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The Relationship between Problem-Solving Skills and Memory Development in Preschool Children

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Abstract

The present study aimed to investigate the correlation between problem-solving and memory skills in preschool children. The study group included 122 4-6 years old children attending pre-school education institutions. Random sampling method was used to determine the study participants. Data were collected with Problem-Solving Skills Scale (PSSS) and Memory Scale for Children (MSC). In data analysis, Pearson's correlation coefficient was used to determine the correlation between the scale scores. The t test and one-way analysis of variance (ANOVA) were used to determine the effect of gender of the children, parental age and educational status on problem solving and memory. The study findings demonstrated that there was a significant correlation between the PSSS and MSC subscale scores, and the problem-solving skills and memories of pre-school children were not affected by gender, school type, parental age and profession, and mother's educational status. There was a difference between memory scores of the children based on the father's educational status and no significant difference was determined in problem-solving skills.

Keywords: Problem-solving, Memory, Cognitive development, Preschool period.

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Introduction

Problem-solving, which is essential for achieving social goals and lifelong learning processes, is a skill that a child needs to develop starting from the early years of life. Therefore, it is important that children make effort and solve as many problems as possible during the early years of their development, hence they become capable of solving social, emotional, cognitive or professional problems that they encounter in the future by using their cognitive abilities (Aydoğan Ertuğrul, 2004). A problem, often defined as a construct that needs to be explained, is a part of any learning process. Therefore, problem-solving is considered as the means to effective learning and developing individual abilities and cause permanent changes in an individual's behavior (Bingham, 2004).

The main purpose of education is to prepare individuals for future life. Such purpose can be fulfilled through providing students with attitudes and skills that help them overcome the problems they might encounter in daily life (Ünsal & Ergin, 2011). Children learn to focus their ideas on a subject, produce different solutions, understand the cause and effect relationships of events, and predict the consequences of events through using the problem-solving behavior. For a child, problem-solving facilitates the discovery of abilities and meeting own needs. The child does not wait for others to make decisions about the problems he/she encounters, seeks solutions, obtains the opportunity to use experience and skills, and the self-confidence of the child increases (Aydoğan Ertuğrul, 2004). It is possible to address the concept of problem-solving in a broad perspective, ranging from simple mathematics or science problems to social, logical, and mental problems. Therefore, activity processes related to problem-solving process might vary (Kalaycı, 2001). Problem-solving involves various dimensions, ranging between the realization of a problem and finding a solution to that problem. Bingham (2004) argued that the problem-solving process occurred in the following order:

1. Acknowledging the problem and the determination to deal with the problem,
2. Explaining and understanding what the problem is,
3. Gathering information about the problem,
4. Selecting and editing the data appropriate to the problem,
5. Determining viable solutions based on the data,
6. Evaluating the solution types and selecting the best one,
7. Trying/implementing the selected solution,
8. Evaluating the solution method that was used.

The challenges encountered by an individual require decision making (Adair, 2000) and the thinking process begins with the acknowledgement of a problem. As problem-solving becomes an aim for the individual, such aim also leads the individual to contemplate (Kalaycı, 2001). Rich and diversified learning experiences that are offered to children in problem-solving process are expected to improve cognitive abilities, creativity levels, thus the problem-solving skills. The well-being of children, especially their mental development and adaptation to the environment vary based on the richness of the opportunities that provide experience (Bradley, Judith & Brisby, 1993).

There exist several factors that affect problem-solving skills positive or negatively. These factors include social factors such as parenting attitudes (Kesicioğlu, 2011) and teacher attitudes (Begde & Özyürek, 2016), individual factors such as intelligence level, motivation, readiness and past experiences, affective and cognitive factors (Aydoğan, 2012) and metacognition (Karakelle, 2012). Furthermore, it is possible to assert that one of the factors closely related to problem-solving skills is cognitive process skills. Memory, which is considered as one of the processes that ensure the survival

of organisms (De La Vaux, 2002), is defined as archiving knowledge in mind and the memory process includes acquisition, retention and retrieval of knowledge when necessary. Strong memory, that enables connection between past, present, and future experiences, facilitates individuals to learn new knowledge through the already archived fundamental knowledge in mind (Özyürek, 2015).

