African Educational Research Journal
Special Issue 8(2), pp. S85-S94, October 2020
DOI: 10.30918/AERJ.xx.xx.xxx
ISSN: 2354-2160
Full Length Research Paper

The analysis of preschool children's inversion skills

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ABSTRACT

This study aimed to examine the inversion skills of preschool children. Within the framework of the main objective of this study, the differentiation of children's inversion skills was analyzed according to various variables (age, gender, school type, mother's and father's education level). The study group consisted of a total of 80 children (40 girls, 40 boys) of 53-76-month-old (average 67.5 months), attending a publicanda private preschool in Istanbul. 29 of the children were 53-66-month-old and 51 of them were 67-76-month-old. Data were collected by using "Personal Information Form" and "Inversion Skills Scale". The scale developed for this study was found to have 2 sub-scales (inversion with concrete objects and inversion in verbal problems). As a result of further analyzes, the measuring tool was decided to be valid and reliable. According to the results of the study, the gender and age variables did not have any significant difference in children'sinversion skills, whereas a significant difference was found in the verbal problems sub-dimension in favor of children attending private school. In addition, the findings indicated significant differences in overall and verbal problems sub-dimension of children's inversion skillsin favor of the children whose mothers have bachelor degree and above. Additionally, a significant difference was found in working with concrete objects and verbal problems sub-dimensions and inversion skills total point, in favor of the children whose fathers have bachelor degree or above.

Keywords: Preschool children, inversion skills.

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INTRODUCTION

Arithmetic is the branch of mathematics that involves counting, numbers and the properties of fractions, and the basic operations applied to these numbers. Arithmetic concepts have an important place in mathematical cognition. Before starting primary school, children begin to learn arithmetic problem solving skills involving objects, using appropriate problem-solving methods (Ginsburg et al., 1998; Klein and Bisanz, 2000). Although children cannot fully understand the principles of arithmetic during this period, but they can understand that addition increases the number of the sequence and subtraction decreases it (Ginsburg et al., 1998). Solving addition and subtraction problems requires understanding the relationship between addition and subtraction (Bryant et al., 1999; Gilmore and Bryant, 2006; Vilette, 2002). There is an inverse relationship between addition and subtraction, which are the two concepts of arithmetic (Robinson and Dubé, 2009). Ramful and Olive (2008) state that inversion is related to mathematical operations, fractions, comparisons, algebra and other sub-topics of mathematics. Inversion is helpful in understanding the process of checking the answer by running it backwards after solving a problem and finding the result. Inversion skill is a useful and flexible mathematical strategy to establish an arithmetic link among numbers (Greer, 2012; Robinson et al., 2006). The inverse relationship between addition and subtraction defines the "Inversion Principle". In a "a + b – b" or "a-b + b" type problem, the result should be equal to "a". Children who understand the inverse relationship between addition and subtraction realize that adding and subtracting the same amount does not change the initial amount, and therefore no calculation is required (Baroody and Lai, 2007; Baroody et al., 2009; Bryant et al., 1999; Lai et al., 2008; Sherman and Bisanz, 2007). Inversion skill is an important milestone for mathematical cognition (Rasmussen et al., 2003; Vilette, 2002) and rational development (Baroody and Lai, 2007; Bryant et al., 1999; Vilette, 2002;

Rasmussen et al., 2003), which provide information about creating the addition components of the number and understanding part-whole relationships.

Learning the inversion principle is also a skill that can be used to create shortcuts that facilitate difficult-to-calculate problems (Bisanz and Lefevre, 1990; Gilmore and Bryant, 2006; Klein and Bisanz, 2000). Gilmore and Spelke (2008) states that the discovery and use of general and abstract principles, facilitate finding solutions to difficult problems in mathematics. According to Baroody et al. (1983), applying mathematical principles can facilitate problem solving and routine calculation by increasing both the accuracy of the solution and speed. Providinginversion problems in educational settings makes important contributions to children in this process, but it is also a difficult skill to acquire (Bisanz et al., 2009; Canobi, 2005). It is also noteworthy that although children learn the principle, they may not always use it (Stern, 1992).

