoolers were free to choose the activity station they wanted to work on. Each activity station had a project, which might last as long as children's inquiry and interest continued, and the children could easily move to another activity station when they were done with one. One of the criteria of play, which is being 'choiceful', was accomplished successfully. The teachers were encouraged to keep in mind Garvey's definition of play (i.e. a pleasurable, enjoyable, spontaneous, choiceful, and voluntary activity for children) and provide play context for science education accordingly.

Activity stations were prepared by the teachers and observed by the teachers for possible teaching moments; they were ready for interaction and discussion while the children were exploring the activity stations. In the current study, by observing the children during play, the teachers were also able to collect information on their interests and then use this information to frame future structured-activities, to make plans to furnish their ongoing play, and provide necessary scaffolding. The teachers provided scaffolding in different ways, such as asking the right questions at the right time, arranging the learning environment to be rich in science, provoking preschoolers' inquiries, providing appropriate help when it was necessary, and creating alternatives (e.g. many activity stations), so the preschoolers could choose among them freely. In short, the current study showed that teachers' guidance is very important to children's usage of science process skills to learn about science.

Moreover, teachers' positive attitude toward science and living things encouraged children's investigation of science. Most of the teachers in the current research showed their excitement for science in various ways and encouraged the preschoolers to use science process skills and work on projects related to science. It can be suggested that teachers keep their personal attitudes (e.g. dislike for touching earthworms) to themselves and encourage children to examine living things. While doing that, it is also important to make sure that the children and creatures are safe.

Furthermore, many stations and projects were designed for the preschoolers to work on science either individually or in groups.

The activity stations supported both hands-on and heads-on experiences. The children found opportunities to use science process skills as well as creative ways of expression. They engaged in many discussions and hands-on experiments. They visited activity stations one by one and became active learners as their interest continued. Some of the projects/activity stations were:

- experiment stations,
- coloring stations (e.g. t-shirt and wall),
- cooking stations (e.g. measuring ingredients while making animal-shaped cookies),
- creative activity stations (e.g. creating noise-making devices),
- tasting colored food stations,
- an examining earthworms station (e.g. examining what earthworms eat),
- an examining rotten lettuce leaves station,
- an examining animal heart station,
- an examining plants/foods station (e.g. inside walnuts).

In the current research, the teachers successfully found ways for children to express their ideas (e.g. coloring, drama, and discussion) but could have used more visual representations.

In the present study, findings for science education are addressed under three layers of the data analysis (i.e. hands-on, heads-on, and hearts-on) and presented in Table 1. Under the column entitled 'Depiction', how each layer of 3Hs depicted itself in the school is shown. Under the column entitled 'Sources', it is aimed to show what lead 3Hs to happen in the school or how they accomplish what is stated under Depiction. Finally, the column 'Example from the school' presents some examples related to each of the 3Hs, as occurred in the school.

Table 1 represents how hands-on, heads-on, and hearts-on science education depicted itself at the school during this study. The analysis of the data shows that hands-on science education depicted itself as the children and teachers working 'actively' on science, instead of children learning science as passive learners. That means that they used their hands and body to engage in science activities. They touched things, manipulated objects and so on. Moreover, the teachers were successful in getting them involved in science processes. So that, hands-on education depicted itself as children and teachers using science process skills as needed, such as observing things/events, predicting, measuring, interpreting, and so on. To accomplish this, the teachers prepared activity stations and an environment which gives children the freedom to choose and work on science actively. For example, they prepared experiment stations, a t-shirt coloring station, a wall coloring station, a cooking station, and a creative activity station (e.g. creating noise-making devices).

As given in Table 1, heads-on science education depicted itself as children asking questions and inquiring about issues related to science. They searched for information about what they inquired, asked questions and created theories, and then tested their theories. This was accomplished by the teachers and the environment that they designed. In other words, the teachers provoked the preschoolers to ask questions by asking questions and by creating provocations (provocative environment) for conflicts and contradictions prepared by the teachers. Some of the questions the teachers asked during the activities are as follows: 'Does a bag of water burn?' 'Does a paper, which covers a glass of water, get wet when the glass is upside-down?' and 'What is there inside an apple?' While play creates an engaging, hands-on, hearts-on context for the children to work on science, teachers' roles in the learning process remain important. The teachers play an important role in provoking children's inquiry and making children's education more effective. The children were getting help from both the teachers and their friends while working on their individual or collective projects. The harmony among them also supported their play activities.

