



Relationship among Preschool Period Children's Mathematical Skills, Socio-demographic Characteristics and Socio-dramatic Play *

Selin Karaman ¹, Asiye İvrendi ²

Abstract

In the preschool period, socio-dramatic play in particular supports children's meta-cognitive skills, such as problem-solving, reasoning, and mathematical skills. It is therefore essential to examine the relationship between socio-dramatic play and mathematical skills. The first purpose of this study, which focuses on the mathematical skills of six-year-old children enrolled in early childhood institutions, is to determine the mathematical skills and aspects of socio-dramatic play. The second purpose is to investigate the relationship among children's mathematical skills, demographic characteristics, and aspects of socio-dramatic play. The results revealed statistically significant differences in mathematics achievement scores of low- and middle-income family children, and children who played at the higher and lower levels of symbolic agent, symbolic substitution, and symbolic complexity.

Keywords

Mathematical Skills in Preschool
Socio-dramatic Play

Article Info

Received: 12.30.2013
Accepted: 11.13.2014
Online Published: 02.15.2015

DOI: 10.15390/EB.2015.3016

Introduction

There is an emphasis on mathematics activities as an important part of early childhood (Akman, 2002), since mathematics experiences obtained in the early years both establish a foundation for later mathematics learning and influence school success (NAEYC and NCTM, 2010; Sarama and Clements, 2009). When preschool education programs are examined, one finds goals such as counting, one-to-one matching, seriation, classification, measurement, geometric shapes, operations, patterns, spatial skills, problem solving, and graphics for preschool children (MEB, 2013).

Mathematics standards prepared for preschool age children by the National Council of Teachers of Mathematics (NCTM, 2000) are divided into two parts: content and process. The content standards include number concept-operations, patterns-relationships, geometry, measurement and data-organizing. Standards related to process comprise problem solving, reasoning, communication, relationships, and representation.

*This work is based on the Master's thesis of the first author.

¹ Ministry of National Education, Turkey, selinkarama@hotmail.com

² Pamukkale University, Faculty of Education, Department of Primary Education, Turkey, aivrendi@pau.edu.tr

Although preschool mathematics includes aspects such as number, operations, geometry, spatial thinking, only number and operations were taken into account in this study. In the literature, children's number and operations skills are measured by different instruments, such as "the subscale focusing on mathematics in the Marmara Elementary School Readiness instrument (Unutkan, 2007), "Number Competence" (Jordan et al., 2009) and "Number Sense" (İvrendi, 2011). For instance, Jordan and others (2009) found that children's number competence in kindergarten predicted the progress rate of mathematics achievement in the first and third grades.

Researchers have emphasized the complex nature of early mathematical development, which is influenced by a variety of factors (Byrnes and Wasik, 2009; Ginsburg and Golbeck, 2004). Age, gender (Arnas Aktaş et al., 2003), socio-economic level of families (Unutkan, 2007), and self-regulation (Bull and Scerif 2001; Espy et al., 2004; İvrendi, 2011) can all influence mathematics skills.

Arnas Aktaş et al.'s (2003) study reveals that number and operations skills increase with age. While some studies examining the effect of gender on mathematics skills found no gender-related significant differences (Arnas Aktaş et al., 2003; Güven 2000; Hyde, Fennema and Lamon, 1990; Unutkan, 2007), others did find gender-related differences (Jordan et al., 2006; Penner and Paret 2008). Similarly, the findings related to the influence of families' SES on mathematics skills are inconsistent. Some studies have shown that lower SES children had lower mathematics skills (Starkey et al., 2004; Unutkan, 2007). Others have found that middle SES children achieved higher scores on addition and subtraction problems requiring the use of language than children from lower-income families. However, no differences were found between the scores of these two groups in nonverbal tasks (Jordan et al., 1994; Jordan et al., 2006). Studies related to the effect of self-regulation demonstrated that children with high self-regulation skills had higher scores in mathematics tests (Bull and Scerif 2001; Espy et al., 2004; İvrendi, 2011).

In developing mathematics skills in early childhood, play has an important role, alongside enriching classrooms, applying projects that help children to be active, using teachable moments, and teaching mathematical concepts through a variety of teaching strategies and techniques (Ginsburg, Lee and Boyd, 2008). In play, a context where children are involved in mathematical concepts with natural interest (NAEYC and NCTM, 2010), they use skills such as patterning, spatial relations, shapes, counting, seriation, and addition-subtraction (Carr, Peters and Young-Yoveridge, 1991; Clements and Sarama, 2005; Geist, 2001; Lee, 2007; Seo and Ginsburg, 2004). Socio-dramatic play is one play type that children frequently engage in.