Theoretical debates about inversion were first put forward by Piaget (1952). According to Piaget (1952), understanding inversion is necessary to understand the nature of numbers (Yiğit, 2011) and real knowledge of addition and subtraction (Bryant et al., 1999; Nunes et al., 2009; Vilette, 2002; Watchorn et al., 2013). Piaget published that inversion is a key feature of cognitive structures that are characteristic of concrete operational thinking (Gilmore and Bryant, 2006). Some studies involving this subject published that the hierarchical structure of the cognitive development process proposed by Piaget may be correct, but some skills can also be acquired at an earlier age (Kolobe, 2004; Lai et al., 2008). As a matter of fact, some studies have concluded that preschool children are quite successful in inversion problems prepared using concrete objects (Bryant et al., 1999; Gilmore and Bryant, 2006; Huttenlocher et al., 1994; Rasmussen et al., 2003; Sherman and Bisanz, 2007; Starkey and Gelman, 1982; Yiğit, 2011). Vilette (2002) also found that 4-5-year-old children can solve inversion problems. But in this study, it was not investigated whether the children secretly counted the objects. Some research results have shown that children could not make generalizations during this period, even if they could correctly solve some problems that require inversion (Klein and Bisanz, 2000; Vilette, 2002).

The origin and the earliest starting period of the inversion skill remain uncertain. In this case, two possibilities can be considered. The first possibility is that the initial ideas of children about inversion originate from everyday experiences, when children realize that the original public remains unchanged when the same thing is given and then taken back. As children learn counting, they may experience the cases where the same number of objects are added and then removed from a set, and in combination they may discover that these operations do not affect the ultimate size of the set. Children can then deduce the principle of inversion from their counting and arithmetic experiences. These two possibilities cannot be separated from each other, but they have different implications that can be evaluated separately, and therefore examining the performance of young children will be useful (Sherman and Bisanz, 2007).

Many studies have examined preschool children's inversion skills in addition and subtraction (Bryant et al., 1999; Canobi, 2005; Starkey and Gelman, 1982; Klein and Bisanz, 2000; Vilette, 2002; Rasmussen et al., 2003; Baroody and Lai, 2007; Sherman and Bisanz, 2007; Gilmore and Spelke, 2008; Lai et al., 2008; Nunes et al., 2009; Ching and Wu, 2019). Ching and Wu (2019) published that preschool period may be an appropriate starting point for teaching inversion strategies to the children, but more research and validation is needed in this regard.

Purpose

This study aimed to investigate the inversion skills of preschool children. In this context, first the "Inversion Skills Scale" was developed for this study, and validity and reliability analysis were performed. Then, the differentiation of children's inversion skills was examined according to various variables (age, gender, parental education status and school type).

METHODOLOGY

This section provides information about the research model, study group, data collection tools, data collection process and data analysis.

Research model

The research is a quantitative research and is designed according to the screening model. In this study, where inversion skills are analyzed according to different variables, the relationship is determined by comparison, thus relational screening by comparison model, one of the quantitative approaches, was used. Relational screening models are research models that aim to determine the presence and/or level of co-variation between two and more variables (Karasar, 2016).

Study group

The study group consisted of a total of 80 children of 53-76-month-old (average 67.5 months), attending 2 preschool education institutions in Istanbul, selected by considering the principle of easy accessibility. 40 of the children were girls (50%); 40 of them were boys (50%); 29 of them were 53-66-month-old (36.25%); and 51 of them were 67-76-month-old (63.75%). Regarding the education level of children's mothers, 28 (35%)

graduated from high schools and below and 52 (65%) hadbachelor degreeand above. Regarding the education level of the fathers, 27 (33.75%) graduated from high schools and below, and 53 (66.25%) had bachelor degreeand above. 40 (50%) of the children attended public preschools, while the other 40 (50%) attended private preschools.

Data collection tools

In this study, "Personal Information Form" and "Inversion Skills Scale" were used as data collection tools.

Personal information form

The form includes the child's age, gender, school type (public or private), and parents' educational status.