Finally, Table 1 presents that hearts-on science education, which depicted itself as children loving science-related subject matters and being interested in science issues. This is accomplished by the teachers, as they provided the preschoolers playful contexts and playful materials, gave them time to play, created alternatives for the children to choose from, planned activities based on children's previous/continuing interests or possible interests foreseen by the teachers. For example, the preschoolers worked on the playful and interesting activity tables that the teachers designed; the children brought science books related to their own interests to share and read together; the children played games like imitating cats growling in free play time; the children listened to sounds of animals on the playground, since they wanted to do so; the children did a creative drama of pretending to be a snowman, who melts inside, as they wished during science activities. The teachers in the research preschool were successful in getting the children interested in science and encouraging them to pursue topics of interest through projects/activity stations.

The current research shows that by utilizing the Turkish National Early Childhood Education Program, which is flexible enough to conduct a project work and accommodate children's emerging interests, it is possible to accomplish the 3Hs, as long as the teachers aim to do this. It is found that projects and activity stations provide the children opportunities for hands-on, playful, teacher-supported work. Projects and activity stations create the necessary context for hands-on, heads-on, and hearts-on science education. While project work supports a playful context in which the children can be actively and happily engaged in science, it also maintains appropriate teacher support when necessary. In conclusion, the research reported shows that it is possible to accomplish all three components of good early childhood science teaching. It can be stated that projects and activity stations for project works help the children be hands-on, heads-on, and hearts-on by providing children with opportunities for manipulation, play, teacher-support, and enriched activities.

The projects conducted in different parts of the school allowed the preschoolers to work on science hands–heads–hearts-on. Here is an example of a short-term project that occurred in the classroom during the research.

Earthworms Project

The preschoolers saw an earthworm on the playground while playing outside. They inquired about earthworms and asked various questions, such as 'What do they eat?', 'Where do they live?', 'How does it feel when we touch an earthworm?' The teachers decided to create an earthworm station in the school and brought an earthworm in a jar to the classroom. They asked preschoolers, 'What is inside the jar?' Different answers came from the preschoolers, such as earth, black pepper. The teachers asked, 'What is inside the earth, then?' The preschoolers looked at the jar and started screaming, 'The earth is moving inside the jar!' Then, they said, 'No, something inside the earth moving!' The earthworm showed up and the preschoolers were very excited. An energetic discussion started among them. While the children were discussing about what is inside the jar, the teachers knew that it is essential to help children learn how to care for the living things around them. The teachers realized that the earthworms were an opportunity to teach children about the environment and living things around them and started working toward this.

The teacher wanted the preschoolers to make a connection between what they were experiencing at school and what they experienced outside of school. The preschoolers talked about their own experiences related to earthworms they had seen before. The following excerpt is taken from the discussion:

Teacher:	What is it?
Preschoolers:	It is an earthworm.
Teacher:	Have you seen an earthworm before? What did it look like?
Preschooler:	Yes, when I was at my grandma's home. It had stripes on it. Short stripes …
Teacher:	What color?
Preschooler:	Red.
Teacher:	Where did you see it?
Preschooler:	Outside the house.
Teacher:	Did you see it in the earth or on the earth?
Preschooler:	I saw it on the road.
Teacher:	Did it have any feet?
Preschooler:	No.
Teacher:	How did it move, then?
Preschooler:	It was crawling.
Teacher:	Did it jump?
Preschooler:	No! It was crawling!

The preschoolers examined the earthworm and their interest lasted about one week. They touched it, observed it, smelled it, and so on. They expressed their thoughts and feelings, such as 'It is soft', 'Ick! It moves', and 'It tickles me!' They looked very happy and excited. They asked some questions. One of the questions, 'What do earthworms eat?' grabbed the teacher's attention. She led the students in a discussion on what earthworms eat, and they decided to give the earthworm some lettuce. The teacher brought a piece of lettuce for the earthworm and the preschoolers observed the earthworm moving on it.

The next day, the edge of the lettuce was darkish. The preschoolers wondered what was happening. After a short discussion, they decided to put it into a glass of water and observe what was happening. The teacher said that when there is no light or food for lettuce this is what happens to it. The preschoolers wanted to put it in front of the window, since there was more light there for the lettuce. They observed it every day. Some other suggestions came from the preschoolers to keep the lettuce fresh. For example, they said:

'If it rains, the lettuce won't die;'
'We should put a piece of ice on it, so it won't die;'
'We should put bubbles on it (detergent bubbles);'
'Let's take the water out;'
'Let's put a bird in it;'
'No! We cannot put a bird in it because a bird cannot fit in the glass;'
'Let's put a piece of cotton in with it' and so on.

The teacher let the preschoolers experiment with their hypotheses. They put the lettuce outside, they put bubbles, cotton, and paper into the glass, and so on. They tried all their ideas to keep the lettuce fresh. The preschoolers were very excited while working on the lettuce project.

