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A Cultural and Artistic Approach to Early Childhood Science Education: Shadow Play

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Abstract

Attitudes towards science and scientific perspectives in the future depend on early childhood science experiences. Preservice teachers who are provided with the opportunity to develop positive attitudes and self-efficacy towards science teaching before they enter professional life are more likely to help preschoolers develop positive attitudes towards science in their professional life. The aim of this 12-week study was, therefore, to determine the effect of a shadow play workshop on early childhood preservice teachers' self-efficacy beliefs and attitudes towards science teaching and to investigate their workshop experiences and application processes. This study employed an explanatory sequential mixed methods design. The sample consisted of 24 first-year early childhood preservice teachers. Quantitative data were collected using the Early Childhood Teachers' Attitudes Toward Science Teaching (TSAS) and the Science Teaching Efficacy Belief Instrument (STEBI) and were analyzed using the Wilcoxon Signed Ranks test and the dependent sample t-test. Qualitative data were collected through focus group interviews and observations and were analyzed using content analysis. Results showed that shadow play had a positive effect on participants' self-efficacy beliefs and attitudes towards science teaching, indicating that shadow play is an interesting, fun, and effective material that can be used in early childhood science education to turn abstract concepts into concrete forms. Results were discussed with reference to literature, and recommendations were made for future studies.

Keywords: Early Childhood, Science Education, Shadow Play, Teacher Education, Arts in Science.

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Introduction

Children defined as "scientists by birth" (Gençer, 2016) learn through their senses by breathing, telling a flat rock from cotton, pushing a toy car down a hill, building a sand castle or checking out the shell of a cicada (Hamlin & Wisneski, 2012). Just like scientists, children need scientific processes to explore the world around them, which draws them into science at early ages (Saçkes et al., 2010) and lays the foundation for their future interest in it. Therefore, many countries focus on improving science education in schools and helping students develop positive attitudes towards science (Küçükturan, 2017). Early childhood science education is part of play, inquiry, and trial and error processes (Osborne et al., 2004; Taha & İvrendi, 2010). Planned and systematic science education programs help children acquire basic knowledge and develop critical thinking and problem-solving skills (Mırzaie et al., 2009). Children should also have mental and physical experiences that provide them with an opportunity to develop conceptual structures and positive attitudes towards science (Loxley et al., 2016).

Research shows that most preschool teachers feel incompetent in science education and putting it into practice, find materials inadequate, and use only a handful of methods (Karamustafaoğlu & Kandaz, 2006; Koç, 2016; Özgül et al., 2017; Saçkes et al., 2010). They use the conventional question and answer method way more than child-centered methods of teaching (Takaoğlu & Demir, 2018). However, science topics involve abstract concepts that are hard to understand, and therefore, teachers should learn how to use child-centered teaching methods to make it easier for children to learn science concepts (Ampartzaki & Kalogiannakis, 2016). John Dewey, an educational theorist, once said, "If we teach today as we taught yesterday, we rob our children of tomorrow" (cited by Koç, 2016), highlighting that correct methods should be used to provide contemporary education to meet the needs of today's students. Preschool science teachers who know how children learn are likely to be better at planning teaching, preparing the learning environment, and choosing the right methods. Children enjoy hands-on science activities because they present challenges to be overcome and encourage them to be active and creative about inquiring and discovering new things by themselves and expressing their thoughts, feelings, and dreams (Loxley et al., 2016). During this period, children perceive most things concretely, and therefore, one of the goals of early childhood science education should be turning events, situations or abstract concepts into concrete visual representations (Greenfield et al., 2009).

Teachers play a key role in developing interactive and applied methods that transform abstract concepts into concrete forms, promote children’s development and respond to their interests and needs in early childhood science education (Diamond et al., 2014; Özgül et al., 2017). Teachers' views, beliefs, and attitudes towards science teaching determine the quality of science education (Diamond et al., 2014; Osborne et al., 2003). Research shows that the most important factors affecting

teachers' attitudes towards science education are associated with the steps taken before professional life (Orkunoğlu, 2016). Preservice science teachers with high professional competence and self-efficacy beliefs and positive attitudes towards science are more likely to help students develop positive attitudes towards science in the future (Güvenir, 2018).

Children learn best when they have fun (Conezio & French, 2002). Teachers should, therefore, present effective and fun materials that attract children's attention to science activities and organize the learning environment in that way. Children may enjoy playing games and singing songs that are rich in cultural values and beliefs, which teachers can also use to teach science concepts (Bose & Seetso, 2016). Shadow play, which is a main component of visual education and based on visual perception, can be used to teach basic concepts in preschool education institutions. This connection between visual arts and science plays a key role in education because it helps children develop comprehension and knowledge-acquiring skills (Dhanapal et al., 2014). What is more, activities and learning areas in early childhood science education curricula should not be separated, but, on the contrary, should be integrated with other types of activities (Chaille & Britain, 2003). This provides suitable learning experiences for children with different learning styles, thereby promoting learning and ensures learning retention in science. Children who are actively engaged in fun art activities are more likely to use their imagination as they wish, develop communication skills, release the emotions they suppress, and discover their own potential (Diğler, 2012).

This study was based on the assumption that early childhood science education through shadow play, which is a cultural and artistic art form also known as shadow puppetry, will improve preservice teachers' self-efficacy beliefs and attitudes towards science teaching. The study also addressed preservice teachers' experiences of shadow puppet-making (cut-out figures) and puppetry and its contributions to early childhood science education. Therefore, the study discussed preservice teachers' views on the use of shadow play as an alternative method in early childhood science education. We believe that our results will pave the way for further research on potential alternative methods that can be used in early childhood science education.

This study (1) investigated the effect of an interactive shadow play workshop (puppet-making and script-writing) on preservice teachers' self-efficacy beliefs and attitudes towards early childhood science teaching, (2) discussed their experiences of the workshop, and (3) examined, through interviews and observations, their views of the usability of shadow play in early childhood science education.

Early Childhood Science Education

The first six years of a child's life, referred to as early childhood, are critical for physical, mental, emotional, and social development. It is the period when children start learning basic science

concepts (Bose et al., 2013; Kalley & Psillos, 2001; Saçkes et al., 2010), develop intrinsic motivation for learning science (French, 2004; Inan et al., 2010), and acquire new knowledge and discover their potential (Jones et al., 2008; Loxley et al., 2016). The goal of early childhood science education is to help children explore their surroundings and observe natural phenomena, interpret new information, and develop scientific process skills and affective characteristics (Eshach & Fried, 2005; French, 2004; Osborne et al., 2004; Worth & Grollman, 2003). Observation and communication regarding science also contributes to language development in children (Jones et al., 2008). It can, therefore, be argued that the right early childhood science education also supports children's social development.

Science concepts and scientific knowledge introduced by early childhood science education lays the groundwork for future science knowledge and promotes future academic performance (Buldu & Olgan, 2018; Saçkes et al., 2010; Trundle, 2010). Early childhood science education not only introduces science concepts and scientific knowledge but also helps children develop high-level thinking skills (problem-solving, scientific, and critical thinking skills) that they will use throughout their lives. Those who fail to develop those skills in early childhood are less likely to acquire further knowledge and develop other skills needed in personal and professional life (Saçkes et. al., 2010; Saçkes et al., 2012). Therefore, children should be provided with high-quality early childhood science education that transforms abstract concepts into concrete forms and triggers curiosity and motivates children to become involved in learning.

Preschool Science Teachers

Preschool teachers play a vital role in providing children with rich and effective learning experiences and helping them develop positive attitudes towards science (Saçkes et al., 2012). Children participating in well-designed early childhood science activities are more likely to develop conceptual understanding of scientific principles (Gallegos Cazares et al., 2009) and scientific frameworks and models to better understand the world (Ravanis et al., 2013). Planning early childhood science education helps to choose the right learning strategies for children (Loxley et al., 2016). Therefore, teachers should design interactive learning environments to promote science education and to encourage students to explore new things (Diamond et. al., 2014; Küçükturan, 2017). Preschool teachers should be able to design and plan engaging activities with new and interesting materials to spark children's curiosity, to encourage them to develop new ideas and use creativity, and to enable them to learn by doing-living (Loxley et al., 2016; Saçkes et. al., 2010). Therefore, teachers should assume different roles, such as an observer, facilitator, and guide, during early childhood science activities (Genç Kumtepe, 2011).