Inversion skills scale

"Inversion Skills Scale" was developed by the researchers tobe used in this research.The literature was reviewed before proceeding with the development of the data collection tool and appropriate question styles for this research were specified, considering previous researches in the literature review (Baroody and Lai, 2007; Bryant et al., 1999; Ginsburg et al., 1998; Robinson and Dube, 2009; Sherman and Bisanz, 2007). After creating the measurement tool, the opinions of 5 expert academicians (2 experts in mathematics, 1 expert in both mathematics and preschool education, and 2 experts in preschool) were consulted. The ratings of expert opinions were classified as "Suitable", "Not suitable" and "Should be revised"; a “Suggestions” part was created for the items to be corrected. After obtaining the approval of being "Suitable" for all items of the measurement tool (only an expert asked for a small expression revision that did not change the meaning), a pilot study was conducted with 5 children. As a result of the pilot study, it was decided to apply this version of the form since no change was needed.

The measuring tool consisted of 2 subtests with 4 different styles of inversion instructions. The total number of items in the measuring tool was 16. Different materials (wooden sticks, plastic tokens, beads, Legos, marbles and box with a lid) were used in the items of the first three subtests (12 items in total). On the other hand, the second test comprised of only verbal instructions, without using any material. The correct answers were awarded “1” point; whereas the questions that were not answered or answered incorrectly were awarded “0” points. The highest score that can be achieved from the measuring tool is“16”, whereas the lowest is“0”.

Below is an example of the subtests of the measuring tool.

Working with concrete objects (a + b - b)

Materials: Sticks, plastic tokens, beads, Legos.
Sample question: The researcher shows child 5 the wooden sticks and says, "Look, there are 5 wooden sticks here" and counts the sticks one by one and puts them in the palm. The researcher says, “Now I add 3 more sticks to these 5 sticks”, and he/she adds the sticks by counting them one by one. He/she counts silently up to three, and says “Now I take out 3 sticks (taking out all 3 sticks at once without counting them)”, he/shethen asks, “How many sticks are left now?”

Working with concrete objects /estimating the result among the options (a + b - b)

Materials: Tokens, sticks, marbles and box with a lid
Sample question: The researcher counts 5 tokens one by one and puts them in a box and says, “Now I put 2 more” and put the tokens in the box one after another and closed the lid. Then he/she says, “I take 2 of them” and takes out 2 token he/she put from the box. He/she closes the lid of the box, then asks “How many tokens are left in the box now? 7 or 5?”

Working with concrete objects (a-b+b)

Materials: Tokens, cubes, marbles, beads and box with a lid.

Sample question: The researcher shows the child 8 beads and says, "Look, there are 8 beads here" and puts the beads into the box by counting them one by one. Then he/she says, "Now I am removing 5 beads out of these 8 beads" and removes them by counting one by one. He/she counts silently up to three, and then says, “Now I add 5 beads” and he/she puts them back in the box without counting one by one. He/she asks, "Now how many beads are in the box?"

Verbal problems (a + b - b)

Sample question: There are 9 people in a bus. Five more people get on the bus from one stop. At the next stop, 5 passengers get off. How many passengers might be left in the bus?

Validity and reliability analysis of the “inversion skills scale”

Construct validity, internal consistency, item total and item discrimination analyses were performed to check the reliability and validity of the scale used to collect data in the research. For the construct (concept) validity of the

measurement tool, the suitability of the data for factor analysis was tested (KMO and Bartlett test) and factor analysis was performed.

KMO test, which tests the adequacy of the sample, was performed before factor analysis and the KMO value was found to be 0.80. According to Seçer (2015), KMO value should be 0.80 and above in order to achieve the most appropriate sample size for factor analysis. Since KMO value was found to be 0.80, it can be said that the sample size is sufficient according to the literature. Then the result of Bartlett test was calculated. Bartlett test result ($\chi 2 = 440.908$, $p = 0.00$) was found to be significant, which enabled the factor analysis to be carried out. Table 1 shows the factor structure of the Inversion Skills Scale.

The 1st factor, namely "working with concrete objects sub-dimension", consists of 12 items and explains 33.45% of the total variance. The 2nd factor, "Verbal Problems sub-dimension", consists of 4 items and explains 10.59% of the total variance. The whole scale is observed to consist of 16 items and 2 sub-dimensions and explains 44.04% of the total variance.