According to the multi-store model of memory, memory is addressed through three structural components, the sensory register, short-term memory, and long-term memory (Fielding, 2004). Sensory register enables the interpretation of stimuli through attention and selective perception and the transfer of such stimuli to short-term memory (Bishop & Cates, 2001), whereas short-term memory temporarily stores the information and transfers it to the working memory. Repeated information in memory is retained for longer periods (Holmes & Adams, 2006). Short-term memory includes visual memory, which facilitates storing visual experiences, motor memory, which entails the knowledge gained due to movement, and the auditory memory, which involves knowledge based on hearing (Schaffer, 2004). The information processed in short-term memory is transferred to long-term memory, which has quite broad scope and boundaries, and becomes the stored knowledge which can be recalled when necessary via recall tips (De La Vaux, 2002). Knowledge is retained in long-term memory for the whole life (Ashcraft, 2002). Long-term memory system includes the semantic memory, where memory, concepts and knowledge based on the experiences of the individual are stored (Bauer, Stennes and Haight, 2003), the implicit memory, where the knowledge on space and time is stored, the explicit memory with more specific learning experiences, the verbal memory, the symbolic memory, and units for the working memory, which stores the forms of the objects (Woolfolk, 2001).

There are numerous factors that affect memory. Variables such as attention and interest of the individual, motivation to learn, level of anxiety, physical conditions, socio-economic status and cultural characteristics, gender, age, and level of intelligence are effective on the development of memory (Özyürek, 2015). Perception allows discerning meaningful patterns from complex senses, whereas attention allows focusing perception on a person, subject, an object or event. Attention allows the coding of stimuli through acknowledging and discerning those stimuli and such experiences are not easily forgotten (Naish, 2005). The desire to remember what was learned, parenting style, which especially includes listening to the ideas of the child and supporting his/her autonomy, enhances motivation and strengthens retention. Negative emotions such as anxiety, anger, fear, or emotions related to excitement and extreme joy result with difficulties in retention through preventing the focus of attention (Fielding, 2004). Environmental conditions rich in stimuli affect learning positively and information learned in an agreeable environment is remembered more easily (Savaş, 2007). It was determined that living conditions affect all areas of individual development, and retention and conceptual knowledge are closely related to attitude, culture and educational status (Hoerl, 2007).

In studies that focus on memory, it was established that differences based on gender decreased in mathematics, verbal and spatial abilities and females remembered more childhood memories compared to males. Köksaldı Özgül (2005) conducted a study with children between the ages of 9 and 11, determined that children with high socio-economic level had better memory, attention and learning performances when compared to those with lower socio-economic status and emphasized that the social environment and cultural characteristics affect children's level of cognitive functions and intellectual development. Studies indicated that age affects memory development and the memory capacity increased due to the increase in age (Bayliss & Jorrold, 2005; Beuscher et al., 2005; Freidman, 2007; Howe et al., 2004; Riggs et al., 2006). The relationship between knowledge and memory of an individual varies based on age. Knowledge is the first step in memory development, and it is emphasized that individuals with stronger memory capacity also have higher levels of intelligence. It was also demonstrated that memory training was effective on memory development (Özyürek, 2015).

Problem-solving requires scientific reasoning, the fundamentals of scientific knowledge. The problem-solving process begins with the transfer of information simultaneously from sensory register and long-term memory to the short-term memory, which is also called the working memory. The most important domain of cognition is the working memory and the processing capacity determines the level of complexity for problem-solving. Working memory is used to process information during problem-solving. It is essential that information is transferred to long-term memory and retrieved from there when required. It is important how information about the problem is stored in long-term memory and information should be retrieved from the long-term memory. Working memory cleared out once problem-solving is complete and space for latest information becomes available, preventing unnecessary load of information (Akıncı, 2012). The theoretical view on working memory indicates that the capacity of the working memory plays an important role in problem-solving (Hambrick & Engle, 2003).