Socio-dramatic play – a more complex form of symbolic play and also with a social aspect – is defined as pretend play involving at least two children (Athey, 1988). According to Smilansky and Shefatya (1990), there are six features of quality socio-dramatic play: role play (children acting like someone or something else), using objects in play differently than they were intended, transforming an event and/or situation through words or actions, maintaining play long enough, social interaction, and verbal interaction.

In socio-dramatic play, understanding the enacted characteristics, taking others' ideas into account, and regulating play behaviors contribute to children's flexible and abstract thinking. Because of these features, socio-dramatic play supports school learning (Smilansky, 1990; cited in Hanline, Milton and Phelps, 2008). On the importance of socio-dramatic play, Bodrova and Leong (2003) state that while children are pretending, they give new meanings to objects and people, focus more on abstract features of objects than concrete ones, and figure out different uses for materials.

Studies of socio-dramatic play reveal that it helps develop meta-cognitive and mathematical skills, such as problem solving, reasoning, and planning (Emfinger, 2009; Fisher, 1992; Gmitrova and Gmitrov, 2003; Gül, 2006; Hanline, Milton and Phelps, 2008; Lee, 2007; Matthews, 2008). Matthews (2008), in a study of 38 children, investigated the relationship among self-regulation, socio-dramatic play, and readiness. The results showed that socio-dramatic play supports the self-regulation skills essential for problem solving, and also that verbal interaction in play fosters self-regulation skills, such as the ability to follow instructions, planning, and organizing.

Another study examining mathematical skills in socio-dramatic play focused on 2-4 year olds. The results indicated that children used geometry and measurement knowledge without adult intervention (Lee, 2007). Research investigating the imaginary play of 23 mixed aged children demonstrated that they used mathematical skills, such as counting, addition, subtraction, and showing numbers with written and verbal signs and symbols (Emfinger, 2009).

In a longitudinal study, Hanline et al. (2008) examined the relationship among early reading and mathematics, symbolic agent, symbolic substitution, and symbolic complexity aspects of socio-dramatic play. They found a positive relationship between symbolic agent and academic skills, with symbolic substitution the strongest predictor of academic skills. However, it was found that symbolic complexity was not associated with academic skills. Development in these three aspects was related to the child's progress from self to others, being able to do more complex transformations and fast and organized actions. From another perspective, Umek and Musek (2013) in a study of levels of dramatic and socio-dramatic play, found that children's level of socio-dramatic play is not only associated with maturity of symbolic thinking, but also with the play context and materials.

In the literature overall, there is a general emphasis on the relationship between children's mathematical skills and socio-dramatic play. First, socio-dramatic play increases awareness of the symbolic systems that help children's learning of letters and numbers. Second, it has been established that children use a variety of mathematical skills in their socio-dramatic play. It is therefore important to examine the relationship between mathematical skills and the levels of socio-dramatic taking place in the play period, which makes up most of the daily plan. Studies conducted in Turkey have mostly examined mathematics and play types (Gül, 2006; Karaman, 2009; Şirin, 2011). There is a lack of Turkish research examining the relationship between mathematical skills and levels of socio-dramatic play. This study addresses the relationship between mathematics and aspects of socio-dramatic play – namely, symbolic agent, symbolic substitution, and symbolic complexity. Its aim is to determine the relationship between mathematical skills and levels related to each aspect of socio-dramatic play, which involves moving from self to others, using complex pretend transformations, and ability to organize well. There are two purposes of this study of the mathematical skills of six-year-old children enrolled in early childhood institutions. The first is to determine the children's mathematical skills and the extent to which they use aspects of socio-dramatic play. The second is to examine the relationship among mathematical skills, socio-demographic characteristics and aspects of socio-dramatic play.

Method

Research Model

This study employs a relational survey model, which is used to determine the existence and level of change in two or more factors (Karasar, 2010), to examine the factors affecting mathematical skills of six-year-old children.