Research shows that preschool teachers recognize the importance of science education, consider early childhood science activities necessary, and have positive attitudes towards science and science teaching (Akcanca et al., 2017; Bahçeci & Sansar, 2010; Karademir et al., 2020; Sağlam &

Aral, 2015; Simsar et al., 2017). However, some studies show that preschool teachers are not interested in science (Babaroğlu & Okur Metwalley, 2018; Can & Şahin, 2015; Tu, 2006; Tu & Hsiao, 2008). Children's attitudes towards science depend very much on the attitudes of teachers who introduce early childhood science education to them. Teachers with positive attitudes towards science are likely to be more active in their teaching, and their students are likely to be more engaged and successful in science. Moreover, teachers who are competent in science teaching have a significant effect on students' creativity and learning outcomes in early science education (Karademir et al., 2020). In this context, we can also talk about the concept of self-efficacy in early childhood science education. Moreover, teachers with high self-efficacy have more positive attitudes towards science education than those with low self-efficacy (Çamlıbel Çakmak, 2006; Orkunoğlu, 2016).

Some studies show that inappropriate classroom environment and inadequate material prevent students from having different levels of knowledge and experience and prevent teachers from developing positive attitudes towards science education and planning lessons (Çınar, 2013; Karademir et al., 2020; Sağlam & Aral, 2015; Saçkes et. al., 2010; Ünal & Akman, 2006). Although early childhood science activities with materials that appeal to different sensory organs play a significant role in helping children develop science skills (Büyüktaşkapu et al., 2012), preschool teachers are particularly incompetent in designing science materials and developing science activities with those materials (Güvenir, 2018; Karaer & Kösterilioğlu, 2005; Karamustafaoğlu & Kandaz, 2006). This means that early childhood science education should involve concept cards, story books, puppets, puzzles, stuffed toys, real objects, models, educational toys, costumes, graphics, charts, tables, and information or communication technology materials (Orhan, 2018). Therefore, undergraduate material development courses should also focus on science materials to help teachers develop their own science education materials (Özbek & Sığırtmaç, 2011).

Integration of Early Childhood Science Education and Art Disciplines

Thompson (1995) argues that interdisciplinary education is a cornerstone of national education. Integrated curriculum models encourage teachers not only to actively develop their own professional knowledge but also to improve their skills from areas other than their field of expertise and put them into practice (Bolotta, 2017). Moreover, integrating different disciplines and teaching methods to plan science education activities results in learning retention (Charlesworth & Lind, 2003). There are studies investigating the effect of science education integrated with different art forms on participants of different ages (Abed, 2016; Archilla, 2017; Braund, 2015; Butler et al., 2009; Gurnon et al., 2013; Hartwig, 2014; Hendrix et al., 2012; Kallunki et al., 2017; Verhoeff, 2017). Those studies conclude that science, math, geography, and history education integrated with visual arts have a significant effect on child development (Dhanapal et al., 2014).

Although science and art, which are the products of human endeavor, seem to be two independent disciplines, they both derive from nature (Bayav, 2009). Science satisfies our curiosity to know how this world works, while art allows us to convey our emotions and innermost thoughts about nature. Therefore, both science and art use the means of data collection, observation, analysis, creativity, imagination, aesthetics, emotions, and communication and interpretation to the same end (Türkoğuz & Yayla, 2011). Scientific developments influence art, and vice versa (Bayav, 2009). However, science is based on observation and experimentation, and thus, objective and data driven, whereas art is subjective and qualitative. Artists approach data from their own perspectives (Tepe Yılmaz, 2014). The integration of science and art allows children to engage in artistic science projects that help them develop imagination, high-level thinking skills, and creativity about both art and science (Dhanapal et al., 2014). The integration of science and art in education can, therefore, provide children with knowledge and resources from different areas and help them develop positive attitudes towards learning in general.

Turkish Shadow Play (Karagöz and Hacivat)

Puppetry, in different forms, is an entertaining drama technique that attracts children's attention and sparks their curiosity (Temuçin, 2007). Shadow play is a form of puppetry that involves manipulating carved leather figures (humans, animals, plants, things, etc.) in front of a light source to cast shadows on a white screen (Kudret, 1992; Sevilen, 1969).

Shadow play is a visual art that is influenced by events and sociocultural changes that take place throughout history and bears the traces of social identities (Ersan, 2011). It evolves in parallel with the sociocultural changes that each society undergoes and with the talent, experience, and knowledge of artists of that society. It is a popular form of entertainment in many countries around the world, such as China, India, and Egypt. The traditional Turkish shadow play is Karagöz and Hacivat (And, 1977), who are also the lead characters. Karagöz represents the lay people while Hacivat represents the upper class (Şişman, 2009). It also includes some other characters: *Çelebi, Tiryaki, Beberuhi, Kastamonulu* (loutish), *Karadenizli* (Laz), *Kürt, Acem, Arap* and *Arap Bacı*, *Arnavut, Rumelili, Yahudi, Frenk* (Greek), *Ermeni, Edirneli, Tuzsuz Deli Bekir* (drunkard), *Zenneler* (women), *Cazu, Cin* (supernatural characters), and *Çengi* and *Köçekler* (Kudret, 1992). A Karagöz and Hacivat play can be written, performed, and directed by one person, or a *hayalî* or *hayalbaz* (meaning imaginary or image creator) can assist the puppeteer and hand him the puppets in the correct order (Bulut, 2014). A Karagöz and Hacivat show can be about any topic and updated to the taste of the day as long as it does not offend good morals, go against common sense and disturb the public order and as long as the puppeteer has a sound grasp of the Turkish shadow play tradition (Atkın, 2010). Unlike most texts and stories, Karagöz and Hacivat scripts have an intuitive and humorous language, rather

than a direct and dry one, to convey messages to readers. They consist of everyday life humorous elements, word games, smart dialogues, jokes, and clever comebacks (Bulut, 2014).

Ersan (2011) argues that European countries, which met the art of shadow play at a later stage in history, did not integrate it with their own culture and turn it into a tradition but instead have taken advantage of its dramatic structure and visuality and decided to use it in education in different ways. Özdemir (2006) calls Karagöz and Hacivat "the cartoon of the day before the cartoon as we know it today was created" and states that it has characters, topics, and technical features that always appeal to children. Karagöz and Hacivat has a wide spectrum of characters, which is, in a sense, the symbol of multiculturalism emphasized all over the world today, and has songs, costumes, and settings, which can be viewed as high art. Karagöz and Hacivat is not only for literary refinement or popular entertainment but can also be used as a cultural and educational tool (Demir & Özdemir, 2013). Shadow play can also be an effective tool for children to overcome the fear of expressing themselves in front of others. They may feel safer and more comfortable speaking as they make puppets talk and move.

Dialogues in Karagöz and Hacivat are thought-provoking, discussion-triggering, and open to controversy, and therefore, may promote effective learning in early childhood science education as well. Karagöz and Hacivat may make early childhood science education topics full of abstract concepts more interesting, motivating, and entertaining because it consists entirely of funny characters, comical skits, clever comebacks, and fun dialogues. Shadow play texts are appealing to many senses because people can read, listen or watch them, and thus, can also develop listening and comprehension skills. Therefore, shadow play texts can be used to appeal to children.

Method

Research approach

This study employed an explanatory sequential mixed methods design and involved two stages; (1) quantitative data collection and analysis, and (2) qualitative data collection and analysis (Creswell & Plano Clark, 2015).

During the workshop, participants made their own shadow puppet figures and came up with scripts about early childhood science education topics and then put on puppet shows. The study integrated quantitative and qualitative processes by first quantitatively testing the effect of workshop on preservice teachers' attitudes and self-efficacy beliefs towards early childhood science education and then qualitatively investigating the effects of the workshop through focus group interviews and observations.

Participants

Participants were recruited using sequential and simultaneous sampling, in which the sample of the qualitative stage depends on that of the quantitative stage (Creswell et al., 2003).

The sample of the quantitative stage consisted of early childhood preservice teachers who took the "Traditional Turkish Handicrafts" course and participated in the workshop of shadow puppet-making and script-writing. They worked on their puppets, sometimes alone and sometimes together with their peers. We encouraged them to cooperate with their peers to teach them how to make and implement joint decisions. We wanted them to demonstrate personal and team accountability and develop personal problem/conflict management and social/communication skills. All participants in the quantitative stage (16 women; 8 men) were first-grade undergraduate preschool education students with a mean age of 20.6 years. The sample of the qualitative stage consisted of six of the 24 preservice teachers who participated in the whole 12-week workshop and put on their own shadow puppet shows about the early childhood science education topics they chose. The mean age of participants in the qualitative stage (4 women; 2 men) was 21 years.