Literature review revealed that there existed studies that focused on the effects of preschool children's attachment patterns on open memory processes and interpersonal problem-solving levels (Türköz, 2007), the effects of memory capacity on the problem-solving skills of students from different age groups (Akıncı, 2012) and the role of working memory in creative problem-solving (Kershaw et al, 2002). There were no studies that compared cognitive problem-solving skills and memory development of preschool children. Based on the hypothesis that problem-solving skills are closely related to memory, the present study was intended to examine the relationship between problem-solving skills and memory development of preschool children. Within the framework of such objective, the present study investigated whether problem-solving skills and memories of preschool children exhibited differences based on gender, parents' age, occupation and educational status.

Method

Model

The present study employed the descriptive screening model (Bütün, 2016), which provides the opportunity to define data numerically, to explain the relationship between the problem-solving skills and memory development of preschool children.

Study Group

The study group consisted of 122 preschool children in total, 66 females and 56 males, who participated the present study as a result of simple random sampling method and who attended an institution for preschool education. The present study was carried out in seven different schools and 77 children attended kindergartens in primary schools and 45 attended independent kindergartens.

Data Collection Tools

Sociodemographic Data Form was used to retrieve personal information on the preschool children and parents, the Problem-Solving Skills Scale (PSSS) developed by Aydoğan et al. (2012) and the Cohen's (1977) Children's Memory Scale (CMS), which was adapted in Turkish by Tekok-Kılıç and Elmastaş-Dikeç (2001) were used in the present study.

Problem-Solving Skills Scale (PSSS), aims to determine the problem-solving skills of children in real world situations and has two types of forms for two different age groups, age 4 to 7 and 8 to 11. The scores obtained from the scale determine the children's performance based on problem-solving skills. The present study used the PSSS form for children between the ages of 4 and 7. The form consists of 10 subscales and 50 items that include specific, observable, and measurable problem situations from the real world. Correct responses are scored as "1" and incorrect responses are scored as "0". The norm study of the Turkish version of the scale was conducted with 1117 children between the ages of

4 and 7, the KR-20 internal consistency was determined as .81 (n=1110) and the test-retest reliability was determined as .75 (n=31).

Children’s Memory Scale (CMS), is individually administered to children between the ages of 5 and 8. The present study applied the following subtests of the scale: Dot Locations, Faces, Stories and Word Pairs. The “Visual Immediate Index” in the scale refers to the visual short-term memory, whereas the “Visual Delayed Index,” “Verbal Immediate Index,” “Verbal Delayed Index,” “Learning Index,” and the “Delayed Recognition Index” refer to visual long-term memory, verbal short-term memory, verbal long-term memory, the skill to learn visual and verbal material, and the recognition of verbal stimuli due to repeated experience, respectively. The sum of the visual and verbal immediate and long-term memory index scores is the Total Memory Index score (Çelik, 2004; Kuyucuklu, 2005). Özyürek (2015) conducted a study with 120 children below the age of 6 and determined that the total reliability score of the scale was $\alpha=.98$ and the test-retest correlation was .73. In this study, the reliability coefficient of the scale was found to be .83.

Data Collection and Analysis

CMS was individually administered to the participant children outside the classroom and PSSS was applied on a separate day, after each child was administered the CMS. The application durations for both scales were 20 to 30 minutes. The scores of children who responded both scales were evaluated in the present study.

The data were analyzed in computer environment. Pearson correlation coefficient was used for the analysis of significant relationship between the PSSS and CMS scores. T-Test and one-way analysis of variance (ANOVA) were used to determine the difference between the PSSS and CMS scores based on gender of the children, parents’ age, occupation, and educational status.

Findings

Correlation, mean, and standard deviation values of the relationships between the PSSS and CMS scores were presented in Table 1.