Participants

The study population consisted of six-year-old children enrolled in state preschool and kindergarten in central Denizli in academic year 2011-2012. Because video recording was used in this study, the sample was chosen by the convenient sampling technique. It included 85 children from two classes in a preschool and two kindergarten classes in an elementary school, run by the Ministry of Turkish National Education. The sample ended up with 57 children, due to absences and some children choosing not to engage in socio-dramatic play.

Instruments

The data in the study was collected by using a "General Information Form", an "Achievement Test for 5-6 Years Old Children's Number and Operation Concepts" (Arnas, Gül, and Sığirtmaç, 2003); and a "Socio-dramatic Play Scale" (Hanline, Milton and Phelps, 2008).

General Information Form: This form is used to determine the socio-demographic characteristics of the participants. It comprises items related to the children's gender, number of siblings, education level of parents, and SES. This form was completed using school registration forms.

Achievement Test for 5-6 Years Old Children's Number and Operation Concepts: We used this instrument, developed by Arnas, Gül and Sığirtmaç (2003), to measure mathematical skills related to number and operation concepts. The test has 88 items and includes items, such as "writing number 3 and adding 4 cubes and 1 cube". Nine experts examined its content validity. The KR-20 value for the whole test was .98 and test-retest Pearson Product Moment Correlation Coefficient was $r=.95$. After explaining the test to the children, it was individually administered by the first author. The items were administered in the same order. Testing took approximately 25 minutes.

Socio-dramatic Play Scale: Children's socio-dramatic play was examined using the "Socio-dramatic Play Scale" developed by Hanline, Milton and Phelps (2008), based on Rogers (1988). The instrument has three aspects: symbolic agent, symbolic substitution, and symbolic complexity. Symbolic agent deals with to whom or to what the play is directed, such as a child pretending she is combing her hair or feeding her doll. Symbolic substitution refers to the level of abstractness and concreteness of materials, such as using a real bag when playing, or acting like opening a door without having a key in her hand. Symbolic complexity is related to the number and inter-relationship of schemas such as first creating a market by aligning legos and then selling things to friends. In Hanline and others' (2008) study, four researchers trained by the third author coded the video recordings. The fourth author recoded the recordings to compute the inter-rater agreement. Cohen's k was found as follows: symbolic agent $k= .76$, symbolic substitution $k= .79$ and symbolic complexity $k= .71$.

In this study, the Socio-dramatic Play Scale was examined by three experts to determine the language equivalence of the instrument and the most appropriate Turkish translations. A pilot study was conducted with 35 children attending kindergartens in four elementary schools, which were not included in the study sample, to learn about the instruments to assess their reliability and validity. A total of 33 minutes of video recordings of 15 children was collected in two kindergartens over three days. Data were coded, using the steps described below, to enable familiarization with the instrument. To determine its reliability and validity and its correlation with the mathematical skills, the general information form, the Socio-dramatic Play Scale, and the Achievement Test for 5-6 Years Old

Children's Number and Operation Concepts were administered to 25 children enrolled in the other two kindergarten classes.

This study used inter-rater agreement, as a reliability measure, and test-retest to measure the repeatability of the observations based on time (Karasar, 2010). To compute inter-rater agreement, 20% of the video recordings coded by the first author was recoded by a preschool teacher with ten years' teaching experience and doing a Master's in early childhood education. Kendall's tau-b correlation coefficient was calculated for the scores obtained separately by the observers. The inter-rater agreement scores were calculated for symbolic agent ($r = .760$), symbolic substitution ($r = .793$), and symbolic complexity ($r = .710$) aspect of the instrument.

For the test-retest, three video recordings of 25 children, each lasting 33 minutes, were coded day by day based on the scale. After three weeks, children's socio-dramatic play was again video-taped, the three videos coded and Spearman correlation coefficients for the data calculated. There was a statistically significant, high and positive relationship in test-retest scores for symbolic agent ($r = 0.704$, $p < 0.01$) and symbolic substitution ($r = 0.770$, $p < 0.01$). Test-retest scores for symbolic complexity were significant, mid-level, and positive ($r = 0.695$; $p = 0.000$; $p < 0.01$). Without any intervention, children's socio-dramatic play was video-taped for three weeks and 15 times during free time period.