Regarding the reliability of the measurement tool, Cronbach Alpha values were checked for internal consistency (Table 2).

In the reliability analysis, Cronbach Alpha value of "Working with Concrete Objects (a + b-b, a-b + b)" sub-dimension was found to be 0.834; Cronbach Alpha of "Verbal problems" sub-dimension was found to be 0.718; and overall Cronbach Alpha value of the Inversion Skills Scale was found to be 0.864. Based on these data, it can be said that internal consistency level of the Inversion Skills Scale's is sufficient.

According to the correct answers of the study group, the lowest score taken from the test was 1 and the highest score was 15. Additionally, the mean value was 8.6; the variance of the test was 13.42; standard deviation was 3.66 and range of the test was 14. KR-21 Internal Consistency value was 0.75 which indicate a high consistency. Item total and item discrimination analyses were performed for the construct validity of the scale. As seen in the Table 3, the result of the Pearson Correlation analysis conducted for item total analysis of the Inversion Skills Scale showed that the relationship of all items with the item total was significant at $p < 0.01$ level. This finding shows that the items have a significant construct integrity.

As seen in Table 4, the result of the independent groups t-test conducted for the item discrimination of the Inversion Skills Scale showed that there is a significant differentiation between Top 27% and Bottom 27% groups for all items at $p < 0.01$ level. This finding shows that all items used in the study are significant in differentiating inversion skills of children.

Table 1. Factor structure of the inversion skills scale (Rotated basic components).

Items	Factor I: Working with concrete objects	Factor II: Verbal problems
Item 1	0.596	-
Item 2	0.677	-
Item 3	0.765	-
Item 4	0.271	-
Item 5	0.738	-
Item 6	0.666	-
Item 7	0.684	-
Item 8	0.583	-
Item 9	0.225	-
Item 10	-0.092	-
Item 11	0.214	-
Item 12	-0.007	-
Item 13	-	0.674
Item 14	-	0.508
Item 15	-	0.400
Item 16	-	0.423

Table 2: Reliability analysis of the inversion skills scale.

Variable	N	Cronbach's Alpha
Working with concrete objects (a+b-b, a-b+b)	12	.83
Verbal problems	4	.72
Total (Inversion skills)	16	.86

Table 3: Item total analysis of inversion skills scale.

Items	Factor	Total	Items		Total
Item 1	*r*	0.538**	Item 9	*r*	0.460**
	p	0.000		*p*	0.000
Item 2	*r*	0.713**	Item10	*r*	0.530**
	p	0.000		*p*	0.000
Item 3	*r*	0.692**	Item 11	*r*	0.649**
	p	0.000		*p*	0.000
Item 4	*r*	0.461**	Item 12	*r*	0.460**
	p	0.000		*p*	0.000
Item 5	*r*	0.719**	Item 13	*r*	0.685**
	p	0.000		*p*	0.000
Item 6	*r*	0.530**	Item 14	*r*	0.586**
	p	0.000		*p*	0.000
Item 7	*r*	0.606**	Item 15	*r*	0.515**
	p	0.000		*p*	0.000
Item8	*r*	0.475**	Item16	*r*	0.505**
	p	0.000		*p*	0.000

Table 4. Item discrimination of inversion skills scale.