Data Collection Tools

Early Childhood Teachers' Attitudes toward Science Teaching (TSAS)

The Teachers' Science Attitudes Scale (TSAS) developed by Thompson and Shrigley (1986) for primary school teachers was adapted to early childhood preservice teachers by Cho et al. (2003). The Early Childhood Teachers Attitudes Toward Science Teaching (TSAS) was adapted to Turkish by Çamlıbel Çakmak (2006).

The TSAS-TR consists of 17 items and four subscales; comfort-discomfort, classroom preparation, managing hands-on science, and developmental appropriateness. The items are scored on a 5-point Likert-type Scale (1 = Strongly disagree, 2 = Disagree, 3 = Neither agree nor disagree, 4 = Agree, 5= Strongly Agree) (Çamlıbel Çakmak, 2006). Three items are reverse scored. The total scale score ranges from 17 to 85. Higher scores indicate more positive attitudes towards science teaching (Güvenir, 2018). The same holds true for the subscales as well (Güvenir, 2018). According to Çamlıbel Çakmak (2006) and Güvenir (2018), the TSAS had a Cronbach's alpha of 0.81.

The TSAS subscales "comfort-discomfort," "classroom preparation," "managing hands-on science," and "developmental appropriateness" had a Cronbach's alpha of 0.66-0.77, 0.75-0.75, 0.52-0.63, and 0.46-0.56, respectively. As noted by Thorndike and Thorndike-Christ (2010), those reliability coefficients indicate that the total scale has good reliability, but that its subscales have low reliability due to low number of items.

Science Teaching Efficacy Belief Instrument (STEBI)

The Science Teaching Efficacy Belief Instrument (STEBI) was developed by Enochs and Riggs (1990) and adapted to Turkish by Tekkaya, Çakıroğlu, and Özkan (2002). It was readapted by Tekkaya et al. (2010) for early childhood preservice teachers. STEBI-TR consists of 23 items and two subscales; (1) personal science teaching efficacy (PSTE) and (2) science teaching outcome expectancy (STOE). The items are scored on a 5-point Likert-type Scale (1 = Strongly Disagree, 2 = Disagree, 3 = Neither Agree Nor Disagree, 4 = Agree, 5= Strongly Agree) (Tekkaya et al., 2002). Ten items are reverse scored. The total scale score ranges from 23 to 115. Higher scores indicate higher self-efficacy in science teaching. The same holds true for the subscales as well

Tekkaya et al. (2002) and Olgan et al. (2014) reported that the PSTE and STOE had a Cronbach's alpha (α) of 0.86 to 0.87 and 0.79 to 0.72, respectively. Fettahlıoğlu et al. (2015) also reported that STEBI had a Cronbach's alpha of 0.85 and that the PSTE and STOE had a Cronbach's alpha of 0.84 and 0.78, respectively.

Focus Group Interview and Observations

Focus group interview is a qualitative interview technique performed with a group of participants on a particular topic (Yıldırım & Şimşek, 2016) and is a dynamic and creative method that allows researchers to collect deep and rich data on research problems (Krueger & Casey, 2000). In this study, a focus group interview was conducted with six participants to gain insight into what they thought about the workshop and use of shadow play in early childhood science education in general.

Observations were made throughout the process to analyze the data with more than one method. The observation method allowed us to draw a comprehensive and detailed picture of participants' views.

Procedure

The quantitative stage involved training on shadow puppet-making, writing scripts on early childhood science education topics, and putting on puppet shows. The effect of the workshop on participants' attitudes and self-efficacy beliefs towards science teaching was experimentally tested. After the quantitative stage, qualitative methods were used to include participants' interviews, observations, and experiences in order to investigate the effects of the workshop. Table 1 shows the procedure steps.

Table 1. Shadow Play Workshop

Week	Date	Step	Hour
1	20.02.2019	Pretest	2
2	27.02.2019	Presentation on shadow play	3
3	06.03.2019	Making figures from leather-drawing-cutting	5
4	13.03.2019	Making figures from leather-piercing-sandpapering	5
5	20.03.2019	Making figures from leather-piercing-sandpapering	5
6	27.03.2019	Making figures from leather-dying	5
7	10.04.2019	Making figures from leather-dying-fixing- presenting script examples	5
8	17.04.2019	Writing a script for preschool science education-sample shadow play–training on shadow play	5
9	24.04.2019	Checking the scripts-putting on shadow puppet shows	5
10	01.05.2019	Putting on shadow puppet shows	5
11	08.05.2019	Posttest	2
12	15.05.2019	Focus group interview	2

The quantitative stage employed an experimental group pretest-posttest design. Participants completed the STEBI (Enochs & Riggs, 1990) and TSAS (Cho et al., 2003) prior to the workshop (pretest) and then were informed about shadow play. They were then allowed to make their own puppet figures in a workshop. Afterwards, they (in groups of two and three) chose early childhood science education topics and wrote scripts about them. Whoever finished writing their script put on their puppet show for other groups to watch. After the workshop, all participants completed the same two scales (posttest). Participants were recruited for the qualitative stage, and a focus group interview was conducted with them. The procedure lasted 12 weeks/49 hours.

In the qualitative stage, a focus group interview was conducted, and then, observations were carried out to support the interview data. The researchers developed an interview form based on the feedback of three experts (two in preschool education and one in measurement) and then conducted the focus group interview in a quiet place in the faculty on a scheduled day and time. The interview was audio-recorded. Participants were informed that the interview would be audio-recorded and that their names would be kept confidential prior to participation. After checking the recording device, asking general introductory questions, and reminding focus group interview rules, the researchers posed questions to elicit information on (1) participants' experience of shadow puppet-making and (2) of script-writing and puppet show, (3) advantages and disadvantages of using shadow play in early childhood science education, and (4) in what disciplines and fields of early childhood education they think shadow play can be used. The researchers asked follow-up questions for clarification and elaboration when needed.

The researchers made observations during the workshop for 12 weeks. They videotaped the observations and took field notes as well in order to obtained more detailed data and to examine over and over again how participants behaved during the workshop sessions. The qualitative and quantitative data were compared and integrated for results.

Data Analysis

Quantitative Analysis

Descriptive statistics, histograms, and Shapiro-Wilk test (sample < 35) results regarding participants' STEBI and TSAS pretest and posttest scores were analyzed together (McKillup, 2012). Data were analyzed using the Statistical Package for Social Sciences (SPSS, v 24.0) at a significance level of 0.05. Table 2 shows the descriptive statistics for participants' STEBI and TSAS pretest and posttest scores and the difference between them.

Table 2. Descriptive Statistics

	STEBI Pretest	STEBI Posttest	STEBI Difference	TSAS Pretest	TSAS Posttest	TSAS Difference
Mean	84.000	89.208	5.208	59.208	66.875	7.666
Median	86.000	90.500	7.000	61.500	68.500	8.000
Mode	86.000	73.000	7.000	67.000	57,000	8,000
SD	9.445	12.782	9.463	9.947	12.515	8.889
Skewness	-.596	-.200	-.062	-,182	-1.040	-.027
Kurtosis	.097	-.798	-.667	-.592	2.318	.325
Minimum	63.000	63.000	-12.000	41.000	29.000	-12.000
Maximum	98.000	109.000	24.000	80.000	85.000	25.000

Participants' STEBI pretest and posttest scores and the difference between them had similar mean, mode, and median values, and the kurtosis and skewness coefficients ranged from +1 to -1. However, their kurtosis and skewness coefficients for TSAS pretest and posttest scores did not range from +1 to -1. When data were normally distributed ($p > 0.05$), dependent (paired) t test was used. When data were not normally distributed ($p < 0.05$), the Wilcoxon Signed Ranks test was used (Howell, 2013). Cohen's d effect size was calculated to determine the magnitude of the effect of the shadow play workshop on participants' self-efficacy beliefs and attitudes towards science teaching (Field, 2009; Sullivan & Feinn, 2012). Cohen (1988) suggests that an effect size of 0.2, 0.5, and 0.8 is small, moderate, and large, respectively.