Data Analysis

In the "Achievement Test" children's correct answers were given 1 point and the total scores were used in the analysis. Children's socio-dramatic play behaviors were coded according to the levels of the "Socio-dramatic Play Scale". Every hour of video recording was divided into one-minute segments. The first three minutes of recordings were not coded, to allow for children getting used to the camera. Every subsequent minute was coded in terms of symbolic agent, symbolic substitution, and symbolic complexity. On the scale, 1 shows the lowest and 4 the highest level (level 1= 1, level 2= 2, level 3= 3, and level 4= 4). Increase from first level to fourth is related to the child's progress in the following areas: moving from self to others, using more complex transformations, and doing better seriation and organizing. The highest level of symbolic agent, symbolic substitution, and symbolic complexity was coded and used in the analysis. Table 1 shows the scoring and examples of the scale.

Table 1. Scoring of Socio-dramatic Play Scale and Explanatory Examples

Score	Symbolic agent	Symbolic substitution	Symbolic complexity
1	Pretending to be ironing.	Using a real camera while pretending to take a photo of her friend.	Pretending to make a cake.
2	Pushing a car.	Pretending to eat from a toy plate and spoon.	Child first combs her own hair and then combs her friend's hair.
3	Walking like a cat.	Pretending to use lego as a car.	Child first feeds herself, then her doll or her friend.
4	Gives a friend the role of pretending to be a dog, gives a name, and showing a glass and plate says, "this is your water and meat."	Tells the friend who is pretending to be a dog, "Let me put you on a leash" and acts as if doing so.	Pretending to be shopping, cooking, and feeding her doll.

Adapted from Hanline et al. (2008).

SPSS 15 program was used in the data analysis. Descriptive statistics were used to describe the participants' socio-demographic features and aspects of their socio-dramatic play. Since the data were not normally distributed, the Mann-Whitney U and Kruskal Wallis H were used to examine the relationship among children's mathematics achievement test scores, demographic features, and aspects of socio-dramatic play (Büyüköztürk, 2002). The significance level was set at 0.05.

Results

In this study, the relationship among 6 years old children's mathematical skills, socio-demographic characteristics and aspects of socio-dramatic play were examined. Participants' socio-demographic characteristics are presented in Table 2.

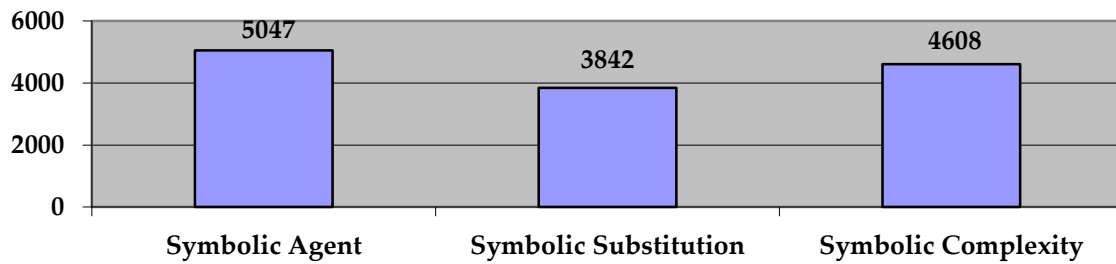
Table 2. Distribution of Participant Children according to their Demographic Characteristics

Variables	Group	Number	Percent
Gender	Girl	23	40,4
	Boy	34	59,6
Number of siblings	No child	8	14,0
	1 sibling	35	61,4
	2 siblings	14	24,6
Mother's education level	Elementary	40	70,2
	Middle school	8	14,0
	High school	9	15,8
Father's education level	Elementary	35	61,4
	Middle school	9	15,8
	High school	13	22,8
Families' socio-economic status	Low level (Below minimum wage)	22	38,6
	Mid-level	35	61,4

Table 2 shows that 40.4% of the children were girls and 59.6% boys. 38.6% of the families were in the low-income group, and 61.4% of them were in the middle-income level. Children's means, standard deviations, and lowest and highest scores in the mathematics achievement test were computed. The results show that the lowest mathematics score was 28, the highest 88, and the average score 72.05 ($X=72.05$, $SD=15.56$).