Item	Group	*n*	$\bar{x}$	*sd*	*t*	*df*	*p*
Item 1	Bottom 27%	22	.36	0.49	-6.062	21.000	0.00
	Top 27%	22	1.00	0.00			
Item 2	Bottom 27%	22	0.05	.21	-11.148	38.286	0.00
	Top 27%	22	0.91	0.29			
Item 3	Bottom 27%	22	0.14	0.35	-9.340	34.624	0.00
	Top 27%	22	0.95	0.21			
Item 4	Bottom 27%	22	.59	0.50	-3.813	21.000	0.00
	Top 27%	22	1.00	0.00			
Item 5	Bottom 27%	22	0.18	.39	-9.721	21.000	0.00
	Top 27%	22	1.00	0.00			
Item 6	Bottom 27%	22	0.41	0.50	-4.681	28.303	0.00
	Top 27%	22	0.95	.21			
Item 7	Bottom 27%	22	.36	.49	-6.062	21.000	.00
	Top 27%	22	1.00	.00			
Item 8	Bottom 27%	22	.50	.51	-4.583	21.000	.00
	Top 27%	22	1.00	.00			
Item 9	Bottom 27%	22	.18	.39	-6.052	41.440	0.00
	Top 27%	22	.86	.35			
Item 10	Bottom 27%	22	.36	.49	-3.878	37.978	0.00
	Top 27%	22	.86	.35			
Item 11	Bottom 27%	22	.09	.29	-9.222	42.000	0.00
	Top 27%	22	0,91	.29			

Table 4. Continues.

Item 12	Bottom 27%	22	.59	.50	-3.813	21.000	0.00
	Top 27%	22	1.00	.00			
Item 13	Bottom 27%	22	.05	.21	-14.142	42.000	0.00
	Top 27%	22	.95	.21			
Item 14	Bottom 27%	22	.09	.29	-5.501	35.911	0.00
	Top 27%	22	.73	.46			
Item 15	Bottom 27%	22	.14	.35	-4.816	39.438	0.00
	Top 27%	22	.73	.46			
Item16	Bottom 27%	22	.14	.35	-3.878	37.978	0.00
	Top 27%	22	.64	.49			

Data collection

Before starting data collection process, the permission to conduct the research in preschoolswas granted from Ministry of National Education (MoNE). The researchers visited the selected schools, talked about the purpose of the research, and obtained the necessary permissions. Then, they carried out the data collection process according to the schedule. In cooperation with the school administration, precautions were taken to ensure that the setting where the study was administered was quiet and not distracting. After asking each item, the researcher silently counted to 5, and the child was deemed unsuccessful for that item in cases where there was no answer, wrong answer, or the child attempted to do mental arithmetic or with fingers. The measuring tool should be administered on the child individually in a quiet environment. After meeting with the children, the researcher initiates the research by saying “We will play a game with you. I'm going to ask you some fun questions in this game. Listen to me and watch carefully". He/she ends the process by thanking after the completion of the measurement tool. The application of the measurement tool took approximately 15-20 min.

Data analysis

Data is analyzed through statistical packet program. To assess whether the data is normally distributed, normality test analysis is done. The Kolmogorov-Smirnov Test, which tests the normality of the data, was carried out before the data analysis. Below are the results of the Kolmogorov Smirnov Test.

Kolmogorov-Smirnov results of Inversion Skills Scale means are given in Table 5. The data were found to be normally distributed ($p > 0.05$) and parametric difference tests were performed. To assess whether there is a meaningful difference according to various variables (age, gender, parental education status and school type), independent groups t-test was done.

Table 5. Kolmogorov-Smirnov results for the means of inversion skills scale.

K-Smirnov Z	df	p
0.098	80	0.057*

P > 0.05.

FINDINGS

This part includes the findings regarding the inversion skills of 53-76-month-old children attending preschoolinstitutions, in line with the main objectives and sub-objectives of the research. The results of independent groups t-test showing the differentiation of inversion skills according to gender is given in Table 6. According to this table, inversion skills did not differ according to the gender of the children. The results of independent groups t-test showing the differentiation of inversion skills according to age is given in Table 7. According to this table, inversion skills did not differ according to the age of the children.

The results of independent groups t-test showing the differentiation of inversion skills according to school type is given in Table 8. According to this table, a difference was found in the “Verbal Problems” subscale of the inversion skills in favor of the children attending private school. No significant difference was found in overall scale and “Working with concrete objects” subscale.

The results of independent groups t-test showing the differentiation of inversion skills according to the education level of the mother is given in Table 9. According to this table, a difference was found in the overall scale and in the “Verbal Problems” subscale in favor of the children whose mothers graduated from

Table 6. Independent groups t-test results showing the differentiation of inversion skills according to gender.