A numerical value calculated for a reliability coefficient varies from group to group (Nitko & Brookhart, 2010). Therefore, Cronbach's alpha (reliability coefficient) was used to determine the internal consistency of STEBI and TSAS for our sample (Taber, 2018). The Cronbach's alpha values based on participants' pretest and posttest scores were assessed using George and Mallery's rules of thumb (2019): $0.70 < \alpha < 0.79$ acceptable, $0.80 < \alpha < 0.89$ good, and $0.90 < \alpha < 1.00$ excellent. The TSAS pretest ($\alpha_{pretest}$=.84) indicated good reliability while posttest ($\alpha_{posttest}$=.93) scores indicated excellent reliability. The STEBI pretest ($\alpha_{pretest}$=.76) score indicated acceptable reliability while the TSAS posttest ($\alpha_{posttest}$=.90) indicated excellent reliability.

Qualitative Analysis

Focus group interview and observation data were thoroughly analyzed to determine participants' experiences of the workshop and their views of the potential of shadow play in early childhood science education. Qualitative data were coded using second-cycle coding and then analyzed using inductive content analysis (Miles et al., 2014). The researchers first read all the focus interview transcripts and observation notes several times and watched the video recordings over and over again to get a general idea about how to code the data in line with the research objectives.

In the first stage of coding, the researchers coded some of the data separately and then compared them to develop themes. They agreed on some of the themes and codes without any revision while they discussed the others and modified them. In the second stage, they used constant comparison to code the remaining data (Corbin & Strauss, 2008). They used the QSR N-Vivo 12 to develop themes, subthemes and categories and then interpreted the findings. They consulted a different expert who had experience in the field to check the codes and themes for reliability. They discussed the codes and themes based on expert feedback and reached a consensus and then interpreted and presented them in Tables.

Results

Quantitative results

The Effect of Shadow Play on Participants' Attitudes towards Science Teaching

The Wilcoxon Signed Ranks test used to determine significant differences between participants' TSAS pretest and posttest scores. Table 3 shows the results.

Table 3. The Wilcoxon Signed Ranks Test Results for Mean TSAS Pretest and Posttest Scores

Total TSAS	N	Mean Rank	Rank Sum	z	p
Negative Ranks	3	10.00	30.00	-3.288	.001**
Positive Ranks	20	12.30	246.00		
Ties	1				
Comfort-Discomfort	N	Mean Rank	Rank Sum	z	p
Negative Ranks	6	8.67	52.00	-2.220	.026*
Positive Ranks	15	11.93	179.00		
Ties	3				
Classroom Preparation	N	Mean Rank	Rank Sum	z	p
Negative Ranks	7	8.36	58.50	-1.474	.140
Positive Ranks	12	10.96	131.50		
Ties	5				
Hands-on Science Activities	N	Mean Rank	Rank Sum	z	p
Negative Ranks	6	9.67	58.00	-2.234	.025*
Positive Ranks	16	12.19	195.00		
Ties	2				
Developmental Appropriateness	N	Mean Rank	Rank Sum	z	p
Negative Ranks	3	3.00	9.00	-3.471	.001**
Positive Ranks	16	11.31	181.00		
Ties	5				

*p<.05, ** p<.01, *** based on negative ranks

Participants' mean TSAS posttest score ($M_{posttest}$=66.87, $Mdn_{(posttest)}$=68.50) was significantly higher than their mean TSAS pretest score ($M_{pretest}$=59.20, $Mdn_{(pretest)}$=61.50) [W=246.00, z= -3.288, p<.01, r=0.67]. These result showed that the workshop significantly improved participants' attitudes towards science teaching (Pallant, 2011). The repeated measures showed that their TSAS posttest comfort-discomfort ($M_{pretest}$=14.29, $M_{posttest}$=15.87; $Mdn_{(pretest)}$=14.00, $Mdn_{(posttest)}$=16.00; W=179.00, z= -2.220, p<.05, r=0.45), hands-on science activities ($M_{pretest}$=14.29, $M_{posttest}$=16.04; $Mdn_{(pretest)}$=15.00, $Mdn_{(posttest)}$=16.00; W=195.00, z= -2.234, p<.05, r=0.46), and developmental appropriateness ($M_{pretest}$=16.70, $M_{posttest}$=19.95; $Mdn_{(pretest)}$=16.00, $Mdn_{(posttest)}$=20.50; W=181.00, z= -3.471, p<.01, r=0.71) subscale scores were significantly higher than their mean TSAS pretest subscale scores. This results showed that the workshop resulted in a moderate or above moderate increase in participants' comfort-discomfort, hands-on science activities, and developmental appropriateness subscale scores. However, the repeated measures showed no significant difference between mean TSAS pretest ($Mdn_{(pretest)}$=15.00, $Mdn_{(pretest)}$=13.91) and posttest ($Mdn_{(posttest)}$=16.00, $Mdn_{(posttest)}$=15.00) classroom preparation subscale scores [W=131.50, z= -1.474, p>.05].

The Effect of Shadow Play on Participants' Self-Efficacy Beliefs in Science Teaching

A dependent samples t-test used to determine significant differences between participants' STEBI pretest and posttest scores. Table 4 shows the results.

Table 4. T-test Results for Mean STEBI Pretest and Posttest Scores

	N	$\bar{X}$	s	sd	t	p
Total Pretest	24	84.00	9.44	23	-2.696	.013*
Total Posttest	24	89.20	12.78			
Subscale	N	$\bar{X}$	s	sd	t	P
PSTE Pretest	24	45.41	6.98	23	-2.148	.042*
PSTE Posttest	24	49.25	9.72			
Subscale	N	$\bar{X}$	s	sd	t	p
STOE Pretest	24	38.58	5.46	23	-1.412	.171
STOE Posttest	24	39.95	5.51			

*p<.05, ** p<.01

Participants' mean STEBI posttest score ($M_{posttest}$=89.20, S.E=2.60) was significantly higher than their mean STEBI pretest score ($M_{pretest}$=84.00, S.E=1.92) [t(23)= -2.696, p<.05, r=.49]. Their mean STEBI PSTE posttest scores ($M_{posttest}$=49.25, S.E=1.98) were significantly higher than their mean STEBI pretest scores ($M_{pretest}$=45.41, S.E=1.42) [t(23)= -2.148, p<.05, r=.41]. These results indicated that the workshop moderately increased participants' STEBI and PSTE scores (Field, 2009). However, there was no significant difference between mean STOE pretest ($M_{pretest}$=38.58, S.E=1.12) and posttest ($M_{posttest}$=39.95, S.E=1.13) scores [t(23)= -1.412, p>.05]. Although participants' mean STOE posttest score was higher than their mean STOE pretest score, the difference was statistically insignificant (p> 0.05).

Qualitative Results

This section presented the themes, subthemes, categories, codes, and sample quotations in Tables. The comments section addressed observation details to provide an accurate and coherent picture of participants' views and to allow readers to easily analyze and interpret the findings.

Participants' Experiences of Shadow Puppet-Making

This section focused on participants' experiences of shadow puppet-making. They were asked the question "How did you feel about making figures for a Turkish shadow puppet show (Karagöz and Hacivat)? What was your experience like?" Their responses were categorized and presented in Table 5.

Table 5. Participants' Experiences of Shadow Puppet-Making

Theme	Subtheme	Category	Codes	Quotations
Positive	Social-affective domain	Entertained	Enjoying (N=3)	I really enjoyed it. It was so much fun, I really had fun doing it. (P4)
		Happy	Doing something important (N=2)	I was happy because I felt like we were doing something important. (P5)
			Experiencing something productive (N=1)	I think it was very a productive class, and the topic was also very productive, so it made me happy. (P6)
			Making the effort worthwhile (N=1)	When I saw the end result, I felt like it was worth the effort, I mean, it was very nice, and I was happy about it. (P1)
		Proud	Preserving traditional culture (N=3)	It made me realize how easily we forget our traditions and how important it is to preserve them. I was proud because now I can preserve this beautiful tradition. (P4)
			Learning traditional culture (N=2)	We were proud that we got to learn, also with your help, about this tradition, which is sadly dying out. It meant more to us. (P1)
			Passing traditional culture down to next generations (N=1)	I was feeling important towards the end because I was going to be one of those who could hand this tradition down to the future generations. When you learn something, you turn into someone who is responsible for transmitting it to the next generations. It feels nice, I feel proud. (P3)
		Improved Self-Confidence	Achieving despite believing the contrary (N=2)	At first I had some doubts because I wasn't sure I could do it. I didn't think I had the manual skills for it, but as I got into it, my skills got better and after a certain point I was doing it easily, and so I was more confident. (P6)
		Lucky	Having this opportunity (N=2)	First of all, I wouldn't imagine the Alparslan University would offer such a workshop. It's good that it did. First of all, I would like to thank the teachers and then to the council of higher education. I feel lucky that that workshop was held here at this university. (P2)