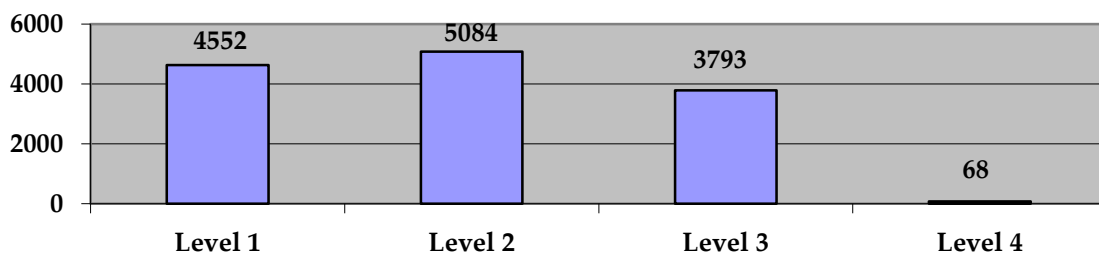
As indicated earlier, the Mann-Whitney U and Kruskal Wallis H were used to examine the relationship among children's mathematics achievement test scores, demographic characteristics, such as gender, number of siblings, parents' education level, and SES, and aspects of socio-dramatic play. Only SES was significantly related to children's mathematical skills. The results showed statistically significant differences in mathematical skills between children from low- and middle-income families ($U=250.50$; $p=0.027$; $p<0.05$). When mean ranks were examined, the mathematical skills of children from low-income families were lower than children from middle income. There were no significant differences in mathematical skills based on gender ($U=333.00$; $p=0.515$; $p>0.05$), number of siblings [$\chi^2(2)=2.46$; $p=0.292$; $p>0.05$], mother's education level [$\chi^2(2)=1.32$; $p=0.515$; $p>0.05$] and father's education level [$\chi^2(2)=2.78$; $p=0.248$; $p>0.05$].

The distribution of children's socio-dramatic play aspects was examined, and the results are presented in Graph 1.



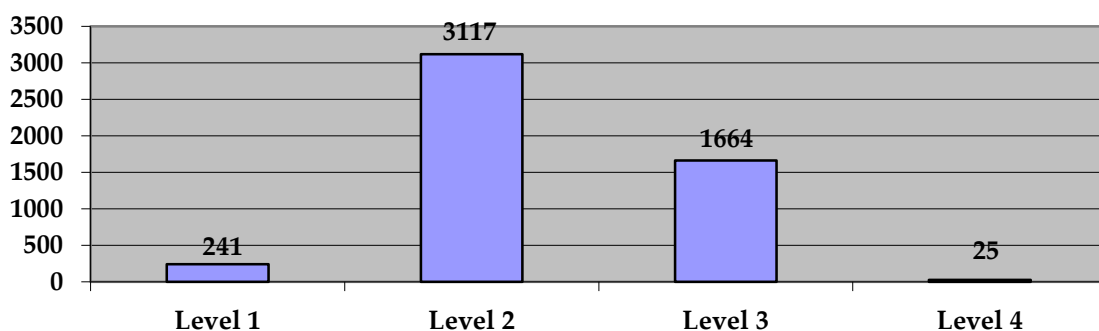
Graph 1. The distribution of children's socio-dramatic play aspects

Children played most in symbolic agent (5047 times) mode and played least in symbolic substitution (3842 times). The distribution of level of children's socio-dramatic play is given in Graph 2.



Graph 2. Distribution of the level of children's socio-dramatic play

The fact that children played mostly in level two indicates that they directed their play behaviors to an object/person, mostly used objects close to real ones, and utilized two or more objects/peers. Playing least in level four demonstrates that children managed their peers without taking a role, used imaginary objects, and acted out a scenario. Distribution of the levels of symbolic agent related behaviors is represented in Graph 3.



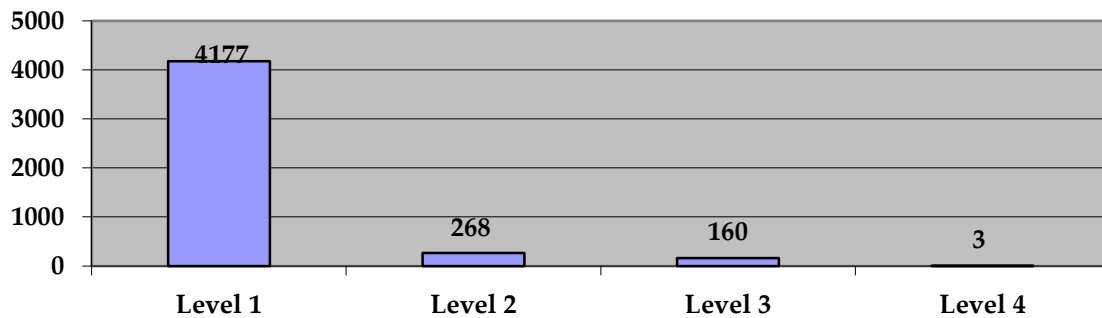
Graph 3. Distribution of the levels of symbolic agent related behaviors

The evidence that children mostly played in the second level and played least in the fourth level of symbolic agent indicates that they mostly directed their behaviors towards an object/person, and less frequently managed their peers without taking a role. Distribution of the level of symbolic substitution is shown in Graph 4.