Table 1. Simple Correlation Coefficients, Mean and Standard Deviation Values Between the Variables

CMS	PSSS										
	Noticing the Problem	Identifying the Problem	Asking Questions About the Problem	Estimating the Cause of the Problem	Deciding Adequacy of Information About the Problem	Defining the Elements of the Problem	Different Use of Objects	Estimating the Results of Some Actions	Finding the Most Suitable Solution	Choosing the Most Unusual Solution	PSSS Total
Visual Immediate	.152	.125	.421*	.255**	.064	.126	.262**	.338**	.101	.138	.407**
Visual Delayed	.108	.142	.243**	.119	.090	.014	.141	.114	.128	.139	.250**
Verbal Immediate	.130	.202*	.239**	.334**	.198*	.064	.292**	.281**	.238**	.175	.436**
Verbal Delayed	.149	.240*	.272**	.322**	.172	.058	.285**	.269**	.204**	.152	.428**
Learning	.172	.174	.301**	.310**	.162	.130	.251**	.326**	.199*	.159	.446**
Delayed Recognition	.167	.180*	.297**	.236**	.182*	.067	.247**	.292**	.121**	.165**	.394**
GENERAL MEMORY	.165*	.233**	.338**	.353**	.189**	.080**	.323**	.323**	.234**	.193**	.493**
Mean	3,96	4,08	1,95	3,51	3,86	3,52	3,51	4,04	3,86	2,43	34,66

Sd	0,96	0,8	1,05	1,09	0,89	1,02	1,02	0,99	1,06	0,96	4,83
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*p<.05, ** p<.01

In Table 1 indicates that all relationships between total PSSS, total CMS and sub-dimensions very significant, with a level of $p < .01$. The correlation coefficient between the PSSS and CMS scores were calculated as .493 ($n=122$, $p=.00$). It was determined that there was a middle level of relationship between the total problem-solving and ten subdimensions of the PSSS and the total CMS, four subdimensions, learning and delayed recognition. Descriptive statistic results represented the highest scores for the PSSS Definition ($\bar{X}=4.08$) and the CMS Visual Immediate Index ($\bar{X}=41.82$) subdimensions, whereas, the lowest scores were for the PSSS Asking Questions About the Problem ($\bar{X}=1.95$) and CMS Verbal Delayed Index subdimensions.

Table 2. Gender-based t-Test results for PSSS and CMS scores

	Gender	N	\bar{X}	S	sd	t	p
PSSS	Female	66	34,15	4,68	120	1,274	0,208
	Male	56	35,26	4,98			
CMS	Female	66	123,63	34,18	120	0,90	0,978
	Male	56	123,07	34,83			

Table 2 indicates that there was no statistically significant difference for the PSSS [$t_{(120)}=1,274$, $p>.05$] and memory [$t_{(120)}=-.90$, $p>.05$] scores of the female and male preschool children.

Table 3. Variance Analysis Results of the PSSS and CMS Scores Based on Parents' Age

	Group	Age	N	\bar{X}	S	Sd	F	p
PSSS	Mother	30 years and younger	39	34,46	4,58	2;119	0,282	0,755
		31-35 years old	51	34,47	5,23			
		36 years and older	32	36,21	4,58			
CMS	Mother	30 years and younger	39	124,61	27,16	2;119	0,068	0,956
		31-35 years old	51	123,54	39,84			
		36 years and older	32	121,59	33,66			
PSSS	Father	30 years and younger	11	33,36	3,88	2;119	0,444	0,642
		31-35 years old	49	34,65	4,95			
		36 years and older	62	35,90	4,92			
CMS	Father	30 years and younger	11	113,18	30,87	2;119	1,160	0,317
		31-35 years old	49	128,08	32,21			
		36 years and older	62	121,46	36,42			

The PSSS and CMS scores of the preschool children exhibited no statistically significant difference based on parents' ages (Table 3) ($p > .05$).

Table 4. Analysis Results of the PSSS and CMS Scores Based on Parents' Occupation

	Group	Profession	N	\bar{X}	S	Sd	t/F	p
<i>PSSS</i>	Mother	Housewife	92	34,34	5,14	120	1,267	0,208
		Working in a job	30	37,63	3,63			
<i>CMS</i>	Mother	Housewife	92	120,89	34,00	120	1,406	0,216
		Working in a job	30	131,00	34,84			
<i>PSSS</i>	Father	Self-employment	46	34,86	5,38	3;118	1,576	0,199
		Officer	14	33,71	5,09			
		Worker	43	33,93	4,36			
		Professional	19	36,52	4,00			
<i>CMS</i>	Father	Self-employment	46	125,97	36,55	3;118	1,149	0,337
		Officer	14	118,28	21,27			
		Worker	43	117,95	35,37			
		Professional	19	133,10	33,67			

As presented in Table 4, there was no statistically significant difference between the PSSS and CMS scores of the preschool children based on parents' occupation ($p > .05$).