Variable	Gender	n	x̄	sd	t	se	P
Working with concrete objects	Girl	40	7.60	3.30	-.96	78	0.33
	Boy	40	8.30	3.15	-1.29	78	0.20
Verbal problems	Girl	40	1.17	1.23	-	-	-
	Boy	40	1.57	1.51	-	-	-
Total (Inversion skills)	Girl	40	8.78	4.25	-1.17	78	.24
	Boy	40	9.88	4.11	-	-	-

Table 7. Independent groups t-test results showing the differentiation of inversion skills according to age.

Variable	Age	n	x̄	sd	t	se	p
Working with concrete objects	53-66-month-old	29	7.65	2.95	-.61	78	.54
	67-76- month-old	51	8.11	3.39			
Verbal problems	53-66-month-old	29	1.13	1.27	-1.15	78	.25
	67-76- month-old	51	1.50	1.44			
Total (Inversion skills)	53-66-month-old	29	8.79	3.61	-.85	78	.39
	67-76- month-old	51	9.63	4.49			

Table 8. Independent groups t-test results showing the differentiation of inversion skills according to school type.

Variable	School type	n	x̄	Sd	t	se	p
Working with concrete objects	Public	40	7.72	3.08	-0.62	78	0.53
	Private	40	8.17	3.38			
Verbal problems	Public	40	1.00	1.10	-2.49	70.69	0.01*
	Private	40	1.75	1.54			
Total (Inversion skills)	Public	40	8.73	3.80	-1.28	78	0.20
	Private	40	9.93	4.52			

Table 9. Independent groups t-test results showing the differentiation of inversion skills according to mother's education level.

Variable	Mother's education level	n	x̄	sd	t	se	p
Working with concrete objects	High school and below	28	7.25	3.18	-1.43	78	0.15
	Bachelor and above	52	8.32	3.22			
Verbal problems	High school and below	28	.78	.91	-3.34	76.65	0.00*
	Bachelor and above	52	1.69	1.50			
Total (Inversion skills)	High school and below	28	8.04	3.71	-2.05	78	0.04*
	Bachelor and above	52	10.02	4.30			

bachelor and above. No significant difference was found in "Working with concrete objects" subscale.

The results of independent groups t-test showing the differentiation of inversion skills according to the education level of the father is given in Table 10. According to this table, a significant difference was found

Table 10. Independent groups t-test results showing the differentiation of inversion skills according to father's education level.

Variable	Father's education level	n	x̄	sd	t	se	p
Working with concrete objects	High school and below	27	6.62	3.22	-2.71	78	0.00*
	Bachelor and above	53	8.62	3.04			
Verbal problems	High school and below	27	.62	.68	-4.58	77.36	0.00*
	Bachelor and above	53	1.75	1.50			
Total (Inversion skills)	High school and below	27	7.26	3.58	-3.33	78	0.00*
	Bachelor and above	53	10.38	4.12			

in the overall scale and in the "Verbal problems" and "Working with concrete objects" subscales in favor of the children whose fathers graduated from bachelor and above.

DISCUSSION AND CONCLUSION

The main objective of this study was to examine 53-76-month-old children's inversion skills. In this context, first the "Inversion Skills Scale" was developed, and then validity and reliability analyses of the scale were performed. Prior to factor analysis, KMO, which tests the suitability of the sample for factor analysis, was performed and KMO value was found to be 0.80. Then the result of Bartlett test was calculated. After discovering that Bartlett test result ($\chi 2$ = 440,908, p = 0.00) was significant, factor analysis was performed. It was concluded that the scale consisting of 2 factors and the structure consisting of 16 items was preserved. The 1st factor "Working with Concrete Objects" sub-dimension, consisted of 12 items and explained 33.45% of the total variance. The 2nd factor, "Verbal Problems" sub-dimension, consisted of 4 items and explained 10.59% of the total variance. The entire scale was observed to explain 44.04% of the total variance. According to the reliability analysis, Cronbach Alpha value of "Working with Concrete Objects" sub-dimension was found to be 0.834; Cronbach Alpha of "Verbal problems" sub-dimension was found to be 0.718; and Cronbach Alpha of overall Inversion Skills Scale was found to be 0.864. Based on these data, it can be said that internal consistency level of the Inversion Skills Scale is sufficient. As a result of the Pearson Correlation analysis conducted for the Item Total Analysis of the Inversion Skills Scale, the relationship of all items with the item total was found to be significant at $p < 0.01$ level. The independent groups t-test conducted for the item discrimination of the scale showed that all items used in the study were significant in differentiating inversion skills of children.