	Psychomotor domain	Making Figures	Improving dexterity(N=5)	You know, we are going to be preschool teachers. We will teach a lot of things to kids, and so we have to be good with our hands. Making figures for the shadow play taught us to use our hands better. (P3)
Negative	Social-affective domain	Having Difficulty	Piercing the leather (N=4)	I had a hard time piercing the leather because I had never done it before. We had never had to pierce calf leather to make figures, so it was hard. (P2)
			Making mistakes in dyeing (N=1)	I painted some parts wrong, which was a hurdle. (P6)
			Choosing the wrong color (N=1)	I chose the wrong colors, which put me in a difficult situation. (P1)
		Upset	The cracking of the leather (N=2)	My figures broke, and I was sad. (P5)
			Failure to meet expectations (N=1)	I couldn't meet the expectations, so my teacher was upset, and I felt sorry that I made her upset. (P5)
		Regretful	Not caring enough (N=1)	To be honest, I could have cared more, I think it would have been better if I had cared more, so I was a bit regretful and I'm sure most of us were. (P5)
			Not paying attention (N=1)	I should have pierced the leather and painted it more carefully, so I wish I had done it that way. (P3)
	Psychomotor domain	Having Difficulty	Piercing the leather (N=6)	I have a degree from a vocational school for girls, so I trust my dexterity, but I also had a hard time piercing the leather. (P5)
			Painting process (Adjusting colors) (N=1)	We just couldn't pick the right colors. (P3)

All participants had positive and negative feelings about puppet-making. Most of them addressed social, affective, and motor skills under the themes of positive and negative. They stated that they enjoyed making puppets and that it made them feel happy, proud, self-confident, and lucky, and taught them how to use their hands better (Table 5).

Participants mostly reported positive developments in the social-affective domain. Those who were happy about making puppets felt like they were doing something important and believed that the activity was very productive and worth the effort. They found it important that they had the opportunity to work on and learn about a tradition and to preserve it by handing it down to the future generations. They were proud of the figures they made and felt more self-confident. Some participants held certain prejudices against the activity but felt more confident as they tried it out. Participants stated that they had prejudices because the activity required manual skills and also because they had never partaken in such an activity before, but that the activity proved them wrong as time went on. We can, therefore, state that participants devoted a lot of time and effort to make their puppets and developed new motor skills and became versed in it thanks to new experiences throughout the activity.

Participants had difficulty piercing the leather and painting it. Some stated that they were upset because the pieces of leather they worked on cracked or because they felt that they disappointed their teachers. Most participants stated that they had difficulty piercing the leather and executing some motor skills and were regretful and wished that they had been more careful.

Participants' Experiences of Shadow Play and Script-Writing

This section addressed participants' experiences of writing shadow play scripts about early childhood science education topics and putting on puppet shows. To that end, they were asked the question, "How did you feel about writing a shadow play script and putting on a puppet show (Karagöz and Hacivat)? What was your experience like?" Their responses were categorized and presented in Table 6.

Table 6. Participants' Experiences of Shadow Play and Script-Writing

Theme	Subtheme	Category	Codes	Quotations
Positive	Cognitive Domain	Learning	Tool (N=4)	Hard topics have two challenges; learning it and teaching it. It is very hard to teach something you don't know well enough, so shadow play is a good way of doing it, I mean, both for you and for those you teach to. It can be used in education, that's what I think. (P4)
	Social-affective domain	Group communication	Getting to know each other(N=3)	This is our first year in college and we got to meet everybody. We got to know each other better with that fun teamwork, I'm glad we did it. I think we feel like classmates now. (P4)
			Improving friendship (N=2)	We had so much fun writing the script. I believe this workshop has improved my relationships with my classmates. (P5)
			Becoming more sociable (N=1)	Some of our classmates used to be shy, but now they are not. I was also very social and active in the group at the writing stage (P6)
			Becoming friends(N=1)	This is our first year in college, so the workshop's helped us get to know each other better (P3)
		Improved sense of humor	Doing jokes (N=2)	The teammates were coming up with jokes at the script-writing stage, we all came up with jokes, so I think we have a better sense of humor now. (P4)
		Having fun	Script-writing (N=2)	When I adjust my tone of voice, I, like, make a high-pitched sound and then a low-pitched sound, so when I do that as a woman, I mean, when I make a low-pitched sound, I feel like laughing. We did that kind of things while writing the script and we had so much fun (P1)
		Team work	Collaboration (N=1)	It's a great teamwork, you get to work together with others, I mean, you realize that you can work with others. (P3)
			Discovering things in common (N=1)	It's made us realize that we have so much in common, like sense of humor and whatnot, and we also started to get to know each other better. (P3)
	Psychomotor domain	Shadow Play performance	Improving professional skills(N=1)	I was adjusting my tone of voice during the show, so I realized that my professional skills were getting better. (P1)

			Exploring talent for acting (N=1)	I realized during the show that I have a talent for acting. (P1)
Negative	Social/Affective Domain	Having Difficulty	Coming up with a plot (N=4)	We sometimes forgot our lines, so we kind of choked. It was the month of Ramadan when we worked on the script, so it may be that, we didn't mean to do that. (P2) Script-writing was too hard for us, we just couldn't do it, I mean, we couldn't think of anything. (P6)
			Disagreements (N=2)	We had some disagreements at the preparation stage, I mean, there was just too many opinions and that led to conflicts, but we got over it when we started writing the script though. (P3)
			Group conflicts (N=2)	We couldn't agree on whether to focus on the topic or on jokes. There were too many disagreements within the group. Another thing was that we had to write the script during the exam week, and I was kind of annoyed at my teammates' demands, so we had a little bit of an argument about that. (P4)
			Confusion (N=1)	We sometimes got confused while writing the script, which put us in a bit of a jam, but we figured it out. (P2)
			Putting the script on a word document (N=1)	One of us was responsible for putting the script on a word document, but there were just too many typos in it, and I was embarrassed to see that, so we had a bit of a problem about that. (P5)
			Inexperience (N=1)	It was the first time we came up with a Karagöz and Hacivat script, so we were completely inexperienced and so had to deal with some problems (P4)
		Upset	Jokes considered bad (N=1)	My teammates did not like my jokes, which was upsetting (P3)
			Ideas considered inappropriate for student level (N=1)	My teammates found some of the things I said inappropriate for the students' level and so refused to put them in the script, which was kind of upsetting. (P2)

All participants had positive and negative feelings about writing Karagöz and Hacivat scripts about early childhood science education topics and putting on puppet shows. Participants' views were grouped under the themes of positive and negative. Participants mostly addressed cognitive, social/affective, and motor skills. Most participants expressed positive views under the subthemes of cognitive, social/affective, and psychomotor domains regarding writing shadow play scripts and putting on puppet shows. Participants stated that shadow play could be used as a means of learning, that they communicated effectively, had fun, did teamwork, discovered that they had a talent for acting, and improved their sense of humor and professional skills during the workshop.

Those who stated that shadow puppet show and script-writing helped them communicate effectively with their teammates also stated that they got to know each other better, made new friends, and became more sociable. This shows that shadow play activities help preservice teachers get to know themselves and others better. Moreover, those who stated that the workshop helped them

develop teamwork skills also stated that they made great effort to accomplish the tasks they were assigned to. This shows that shadow play activities make preservice teachers push themselves to develop self-discipline. Participants' statements also showed that writing scripts and putting on shadow puppet shows made them more willing to cooperate and respect differences.

Participants expressed some negative opinions about the workshop as well. Some participants who reported challenges especially on the social/affective domain stated that they had encountered disagreements and group conflicts while writing scripts. We think that participants had difficulty coming up with storylines due to the lack of experience. Some participants were upset by the fact that their teammates did not find their jokes funny or appropriate.

Participants' Positive Views of the Use of Shadow Play in Early Childhood Science Education

This section investigated participants' views of the use of shadow play in early childhood science education. To that end, they were asked the questions, "In what way do you think the Turkish shadow play (Karagöz and Hacivat) might positively affect early childhood education? and "In what way do you think shadow play might positively affect early childhood education? Their responses were categorized and presented in Table 7.