Table 5. Variance Analysis Results of the PSSS and CMS Scores Based on Parents' Education Level

	Group	Graduated School	N	\bar{X}	S	Sd	F	p
<i>PSSS</i>	Mother	Primary school	45	33,53	4,07	3;118	1,575	0,186
		Middle School	16	34,37	6,02			
		High school	36	35,02	5,38			
		University	25	36,36	4,11			
<i>CMS</i>	Mother	Primary school	45	116,68	25,22	3;118	1,612	0,176
		Middle School	16	118,68	35,26			
		High school	36	123,72	43,44			
		University	25	137,92	30,52			
<i>PSSS</i>	Father	Primary school	33	33,72	5,13	3;118	2,681	0,035*
		Middle School	17	35,11	4,28			
		High school	41	33,53	5,09			
		University	31	36,90	3,72			
<i>CMS</i>	Father	Primary school	33	120,51	33,71	3;118	1,392	0,241

Middle School	17	124.94	28,17
High school	41	117.39	38,84
University	31	133.48	30,72

* $p < .05$

Table 5 indicates that the children, whose mothers ($\bar{X}=36,36$) and fathers ($\bar{X}=36,90$) had a bachelor degree, had higher PSSS scores when compared to other groups. Furthermore, the findings were similar for the CMS scores, for mothers ($\bar{X}=137,92$) and fathers ($\bar{X}=133,48$), who had a bachelor degree. The variance analysis results indicated that PSSS scores and the education level of the fathers had a significant difference [$F_{(118)}=2,681, p < .05$] and the Tukey test results revealed that such difference was based on the fathers with bachelor degree and others with primary and secondary school degree. Differences between other groups were not found to be statistically significant [$p > .05$].

Discussion, Conclusion and Recommendations

The present study, which adopted descriptive research approach, determined that there was a high level of relationship between preschool children's problem-solving total scores and both sub-dimensions of problem-solving and visual and verbal short-term and long-term memory, overall memory, learning and delayed recognition scores. Such outcome confirmed the hypothesis of the present study, which asserted that there was a significant relationship between the problem-solving skills and memory development of preschool children. Problem-solving is an effective tool for learning and individual ability development and it accelerates child development, supports the development of self-esteem and confidence, and allows children to discover alternative solutions as they develop and gain experience (Eroğlu, 2011). Karakelle (2012) argued that metacognitive awareness, perception towards problem-solving and the need to develop ideas were significantly related with each other. The concept of the need to develop ideas is considered to take place within the cognitive and affective domains, especially within the scope of the problem-solving processes of everyday life.

The findings related to problem-solving skills indicated that children were relatively unsuccessful in asking questions, one of the most critical sub-dimensions of the problem-solving scale. Question, which refers to a verbal or written statement that requires a response, is an important learning tool in acquiring high level skills such as creative thinking, decision making, analysis, synthesis, problem-solving and critical thinking. An individual with a question in mind on any subject becomes aware of a situation and starts to seek a solution (Büyükalın Filiz, 2007). The detailing process in the working memory is effective in transferring information from short-term memory to long-term memory and ensuring the permanence of the information. Questions are also effectively used in detailing information. The question acts as a tool for processing information (Onan, 2016). Asking questions is about language development, and the language becomes a mental tool for thinking. Language includes cognitive processes such as memory, reasoning, problem-solving and planning, as well as thinking (Kandır & Koçak Tümer, 2013).

In the present study, it was determined that gender was not an effective factor on problem-solving and memory scores. Similarly, Begde and Özyürek (2016) determined that problem-solving skills and Özyürek (2015) memory processes were not significantly affected by children's gender. Begde and Özyürek's finding supports the findings of the present research. Accordingly, implementing activities for problem-solving and memory processes are expected to have a common effect, regardless of gender differences. Furthermore, findings in different studies also suggested that gender was effective on memory. Kuyucuklu (2005) conducted a study with

children aged between 14 and 16 and found that females performed better in word pairs, word lists and family pictures compared to males, yet, there existed no significant difference in visual-spatial memory tasks based on gender.