Graph 4. Distribution of the level of symbolic substitution related behaviors

The children mostly played in the third level and played least in the fourth level of symbolic substitution, demonstrating that they mostly attributed other functions to the objects, and less frequently pretended to use imaginary materials. Distribution of the level of symbolic complexity is given in Graph 5.



Graph 5. Distribution of the level of symbolic complexity related behaviors

The graph reveals that the children mostly played in the first level and played least in the fourth level of symbolic complexity. They mostly played alone, and less frequently used imaginary scenarios including symbolic schemata.

Having examined all three aspects, it is clear that the children mostly played in symbolic agent aspect and played least in symbolic substitution. In terms of each level of the three aspects, children mostly played in the second level of symbolic agent, in the third level of symbolic substitution and in the first level of symbolic complexity. In the three aspects overall, children less frequently played in the fourth level.

The results of the Kruskal-Wallis H test for the relationship among the children's mathematics achievement test scores and symbolic agent, symbolic substitution, and symbolic complexity are presented in Table 3.

Table 3. Results of Kruskal -Wallis H Test Related to Mathematics Achievement Test Scores by Socio-dramatic Play

Symbolic Agent	n	Rank Oreder	sd	x²	p	Significant difference
Level 1	5	3.00				Between level 4 & level 1
Level 2	5	16.70				Between level 3 & level 1
Level 3	42	32.79	3	18.00	.000	Between level 4 & level 2
Level 4	5	35.50				Between level 3 & level 2
Symbolic Substitution	n	Rank Oreder	sd	x²	P	Anlamlı Fark
Level 1	5	3.30				Between level 4 & level 1
Level 2	5	18.00				Between level 3 & level 1
Level 3	40	31.45	3	18.88	.000	Between level 4 & level 2
Level 4	7	41.21				Between level 3 & level 2
Symbolic Complexity	n	Rank Oreder	sd	x²	P	Anlamlı Fark
Level 1	29	23.50				Between level 4 & level 1
Level 2	11	38.55				Between level 3 & level 1
Level 3	14	30.25	2	8.57	.036	Between level 4 & level 2
Level 4	3	41.33				Between level 3 & level 2

*p< .05

Table 3 identifies significant differences between the children's mathematical skills and symbolic agent [$\chi^2(3)=18.00$; $p=0.000$; $p<.05$], symbolic substitution [$\chi^2(3)=18.88$; $p=0.000$; $p<.05$] and symbolic complexity [$\chi^2(2)=8.57$; $p=0.036$; $p<.05$] aspects. Their mathematical skills differ according to the levels of these aspects. Examination of the rank orders shows that children playing at the fourth level of symbolic agent, symbolic substitution, and symbolic complexity had higher scores, and those playing at the first level of these aspects had the lowest scores in the mathematics achievement test. In terms of symbolic agent, symbolic substitution, and symbolic complexity, there is a significant difference between children who played at the fourth and first levels, third and first levels, fourth and second levels, third and second levels.

Discussion

This study has established that these six-year-old children's mathematical skills are related to their families' SES and their experience of playing at the higher levels of socio-dramatic play. The mathematics achievement test scores of children from low-income families were lower than those of children from mid-level income families. However, the noted lack of significant differences related to the children's gender, number of siblings, and parents' education level is consistent with other research findings (Starkey et al., 2004; Unutkan, 2007). This may stem from the possibility that low-income families may not provide a supportive home environment for mathematics learning (Bull and Scerif 2001; Espy et al., 2004; İvrendi, 2011). On the other hand, the relevant literature claims that the content of mathematics tests determines the influence of SES. It has been found that, while children from low-income families had low scores in mathematics tests requiring language, such as verbal addition and subtraction problems, no differences were found between low- and mid-level income family children's scores in tests not requiring language (Jordan et al., 1992; Jordan et al., 2006). The mathematics achievement test used in this study includes verbal addition and subtraction problems. Moving from this point, an impression arises that the language limitation of low-income family children may have negatively influenced their mathematical skills. However, the inconsistent findings in the literature emphasize the need to investigate children's mathematics skills along with SES and other developmental areas, such as language skills.