Table 7. Positive Effects of Shadow Play on Early Childhood Science Education

Category	Codes	Quotations
Teacher	Fun education (N=5)	You know, we are going to be preschool teachers. We are going to teach kids a lot of things but we can't do that all at once. We should make it fun, and I think that we can use the things we've learned from the workshop. (P3)
	Alternative method (N=4)	How can I explain a topic? What can I do to make it more effective? The workshop gave me a solution, Karagöz and Hacivat is a new way, a new method. (P3)
	Turning abstract into concrete (N=3)	Science topics are a bit hard to understand, and using Karagöz and Hacivat is important to ensure learning retention, because there are abstract concepts, so Karagöz and Hacivat can be used to turn abstract concepts into concrete forms and help students keep them in mind. (P2)
	Drawing attention (N=3)	Today, children live in the digital age, so they have short attention span, be it a game or a class, but we can use this handicraft, that is, Karagöz and Hacivat, to draw their attention to class, we can use visuals and sounds to do that. (P5)
	Discovering a talent (N=3)	It is very important for discovering kids with related skills. For example, acting, I mean, maybe the parents or the teacher can't notice it, but the kids can discover their or each other's talent for acting, and the teacher can notice that and tell that to parents, and the kid gets a chance to maybe go in that direction in life. (P3)
	Easy teaching (N=3)	It allows us to teach topics much more easily, and so the kids can comprehend them much more quickly and put them in practice. Karagöz and Hacivat works miracles, so I think it's a promising method. (P4)
	Learning retention (N=2)	I used Karagöz and Hacivat to teach my 5-year-old niece about rain. In another setting, he described the rain with the voice of Karagöz, so I saw that it helps with learning retention. (P6)

	Effective learning (N=2)	There's this thing in Karagöz and Hacivat, it makes a topic fun, which helps with learning. You can't teach kids something at all once, you should make them laugh and make sure that they enjoy it; when you do that, they will learn without even knowing that they do. I think this is the greatest perk of Karagöz and Hacivat. (P4)
	Pointing out errors (N=2)	I had a story about a smoker ruining his lungs, like messed up lungs and whatnot, you know, to explain the health risks of smoking, I think we can use Karagöz and Hacivat characters to teach the kids what's right and what's wrong. (P5)
	Solution to lack of material (N=1)	When we think of science education, we think of experiments and a laboratory etc. Not everybody can do experiments, I mean, maybe they don't have an appropriate setting or materials, but we saw that, with Karagöz and Hacivat, we can teach science even in schools in villages with no materials to be used. (P5)
	Explaining class rules effectively (N=1)	We can also use Karagöz and Hacivat to teach children class rules. (P2)
	Getting down to students' level (N=1)	Karagöz and Hacivat brings down a topic to the simplest level, I mean, to the level of children, so they get more enthusiastic about learning and take firm steps forward and learn easily. (P1)
	Discovering theatrical skills (N=1)	I personally had never thought that I had a talent for theater, I mean, acting and doing voices etc. But when we put on our puppet show, I realized that I'm really good at it, and I think I may consider a career in theatre, I mean, I think I can participate in different activities. (P1)
	Gamification (N=1)	Children love playing games, and Karagöz and Hacivat is like a game, and when they play it, they do voices and actually improve their skills. (P6)
	Making communication stronger (N=1)	When the puppeteer makes the figures talk and when it's all fun and funny, the teacher and kids bond and communicate better. (P2)
Child	Development of dexterity (N=4)	We can use Karagöz and Hacivat to help preschoolers develop manual skills, especially while making puppet figures. (P4)
	Development of theatrical skills (N=3)	Kids watching a shadow puppetry show would also like to make the characters talk, and when doing that, they'll improve their theatrical as well as some other skills. (P2)
	Being active (N=3)	Karagöz and Hacivat makes the kids more active, they answer questions more quickly. (P3) We can use Karagöz and Hacivat to engage students more in class. (P5)
	Increased attention span (N=3)	I think that Karagöz and Hacivat increases the kids' attention span because if it's a long story animation, then the kids have a hard time keeping focused, but they will get more focused if it's a Karagöz and Hacivat show. They will want to see the whole thing, so I believe it can increase their attention span. (P2)
	Learning with one's own materials (N=2)	Kids can learn how to use their hands better when preparing a Karagöz and Hacivat show, and then they'll get to learn the topic because they will be putting on a show about it. (P1)
	Being more social (N=2)	Today kids live in the digital age, Karagöz and Hacivat can help them socialize and develop theatrical skills. (P5)
	Overcoming technology addiction (N=2)	Today, children are addicted to technology, but, with Karagöz and Hacivat, they can learn how to use their hands better and overcome that addiction. (P2)
	Easy learning (N=2)	We've realized that we learned better using this method, so since it helps us learn faster, I think that it would work miracles for secondary school or primary school students or even for preschoolers. (P2)
	Willingness for engagement in activities (N=1)	Students at that age see their teacher as god and want to do what she does, so a teacher putting on a Karagöz and Hacivat show would definitely make her students enthusiastic about taking part in it. (P2)

Social-Cultural	Handing culture down to future generations (N=4)	I will use Karagöz and Hacivat in professional life and help it be known better and handed down to the future generations. (P3) An important thing that we've learned from the workshop is that Karagöz and Hacivat are not only for the month of Ramadan but that it can be performed anytime of the year. We can let that be known by the public as well. (P2)
	Integrating culture and education (N=1)	Karagöz and Hacivat combines culture and education. This is actually very important because we should know about our own past to be able to take firm steps into the future, I mean, we can blend culture with education because it's a very different thing. (P6)
	A component of culture in values education (N=1)	I think it has a very important place as a cultural element in values education. (P2)

Participants' views of the integration of early childhood science education with shadow play were grouped under the categories of "teacher," "child," and "social-cultural." They agreed that shadow play could be used by teachers because it was a child-centered education approach that helped them make teaching easier and more fun and effective. According to them, it is hard to keep preschoolers focused because they are addicted to technology, and therefore, teachers can use shadow play to keep them focused, to help them discover their potential and to ensure learning retention. They were of the opinion that shadow play could be used to turn abstract concepts into concrete forms, to overcome the lack of teaching materials, to explain class rules, to make communication stronger, and to bring science topics down to the level of children. They also maintained that shadow play could result in increased motivation and easier learning. They thought that children learned and developed skills by playing games and that shadow play was on the same page as learning by playing and gamification.

Participants remarked that science education with shadow play resulted in active learning and that students participating in shadow play activities, such as puppet-making, were likely to have a longer attention span and learn more easily. They also noted that puppet-making could help children develop manual skills, overcome technology addiction, and socialize more.

The contributions of shadow play to social-cultural domain were grouped under the codes of "handing culture down to future generations," "integrating culture and education," and "a component of culture in values education." Participants were of the opinion that shadow play could provide fun teaching and learning opportunities and turn children into people who respect and protect their traditions. Participants asserted that shadow play was an important component of culture in values education, and therefore, could be a bridge between culture and education.

Participants' Negative Views of the Use of Shadow Play in Early Childhood Science Education

This section investigated participants' negative views of the use of shadow play in early childhood science education. To that end, they were asked the questions, "In what way do you think

the Turkish shadow play (Karagöz and Hacivat) might negatively affect early childhood education? and "In what way do you think shadow play might negatively affect early childhood education? Their responses were categorized and presented in Table 8.