There was no statistically significant difference between the problem-solving and memory scores, and the age, occupation and education level of the parents. It was observed that problem-solving and memory scores of the children, whose mothers and fathers had a bachelor's degree, were higher when compared to other groups. The factor that had the highest effect on child development was acknowledged as the primary environment of the family institution (Erdoğan & Uçukoğlu, 2011). Therefore, parental factors were expected to affect all developmental domains in children. Research indicating a positive and strong relationship between the education level and occupation of the parents and the parenting attitudes, relationships with children, children's competence in various fields are prevalent (Şanlı & Öztürk, 2012).

As a result, it is possible to state that problem-solving skills are closely related to memory development. Retention of learnt knowledge in memory facilitates its transfer to new situations. Therefore, facilitating the information in short-term and long-term verbal and visual memory at each phase of problem-solving skills, such as acknowledging a problem, predicting causes and developing solution suggestions, becomes possible. The findings of the present study and other supporting evidence in literature suggest that parents and educators could provide significant assistance towards developing problem-solving skills and memory in children, starting from an early age.

Problem-solving skill is a skill that can be learnt. Therefore, providing children with problem-solving opportunities on different topics enable different approaches towards the encountered problems. Especially, the preschool period is the best available period to support the development of problem-solving and memory skills in children. Children should be encouraged to use certain approaches to develop their problem-solving and memory skills. The experiences acquired via solving simple problems could be an important resource for the children, since they can use these experiences in solving more challenging problems.

Problem-solving is a fundamental skill in learning. Children acquire new experiences while working on the solution of a problem through retrieving the knowledge of their past experiences from memory. Effective learning takes place since information provided via direct experiences are easily retained in memory and remembered when necessary. Therefore, children need to learn memory-enhancing strategies.

Problem-solving and memory functions require the brain to work effectively. In this respect, physical health is important and self-care needs, social and emotional needs of children such as nutrition, sleep and rest must be met first. It will be possible for the child to actively participate in learning activities, to provide learning opportunities that will enable them to use all their senses instead of learning by hearing or seeing information, and it will be possible to bring the information back to memory in the problem-solving process more easily and in a short time.

Problem solving and memory operations require an effectively working brain. Therefore, it is essential to meet needs such as physical health, affected by self-care requirements such as nutrition, sleeping and resting, and the social and emotional needs of children. Learning opportunities that facilitate learning through experience, with the use of all senses, instead of learning by hearing or seeing information lead to effective and easy information retrieval from memory during problem-solving processes, and such skills are expected to be developed through learning activities that children can actively participate in.

Asking questions is a crucial step in problem-solving. The child should be encouraged to ask questions while learning new information. Asking questions to children might ensure a critical perspective towards events. A child's verbal expressions, or other means of expression such as painting, on what he/she hears or sees facilitate both storing the information in memory and creating promising clues for further recognition.

Operations such as sorting, classifying, grouping, establishing relationships, analyzing and synthesizing should be taught to achieve the information processing in memory. Such interventions should be conducted through tangible objects at early ages and evolve into abstract concepts as the age progresses. Playing word games, encouraging riddles, rhymes, reading and writing poems, talking about past events, talking about future predictions and expectations, encouraging speech through asking questions on the past and the future, repetitions, providing environments in which the child can express himself, discussing events and facts enable the brain to perform its functions more effectively.

Parents and teachers need guidance in developing problem-solving skills of children, who would become the adults of the future. Besides the efforts that support development, care should be premium towards avoiding circumstances such as using computers for longer periods, which might adversely affect the child. Hence, it is essential to carry out institutional activities as well as individual efforts of parents, and to implement training programs that support problem-solving and memory development through planned activities, starting from the preschool years.

Further studies, which focus on comparative studies of intelligence and thinking skills, problem-solving and memory processes associated with mental abilities could provide detailed insight on the research domain. Studies that compare problem-solving skills and memory development of children from different age groups could be carried out and the relationship between problem-solving and several variables that affect memory development could be discussed.

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