In line with the main objective of the research, the differentiation of preschool children's inversion skills was also examined according to age, gender, school type, mother's and father's education levels. Since there is no study available in the literature involving the relationship of inversion skills with the above-mentioned variables, the discussion was based on the studies involving mathematics. The findings obtained from the study showed that there is no significant difference between girls and boys in terms of inversion skills for both overall and sub-dimensions. There are many studies in the literature showing that math abilities/skills/ achievements of preschool children do not differ according to gender (Arnas et al., 2003; Bakker et al., 2018; Burgazlı, 2018; Güven, 1997, 2007, 2001; Karakuş and Akman, 2015; Klein et al., 2010; Pay, 2018; Polat Unutkan, 2007; Sezer and Güven, 2019; Tok and Ünal, 2020: Taşkın, 2013).

The study findings showed that inversion skills did not significantly differ between children of 53-66-month-old and 67-76-month-old. Considering that inversion skill is a skill that is quite difficult to acquire in preschool period and because of the closeness of the age ranges, there was nosignificant difference found that can be considered as an expected result.

Regarding the differentiation of children's inversion skills according to school type (public and private school), a significant difference was found in "verbal problems" subscale, in favor of the children attending private school. Researchers have drawn attention to the debate on the qualities of private and public schools in various dimensions (Azigwe et al., 2016; Day et al., 2014; Lubienski and Lubienski, 2006; Ntim, 2014). For example, Lubienski and Lubienski (2006) published that although the children in private schools seem to be more successful in mathematics compared to the children in public schools, the effect of the private school disappears and even reverses in most cases when the variables are controlled. Nitm (2014) believes that further researchis needed for comparing private and public schools.

There are many studies in the literature that show the significant effect of parent's education level on children's mathematics performance (Gadsden and Ray, 2003; Oktay and Güven, 1998). The differentiation of the children's inversion skills according to the education level of the parents was also tested in this study. The findings revealed a significant difference in overall and "Verbal problems" subscale in favor of the mothers having

bachelor and above education. Researches have shown that the increase in the mother's education level affects children's mathematics skills/abilities/achievements positively (Avcı, 2015; Burgazlı, 2018; Çelik, 2015; Dursun and Dede, 2004; Güven, 2007; Pay, 2018; Tok and Ünal, 2020). Moreover, a significant difference was found in children's overall inversion skills, as well as in "Working with concrete objects" and "Verbal problems" sub-dimensions in favor of the fathers having bachelor degree and above. The literature review revealed some studies showing that the increase in the education level of the father affects children's math abilities/skills positively (Dursun and Dede, 2004; Güven, 2007; Özdemir, 2018; Pay, 2018; Tok and Ünal, 2020).

As a result of the research, it can be suggested to examine children's inversion skills on different study groups including other variables (socio-economic levels, educational approaches). The data of the study were collected by using a quantitative research method. It is therefore necessary to conduct similar research on this subject using qualitative methods. On the other hand, the study was conducted by collecting data from only one public and one private school, which can be seen as a limitation of the study. Therefore, the study can be repeated with the participation of more children from different schools. In addition to these suggestions, the relationships between children's inversion skills and different thinking skills (problem solving, intuitive thinking, self-regulation skills) can be analyzed.

Researchers emphasized that preschool children have the potential of understanding inversion. In particular, as a result of the studies, the use of concrete objects was observed to increase the achievement of children in inversion skills (Bryant et al., 1999; Ching and Wu, 2019). Considering these results, teachers can be informed about doing various activities with children in the classroom setting to improve their inversion skills.

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Citation: Güven, Y., Uzel, H. B., and Dönmez, O. (2020). The analysis of preschool children's inversion skills. African Educational Research Journal, 8(2): S85-S94.