The preschoolers made comments whenever they saw their teacher. One of them said, 'I asked my mom about the lettuce, and she said that if we put it into the earth it won't die.' In short, the preschoolers were interested in their work, actively worked on it, searched for information about it, asked questions and created theories, and then tested their theories. Here are what the teachers accomplished in the Earthworms Project according to NAEYC & NCATE's (2001, p. 22) criteria (accomplishments checked with the sign (☑):

- ☑ Raise questions about objects and events around them
- ☑ Explore materials, objects, and events by acting upon them and noticing what happens
- ☑ Make careful observations of objects, organisms, and events using all their senses
- ☑ Describe, compare, sort, classify, and order in terms of observable characteristics and properties
- ☑ Use a variety of simple tools to extend their observations (e.g. hand lens, measuring tools, eye dropper)
- ☑ Engage in simple investigations including making predictions, gathering and interpreting data, recognizing simple patterns, and drawing conclusions
- \- Record observations, explanations, and ideas through multiple forms of representation
- ☑ Work collaboratively with others, share and discuss ideas, and listen to new perspectives.

As given in the table, they were very successful in terms of almost all criteria but could support representation of ideas more, in various ways, such as visual representations.

It is seen that the 3Hs were explicitly present in this school. The teachers accomplished all 3Hs and the preschoolers had hands-on, heads-on, and hearts-on science experiences while playing/working on projects in activity stations.

Discussion and Conclusion

In this study, the activity stations were prepared by the teachers and observed by the teachers for possible teaching moments so that they could discuss and interact with the children while the children were exploring the activity stations. Similarly, Samuelsson and Carlsson (2008) state that the teacher's role continues even after preparing the environment by giving children support and inspiration and by challenging and encouraging their willingness and desire to continue the process of making sense of the world. In the current study, the children had supervision and help from the teachers when it was necessary. Lee and Ginsburg (2009) point out an important misconception of teachers, e.g. 'Teachers should provide an enriched physical environment, step back, and let the children play' (p. 37). Teachers should continue to scaffold children's learning after enriching the environment.

In the current research, the teachers successfully found ways for the children to express their ideas (e.g. coloring, drama, and discussion) but could have used more visual representations. Similarly, Brooks (2009) states,

> Drawing and visualization can assist young children in their shift from every day, or spontaneous concepts, to more scientific concepts. Drawing also assists young children's

> interactions and competencies with spatial visualizations, interpretations, orientations and relations. When young children are able to create visual representations of their ideas they are then more able to work at a metacognitive level. When children are encouraged to revisit, revise and dialogue through and with their drawing they are able to represent and explore increasingly complex ideas. (p. 319)

In the current study, the teachers had hidden curriculum objectives in their minds, and when they saw an opportunity to teach they started working on it. For example, Witt and Kimple (2008) indicate that

> Raising consciousness about the environment and learning ways to care for our planet are important for all citizens of the world. Young children are particularly receptive to learning new concepts; thus the preschool years are an ideal time to teach lessons about the environment. (p. 41)

Thus, it is essential to help children be cognizant of the living things around them. In the current research, the teachers realized that the earthworms were an opportunity to teach the children about the environment and living things around them.

In the current research, the preschoolers were interested in their work, actively worked on it, searched for information about it, asked questions and created theories, and then tested their theories. Similarly, Yoon and Onchwari (2006) state, in science education it is essential for teachers to use developmentally appropriate approach, higher level questioning, and the 5Es (e.g. engaging, exploring, explaining, elaborating, and evaluating), so that active engagement can be accomplished. It is also seen that the teachers accomplished in the Earthworms Project almost all the NAEYC & NCATE's criteria. In the current study, they were very successful in terms of almost all criteria but could support representation of ideas in various ways more, such as visual representations.

In this interpretivist research study, we sought to answer the question 'How can teachers accomplish hands-on, minds-on science education and get preschoolers interested in science at the same time?' The research shows that it is possible to accomplish all three components of an ideal early childhood education, namely 3Hs science education through project works and activity stations, which are based on children's interests. The current study did not aim to suggest a prescribed program or curricula which can accomplish the 3Hs in their early childhood science education. As stated by Inan (2009), even in the same classroom with the same teachers, science experiences might be different with different children, so it is essential to look at the culture of a specific classroom and construct the program accordingly. The current research shows that by utilizing the Turkish National Early Childhood Education Program, which is flexible enough to conduct projects and accommodate children's emerging interests, it is possible to accomplish the 3Hs as long as teachers aim to do this. The teachers in the research preschool were successful in getting the children interested in science, getting them involved in science processes, provoking them to ask questions and inquire about issues related to science, and encouraging them to pursue their topics of interest through projects/activity stations. As stated by Mullis and Jenkins (1988) in *NAEP Science Report Card,*