Another finding of this study is that children's mathematics achievement scores were related to their socio-dramatic play. This is congruent with the studies examining socio-dramatic play with cognitive and mathematical skills (Gmitrova and Gmitrov, 2003; Gül, 2006; Hanline et al., 2008; Lee, 2007; Matthews, 2008). This study found that children playing at the highest level of symbolic agent, symbolic substitution, and symbolic complexity had higher mathematics achievement scores. Every aspect of socio-dramatic play's first level, which shows the lowest level, and the fourth level, which indicates the highest level, is related to children's moving from self to others, using more complex pretending transformations, and being able to create better organization (Bodrova and Leong, 2003; Hanline et al., 2008). In other words, it can be said that children able to take into account others' views, do more complex pretending transformations, and regulate their behaviors had higher scores in the test measuring number and operations skills. The significant difference found between mathematics skills and symbolic agent and symbolic substitution echoes Hanline et al. (2008). In symbolic agent aspect, while the child acts by herself, she gradually starts taking more roles, shaping objects based on the role, and managing peers' play. The finding of the significant relationship between mathematical skills and symbolic agent may stem, as Bodrova and Leong (2003) state, from opportunities to give new meanings to objects and people, to focus more on abstractness than concreteness, and to explore different uses of materials. In terms of symbolic substitution, children's giving meaning to toys shows the development from concreteness to abstractness. While children use concrete materials initially, they gradually start transforming toys into different objects and pretending without using any materials (Hanline et al., 2008).

This feature of symbolic substitution, being related to abstract thinking and raising awareness toward symbolic systems, which helps the learning of letters and numbers (Bodrova and Leong, 2003), is thought also to be related to mathematical skills. The finding that the mathematical skills showed significant differences according to the levels of symbolic complexity does not align with the results of Hanline et al. (2008). The researchers video recorded children's play on two occasions for a total of 180 minutes, and found that symbolic complexity was not related to mathematical and reading skills. It is possible that short-time observations may not provide adequate opportunities for symbolic substitution to be observed. In this research, video recording of children's socio-dramatic play on 15 occasions, resulting in 450 minutes of observation, might yield longer observations of children's play. Therefore, a significant difference might emerge between children's mathematical skills and symbolic complexity.

Conclusions

Mathematical skills learned in the preschool period influence children's later school success (NAEYC and NCTM, 2010; Sarama and Clements, 2009). The findings that children's mathematical skills are related to family SES and the highest level of symbolic agent, symbolic substitution and symbolic complexity underline the importance of both families and quality play. Therefore, seminars about supporting children's mathematical learning experiences at home could be given to low SES families. These experiences should focus on routines, such as setting the table with cutlery according to the number of people, and can also involve activities such as regular storytelling or reading books, and expressing the order of events in a story. All of these can be stimulation for parents to do with their children.

Socio-dramatic play, which children play frequently, is one way to support children's mathematical skills. However, what is important for mathematics skills is the complexity of such play. Thus, it is essential to give teachers seminars about mathematics education and features of quality socio-dramatic play. These seminars can support teachers developing a view towards guiding, rather than interfering with, children's play, encouraging them to play at the highest level of socio-dramatic play. In particular, this type of approach can enhance preschool education's emphasis on the importance of teaching through play.

Although this study revealed important findings about mathematical skills and socio-dramatic play, its limitations should also be taken into account. Including only 57 children and of low- and mid-level SES can be considered a limitation. Studying a larger sample would be important in terms of gaining information about mathematical skills and socio-dramatic play of children coming from different SES. As noted previously, studies on Turkish children focusing, for example, on quality socio-dramatic play features and children's mathematics, readiness to reading and writing, and language skills are quite limited. Hence, there is a need for further research on socio-dramatic play and mathematical skills. The mathematics test used in this study was about number and operations. Further studies examining the relationship among socio-dramatic play, spatial perception and geometric shapes, and supportive teacher roles for such play would be a major contribution to the literature.

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