Table 8. Negative Effects of Shadow Play on Early Childhood Science Education

Category	Codes	Quotations
Practicality	Not appropriate for every science activity (N=5)	For example, we can't use Karagöz and Hacivat to teach science topics that require experiments. It might be a little hard to adapt it to every science topic. (P1) We have to take children out and allow them to observe so that they can learn some topics (e.g. adaptation of plants and animals). We can't use Karagöz and Hacivat to teach such topics. (P4)
	Knowing the topic very well (N=4)	You need to know a topic very well or do some research on it before you write a script about it. (P3) Well, hard topics have two challenges; learning it and teaching it. A teacher should know a topic well to teach it well to her students, so you should know a lot about a topic before you can come up with a Karagöz and Hacivat story about it. (P4)
	Having stories appropriate to the level of children (N=1)	You should know about the characteristics of the age group you work with and the topic you want to teach to be able to come up with a storyline (P5)
	Doing some research (N=1)	The teacher should know a topic before writing a script about it, I mean, we checked three different resources to come up with a story, so you have to do a lot of research. (P6)
	Effort and time intensive (N=1)	I don't think shadow play is very practical because it's too inconvenient, I mean, you have to put so much effort on it both to make puppet figures and to come up with a story, and you also have to think of a way of conveying it to students. Maybe teachers can be a bit reserved about that, but I will definitely use Karagöz and Hacivat activities and teach science topics to my students that way. (P1)
	Limited time (N=1)	Time is also crucial, I mean, making puppets, coming up with a story and putting on a show...I mean, if it takes two hours of class to teach a topic, it will not take longer than that with a conventional method, but if you use Karagöz and Hacivat, then I think it might take longer than that, so, it's a bit of a drag. (P6)
Characters	Inappropriate characters for preschoolers (N=3)	Some characters are bad influence, for example, the character Tiryaki, he is a smoker. I wonder if it would confuse the kids, I mean, I have some doubts about that because whatever you teach the kids at that age, it sticks with them. Maybe we don't have to portray Tiryaki as an addict, I mean, we could portray him in a different way. We can talk about how he quit smoking, like what kind of treatment he received or how regretful he is that he's smoked for years. (P1)
	Knowing all the characters (N=1)	You should also know about what kind of characters they are; you should definitely have some idea about it because you'll write a story with those characters. (P3)
	Inappropriate behaviors (N=1)	Hacivat and Karagöz kick and punch each other, which set bad examples for kids (P2)

Participants stated that shadow play might have some disadvantages for early childhood science education, such as impracticality and characters who might be a bad influence. Under the category of practicality, they argued that shadow play might not be appropriate for every science activity and that it might be hard to come up with storylines appropriate for students' level. They pointed out that teachers should do a lot of research and know science topics very well, and devote a

lot of time and effort to make puppets and come up with storylines before they could use shadow play in early childhood science education (Table 8).

Under the category of characters, participants maintained that some characters in Karagöz and Hacivat might be a bad influence on preschoolers. The participant P3 approached the matter from a different perspective and highlighted that teachers should know the characters in Karagöz and Hacivat very well to be able to come up with storylines. These statements show that preservice teachers should be trained on shadow play during undergraduate years before they can use it effectively in early childhood science education.

Participants' Views of Early Childhood Science Education Topics for Shadow Play

This section investigated for what early childhood science education topics participants thought shadow play could be used. To that end, they were asked the question "In what areas or disciplines of preschool education can the Turkish shadow play (Karagöz-Hacivat) be used?" Their responses were categorized and presented in Table 9.

Table 9. Participants' Views of Early Childhood Science Education Topics for Shadow Play

Discipline	Area	Quotations
Art	Making figures (N=3)	Making figures is an art activity in itself. It's hard to make figures from leather, but kids can use acetate paper. It'll help them develop manual skills and get involved in an art activity. (P1)
	Shadow puppet show (N=2)	Shadow puppet shows are a visual feast for children, so it can be used in the visual arts lesson. (P5)
	Visual activities (N=2)	The characters in Karagöz and Hacivat are visually appealing to kids. (P2) Karagöz and Hacivat is like a painting, so it can be used in such activities. (P4)
	Teaching colors (N=1)	Kids can paint the figures in different colors, it'll improve their manual skills. It can also be used in visual arts lessons to teach the kids the colors. (P4)
Turkish	Pronunciation (N=2)	Teachers can use shadow play in Turkish lessons. Let's say, one character pronounces some words wrong and another character corrects him, so it can be used to teach kids how to pronounce words right. (P2)
	Elocution (N=2)	I think that teachers can use Karagöz and Hacivat activities to help kids speak Turkish well and properly because the character, Karagöz, for example, pronounces a lot of words wrong, and Hacivat corrects them, so you get the chance to teach kids how to pronounce words right. (P3)
	Coming up with a plot (N=1)	Writing scripts is also a good Turkish activity for kids. I mean, they want to use the new words they learn and can use them in scripts. (P4)
	Coming up with new words and using them (N=1)	Kids can also come up with new words while writing scripts and use them in their stories. My niece also participated in the workshop and then used the words she learned when she was playing with her friends and came up with new words by herself. (P6)
	Teaching new words (N=1)	We can use Karagöz and Hacivat to teach new words. For example, we can write down a script and use the words we want to teach kids in it, and after the puppet show, we can talk to them about those words, and this way, we can help them learn those words by heart. (P3)

Science	Providing information (N=3)	We are going to teach kids about science, so we can use Karagöz and Hacivat to do that; we can use the Karagöz and Hacivat characters to do it. I mean, when we teach students science topics, we can come up with creative activities and stories with Karagöz and Hacivat. (P2)
	Making hard topics easy to understand (N=1)	It's really hard to teach some science concepts, I mean, it's hard and sometimes boring, so, I think we can use Karagöz and Hacivat to make hard topics easy to understand . (P1)
	Learning retention (N=1)	We can perform science activities with Karagöz and Hacivat to teach students science concepts, I think that that kind of activities result in learning retention. (P3)
Music	Improving rhythm and timing (N=3)	Karagöz and Hacivat is a visual feast for kids, when it comes to puppet shows and dubbing characters, and music etc. The dialogues between Karagöz and Hacivat and other characters are in harmony with music, so I believe Karagöz and Hacivat shows can help kids learn to get rhythm. (P5)
	Teaching songs (N=3)	Karagöz and Hacivat has auditory elements, so it can be used in science education. Every character in it has his own music, so it can even be used to teach kids songs. We can integrate in Karagöz and Hacivat shows the songs we want to teach. (P2)
	Recognizing different sounds (N=1)	Every character in Karagöz and Hacivat has his own voice and music, and there are many other characters with different voice and music. Teachers can use Karagöz and Hacivat to help kids recognize different sounds. (P4)
	Playing musical instruments (N=1)	Musical instruments, such as def and nareke (some sort of a flute) are used in Karagöz and Hacivat shows, so kids who see that may become interested in musical instruments, so I think that Karagöz and Hacivat can be used in music education as well. (P5)

Participants stated that shadow play could be used in early childhood art, Turkish, science, and music activities because it involved visual and auditory elements and allowed children to make figures, learn colors, and put on puppet shows. They remarked that shadow play could also be used for Turkish education because children participating in shadow play could come up with storylines and new words and use them in their scripts and learn new words and how to pronounce them correctly and how to speak eloquently (Table 9).

Participants noted that shadow play could be used in preschool science activities because it provided information, ensured learning retention, made hard topics easy to understand and could also be used in early childhood music activities because it helped children develop musical skills, recognize different sounds, learn songs, and play musical instruments.

Discussion

Preschool science teachers generally use the question and answer and analogy methods as well as trip-observation and plant activities (Akyol & Birinci Konur, 2018; Karamustafaoğlu & Kandaz, 2006). However, these methods and activities are mostly teacher-centered. To our knowledge, there is no research on the effect of shadow play, which is a traditional art form, on early childhood science education. This study revealed important results regarding the effect of shadow play on early childhood preservice teachers' self-efficacy beliefs and attitudes towards science teaching and their views of the usability of shadow play in early childhood science education in general.

The shadow play workshop helped participants interact more, recognize simple scientific facts, and develop social and academic skills and positive attitudes towards science and art, and made them more interested in learning, more motivated to do research, and more curious about scientific issues. They found the workshop productive and enjoyed taking part in it. They took pride in their work and felt more confident and luckier. The workshop also helped them develop manual skills, made them more sociable and enabled them to express themselves more easily than before. The workshop provided them with the opportunity to recognize the relationship between everyday life and science and to raise questions about it. They sought answers to those questions by making shadow puppet figures, writing scripts, and putting on puppet shows on a white screen.

Participants' Self-Efficacy Beliefs and Attitudes towards Early Childhood Science Education

The workshop improved participants' self-efficacy beliefs and attitudes towards early childhood science teaching and also taught them how to use different materials in preschool education, helped them develop different perspectives of art and communication skills, and made them more interested in learning, more motivated to do research, and more curious about scientific issues.

Research shows that preschool teachers' perspectives and attitudes towards science teaching affect science teaching processes (Orkunoğlu, 2016; Osborne et al., 2003). Moreover, teachers with high self-efficacy beliefs are likely to be more active and suffer less from stress (Chan, 2003; Henson, 2001).