> As active rather than passive participants in the learning process, students can strengthen their full range of mental process, from formulating hypothesis, explaining observations, and interpreting data to other thinking skills used by scientists in their efforts to build understanding. (pp. 13–14)

It is found that projects and activity stations provide the children opportunities for hands-on, playful, teacher-supported work. Projects and activity stations create the necessary context for hands-on, heads-on, and interest-based (hearts-on) science education. While projects support a playful context in which children can be actively and happily engaged in science, they also maintain appropriate teacher support when necessary. This supported the research conducted by Julyan and Duckworth (2005). They indicate that the atmosphere of playfulness is most likely to encourage children to express feelings and release the frustration that is inherent in constructing one's own understanding. Moreover, they state that by encouraging children to express feelings related to their work, the teacher can encourage children to consider the whole learning process.

As seen in the early childhood science education literature, play is cited as one of the contexts in which children can be actively engaged in science, take control of their actions, and have fun while learning science. While play creates an engaging, hands-on, hearts-on context for children to work on science, teachers' roles in the learning process remain important. Teachers play an important role in provoking children's inquiry and making children's education more effective.

It is also seen that the socially constructivist concept of scaffolding was present in the context of the playful science projects for children. The children were getting help from both the teachers and their friends while working on their individual or collective projects. The harmony among them also supported their play activities. As suggested by NRC (2001), teachers were successful in providing help and supporting children to help each other and then gradually giving the child a more active role while working on science projects.

Hoorn et al. (1993) state that teachers can observe children's play to figure out their interests, so that they can create more opportunities and structured activities drawing upon children's expressed interests. Irving (2000) states, 'observing children has served as the foundation for curriculum planning and has enabled teachers to center their programs on the specific needs of individual children' (p. 77). Accordingly, in the current study, by observing the children during play, the teachers were also able to collect information on their interests and then use this information to frame the future structured-activities, to make plans to furnish their ongoing play, and provide necessary scaffolding.

The teachers provided scaffolding in different ways, such as asking the right questions at the right time, arranging the learning environment to be rich in science, provoking preschoolers' inquiries, providing appropriate help when necessary, and creating alternatives (e.g. many activity stations) so the preschoolers could choose among them freely. In short, the current study showed that teachers' guidance is very important to children's usage of science process skills to learn about science. Accordingly, it can be suggested that teachers not only should provide guidance and help when necessary, but also let children work actively on constructing their own knowledge. Moreover, as indicated by Julyan and Duckworth (2005), during the meaning-making process, the preschoolers dealt with some conflicts, contradictions, conundrums, puzzlements, and confusions, which were planned by teachers to grab the preschoolers' attention.

Based on the findings of the current research, it is recommended that teachers provide children with several differed activities so that children can choose the activities that most interest them. Many different activity stations were planned by the teachers and the children were free to choose what they wanted to work on and move to other work areas when they were done with one. One of the criteria of play, which is being 'choiceful', was accomplished successfully. It is recommended for teachers to keep in mind the definition of play and provide play context for science education accordingly. Briefly, play is defined as a pleasurable, enjoyable, spontaneous, choiceful, and voluntary activity (Garvey, 1990), which can fulfill children's interest in science (Fromberg, 1999; Hoorn et al., 1993; NRC, 2001; Zoldosova & Prokop, 2006).

One of the problems teacher candidates reported was some teachers' negative attitudes toward 'disgusting' creatures (Prokop & Tunnicliffe, 2008). Based on the results of the current research, we can state that teachers' negative attitude or pressure on children to behave in a specific way may block children's investigation of science and discourage them from doing science. Accordingly, it is suggested that teachers keep their personal attitudes (e.g. dislike for touching earthworms) to themselves and instead make sure that the children and creatures are safe. On the other hand, the current research also shows that many of the teachers also had positive attitudes toward science. They showed their excitement for science in various ways and encouraged the preschoolers to use science process skills and work on projects related to science. More research on attitudes of early childhood education teachers toward science is needed. Accordingly, future research and studies can be conducted on improving teachers' attitudes toward science.

In conclusion, the research reported shows that it is possible to accomplish all three components of good early childhood science teaching. It can be stated that projects and activity stations for project work help children to be hands-on, heads-on, and hearts-on by providing children with opportunities for manipulation, play, teacher-support, and enriched activities.

Disclosure statement

No potential conflict of interest was reported by the authors.

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