However, some studies show that some preschool teachers do not like or are not interested in science teaching (Babaroğlu & Okur Metwalley, 2018; Can & Şahin, 2015; Tu, 2006; Tu & Hsiao, 2008). Can and Şahin (2015) reported that early childhood preservice teachers had lower science attitude scores than science teaching attitude scores and concluded that this might be because preservice teachers might have thought that they were supposed to teach science even if they did not like or were not interested in it, however, the researchers also stated that it was uncertain how a teacher who was not interested in science could teach it to students and make it appealing to them. However, as noted by Orkunoğlu (2016), preschool teachers' attitudes towards science teaching affect how well they perform science activities and how much their students enjoy those activities. Therefore, what undergraduate education should first focus on is addressing preservice teachers' negative attitudes towards science teaching and turning them into positive before teaching them science topics.

Integration of Shadow Play with Early Childhood Science Education

Increased interest in programs that focus on putting knowledge into practice, new findings on how the brain functions during learning, and teachers who support progressive educational ideas are factors that contribute to integrated curricula (Smar, 2000).

Play is a fun activity that appeals to children and makes them more creative and sociable and ensures learning retention in early childhood (Bose & Seetso, 2016). Play is one of the most effective methods that can be used in science education because it can easily be integrated with other methods and promotes intrinsic motivation in children (Özgül et al., 2017). Teachers should be able to use play and involve children in science activities and scientific research to enable them to learn science topics through experience (Hamlin & Wisneski, 2012). Shadow play, which is a form of art, helped our participants develop interdisciplinary perspectives and provided them with the opportunity to have science-related experiences and develop skills that they will use in their professional lives.

Previous studies have investigated the effects of science education integrated with different art forms on students' attitudes towards science (Abed, 2016; Archilla, 2017; Braund, 2015; Gurnon et al., 2013; Hartwig, 2014; Kallunki et al., 2017; Verhoeff, 2017). However, what Öztürk (2010) found was that preschool science teachers first presented science activities and then art activities. However, they could integrate science with art and drama and play and come up with large group or integrated small group activities. In conclusion, early childhood science education can be easily integrated with different art forms, such as shadow play.

Materials in Early Childhood Science Education

Research shows that preschool teachers cannot apply science activities in the curriculum due to the lack of materials (Çınar, 2013; Karademir et al., 2020; Karamustafaoğlu & Kandaz, 2006; Saçkes et. al., 2010; Sağlam & Aral, 2015; Simsar et al., 2017; Trnova & Trna, 2015). Trnova and Trna (2015) argue that preschool science teachers can actually use simple toys and everyday materials to teach science concepts.

Our participants stressed that shadow play could provide teachers with different teaching methods and help them create different educational settings and also help students develop social/affective and communication skills. Shadow play scripts and shows can be used as a basic tool in education (Demir & Özdemir, 2013). Shadow play dialogues are good educational materials that provide effective learning and enable children to participate in activities (Öcal, 2014). Puppets can be used as supportive materials to improve teacher-student and student-student interaction (Anagün et al., 2010; Öcal et al., 2021)

The Effect of Shadow Play on Children

Activities integrated with drama and puppetry have long-term positive effects on children's social and emotional skills (Aydoğdu & Halim, 2017). Puppets become role models for children and present them with different situations in which they can develop thinking, cognitive, and social skills (Bai et al., 2015). Puppets help children develop thinking, learning, creativity (Causa et al., 2015) and interaction and independence skills (Bulut, 2014; Causa et al., 2015; Öcal et al., 2021). Shadow play scripts can also help children develop linguistic skills (Bulut, 2014; Demir & Özdemir, 2013; Yılmaz & Taşkın, 2014). Using shadow puppet figures to teach early childhood science topics encourages children to engage in learning, to express their thoughts about science activities, and to develop alternative perspectives about them.

Children should be actively involved in science learning while teachers should turn abstract science concepts into concrete forms (Brunton & Thornton, 2010; Skamp, 2011). Our participants noted that shadow play was a child-centered method that helped preschool science teachers to attract children's attention to activities and to turn abstract science concepts into concrete forms.

Our participants maintained that shadow play allowed students to come up with science-related stories and have fun while learning. They also stated that shadow play could teach children the importance of preserving cultural traditions. Fleer (2013) highlights that storylines are culturally and emotionally important in early childhood science activities because they support science education and help children develop a common scientific awareness. Research also shows that Karagöz and Hacivat serves as a means of transmitting culture to the next generation (Bulut, 2014; Demir & Özdemir, 2013; Yılmaz & Taşkın, 2014). Our participants also emphasized that shadow play could help children overcome technology addiction and positively affect their future learning.

Limitations and Future Research

This is the first study to investigate the effect of the integration of shadow play with early childhood science education. Therefore, it has some limitations: ambient light, the size of the white screen, and the location of the white screen. The ambient light should be as dim as possible for shadow play. However, we had difficulty adjusting the light in the workshop, especially during the first couple of shows. The white screen was not wide and high enough for all participants to view the shows, which was therefore distracting for some. We tried to fix these problems as soon as we noticed them. Therefore, teachers should arrange their classrooms and check the ambient light and the size and height of the white screen and students' position to make sure that they all can view the shadow puppet shows.

Another limitation was about early childhood science topics. Participants were allowed to write a script about any science topic because they did not know what topics could be taught through

shadow play. However, this caused them to choose the topics with which they were familiar. Therefore, further research is warranted to determine shadow play can be used to teach what early childhood science topics.

The third limitation was that the sample consisted only of 24 first-year early childhood preservice teachers. It is, therefore, necessary to conduct further studies with larger sample sizes to provide more insight into the contribution of shadow play to early childhood science education. Early childhood preservice teachers should be trained on shadow play during pedagogical education so that they can use it in their professional lives. A number of recommendations were made for future research on the use of shadow play for education and early childhood science education:

This study investigated the effect of shadow play on early childhood science teaching. Future studies should integrate shadow play with different active learning approaches and examine its effect on early childhood science teaching. Future studies should also identify the early childhood science topics for which shadow play can be used and how it helps students develop positive attitudes towards those topics. For example, studies should be conducted to determine whether shadow play activities help children develop cognitive, language, moral, psychomotor, and self-care skills.

Conclusion and Implications

This study determined the effect of shadow play, which is a cultural and artistic form of puppet theatre, on early childhood preservice teachers' self-efficacy beliefs and attitudes towards science teaching. It also addressed their views of early childhood science education integrated with shadow play. Early childhood science education helps children develop positive attitudes towards science in the future (Güvenir, 2018). But for this, it is first the teachers who should possess positive attitudes towards science. Our results show that shadow play is an effective, engaging, and fun method that preschool science teachers can use to turn abstract science concepts into concrete forms. It also improves their attitudes and self-efficacy towards science teaching. Our participants shared with each other what they learned in the workshop, and thus, developed an awareness of science. Shadow play provided them with knowledge and experience about how scientific environments should be like. Preschool science teachers can use shadow play to spark their students' curiosity and motivate them to learn.

Preservice teachers actively participating in science education classes in education faculties, using methods and techniques to improve themselves personally and professionally, and receiving support and guidance from their professors are likely to have more positive attitudes and self-efficacy beliefs towards science teaching. Undergraduate science courses should teach early childhood preservice teachers how to develop materials for science activities, and thus, make them more equipped for teaching science. Preschool teachers' gap in their knowledge of planning and

implementing shadow play science activities should be identified, and in-service training should be offered accordingly. Moreover, notes and guidebooks should be prepared, and meetings, workshops, projects, and symposiums should be organized to teach teachers and preservice teachers shadow play and make sure that they have shadow play-related experience and to make it easier for them to use it easily in their professional lives.

Our results show that shadow play helps children actively engage in activities, express their feelings and thoughts openly, put themselves in someone else's shoes, build social relationships, and develop basic social/affective skills. Shadow play is an interesting and motivating play-like method that contains fun characters and allows participants to come up with different stories. Therefore, shadow play dialogues can promote classroom interaction and child-child and teacher-child communication and engagement in activities in early childhood science education. In a nutshell, shadow play activities can be structured in line with learning outcomes and indicators and used in early childhood science education. For example, children can choose an appropriate science topic and come up with a plot about it and put on a shadow puppet show so that they can learn it easily and enjoy learning it.

Shadow play can be performed in early childhood classrooms. The white screen can be placed in a way they all children can view the shadow puppet shows. Even a permanent stage can be set up in the classroom and can be referred to as "dream scene." Children learn easily through play. Therefore, parents should also support their children to perform shadow play activities to develop collaboration skills, and to learn to take responsibility and follow rules.

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