EFFECTIVENESS IN THE DEVELOPMENT AND ACQUISITION OF MATHEMATICAL SKILLS IN CHILDREN IN RURAL AND URBAN PRESCHOOLS

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Abstract

The aim of the research was to determine whether geometric skills of the children in rural preschools are at the same level as those of their peers in urban preschools. The research included 352 preschool-age children (5 to 7 years old) residing in Poland, both in cities and the countryside. The measurements were carried out in the Biała Podlaska Laboratory of Psycho-Motor Skills. A SensoMotoric Instrument (SMI) eye tracking device and the i ViewX platform registering data with a frame rate of 250 Hz were used. The device has a special measurement system which tracks and records eye movements in a sequence and at a pace of an analyzed person. With a view to demonstrate the differences between the correctness of task performance and the place of residence of the children, a Pearson's Chi-squared test was performed. To evaluate the differences in the time of task execution, a single factor analysis of variance (ANOVA) and the Student's t-test for independent samples were employed. In all of the analyzed cases, the level of statistical significance adopted was p=.05.

The results of the research conducted on the studied group of children show that there are differences in the level of geometric skills between the children in rural and urban areas. It was established that a crucial factor which affected both the geometric knowledge and skills of the preschoolers were the place of residence, the age at which they started learning, and the duration of preschool education.

Keywords: *geometry teaching, mathematical skills, preschool-age child, preschool education*.

Introduction

The specific objectives and activities of Polish preschools are set out in the document referred to as the Core Curriculum (Guidelines) for Pre-school Education, authorized for use by the Polish Ministry for National Education (Journal of Laws of 24 February 2017, Item 356). This document states that the goal of didactic and educational work of preschools is to support child's development in all its spheres, i.e. the cognitive, social, physical and emotional one, while the target of the teachers working with preschool children is to prepare children to study in schools. Therefore, children graduating from preschools, irrespective of their place of residence, should acquire the same key competencies, i.e. mathematical, language, social, and motor competencies required to commence school education.

The key competencies enumerated in the Core Curriculum stress the importance of mathematical competencies as significantly affecting one's future school success.

It is worth to note that the quality of the process of competency development, both in preschool and school, is affected by a number of factors preconditioned by child's onto-genetic development and the family and school environments (Dixon, 2005; Kapur & Toh, 2013; Klim-Klimaszewska &Nazaruk, 2017). These include one's predisposition to learn (intelligence), interests, teachers' professional competencies, teaching methods, didactic aids, child's health condition, living environment, family situation, and many others.

Polish reports regarding educational maturity of 6-year-olds demonstrate large and clear relations between children's competencies, their living environment, and the level of parents' education (Frydrychowicz & Koźniewska, 2006). Studies conducted on all-Poland samples showed that preschool education had an impact on students' achievements in primary schools (Pregler & Wiatrak, 2011; Dąbrowski, 2015; La Freniere & Dumas, 1996).

The research presented the analyzed effect of cultural factors of the family and living environment on school successes of students in the early years of primary education. The conclusions drawn from the reports authorize me to claim that the optimum time spent in preschools is 3 to 4 years. It is particularly important for boys and girls of lower cultural potential in rural environments.

Against this background and on the basis of conducted research, the study is an attempt to address the major issue: do rural and urban preschools attain didactic goals (learning outcomes) set by the Core Curriculum at the same level? In other words, do the children from the countryside and from urban areas have equal educational opportunities and abilities? In this perspective, not only the place of residence but also the age at which a child begins his preschool education appear vital.

Having regard to the presented outline of the issues covered, a research project was carried out with a view to diagnosing mathematic competencies of children attending rural and urban preschools. The project was created with the cooperation of the Pope John Paul II State School of Higher Education in Biała Podlaska and preschools located across the city of Biała Podlaska and two rural communes of the Bialski Poviat. Due to the wide scope of the adopted research project, the research presents only partial results concerning the diagnosis of mathematical skills with respect to geometry.

The main research problem is laid down in the form of the following question:

Are the geometric skills of children in rural preschools at the same level as those of their peers in urban preschools?

The main research question is further detailed as follows:

1. What is the level of geometric skills in the studied children?
2. Are there any differences in children's achievements in geometry depending on preschool location (in the countryside or in the city), and if so - what are they?
3. Can the age at which preschool education is commenced and its duration have a significant effect on the level of geometric skills?

Research Methodology

Participants

The research included 352 preschool-age children (5 to 7 years old) and was conducted upon the consent of parents and preschool management. The basic data regarding preschools, their location and the number of children participating in the study are set out in Table 1.

Table 1. Essential preschool data and the number of study participants.

Preschool name and location	Number of children		Number of children	
	N	*%*	*N*	*%*
Preschool No. 1 - Biała Podlaska city	52	14.78	254	72.16
Preschool No. 2 - Biała Podlaska city	80	22.72		
Preschool No. 3 - Biała Podlaska city	122	34.66		
Preschool No. 1 - rural commune in the Bialski Poviat	70	19.88	98	27.84
Preschool No. 2 - rural commune in the Bialski Poviat	28	7.96		
Total	352	100.00	352	100.00

Biała Podlaska is a small city with a population of just under 60 thousand people, located 30 km away from the border with the Republic of Belarus. It has a well-developed network of schools and other educational establishments, including preschools. The city is surrounded by typically agricultural communes, dominated by medium-sized individual farms. The rural areas across which the research was carried out has a very well-developed network of primary (elementary) schools. The preschool infrastructure, in contrast, is only now being intensively redeveloped.

Instrument and Procedures

The measurements were conducted in the Biała Podlaska Laboratory of Psycho-Motor Skills in Poland in June 2018. A SensoMotoric Instrument (SMI) eye tracking device and the i ViewX platform registering data with a frame rate of 250 Hz were used. Thanks to a special measurement system the device can track and record eye movements in a sequence and at a speed of an analyzed person. The analysis of research findings was performed with the application of BeGaze 3.4 (SMI) software. The sources of the addresses of the children and the length of their preschool education were their parents. The examination involved children observing a picture/scene on a computer screen comprising geometric figures and various objects, such as a house, a tree, and animals, and next having to find and identify a given geometric figure on the picture - depending on the task received. The tasks were designed on the basis of the Core Curriculum of

Preschool Education, which sets forth the key competencies of children graduating from preschools (Journal of Laws of 24 February 2017, Item 356). The contents and compositions of the tasks were appropriate to the age-specific physical and mental abilities of the children. When instructed by the teacher, children started to look for and point at geometric figures seen on the computer screen in the following task sequence:

Task 1: find and point at a circle in Picture 1;
Task 2: find and point at a triangle in Picture 2;
Task 3: find and point at a square in Picture 3;
Task 4: find and point at a rectangle in Picture 4;
Task 5: find and point at two identical triangles in Picture 5;
Task 6: find and point at two different-sized squares in Picture 6;

The scores for task completion were distributed as follows: correct answer: 1 point, incorrect or no answer: 0 points. Six correct answers (tasks) were awarded 6 points.

Data Analysis

The analysis of data obtained was based on, first of all, the evaluation of the results of task performance. The summary table shows first the tasks which were correctly performed and then the tasks which were either incorrectly performed or not performed at all.

With a view to demonstrate the differences between the correctness of task performance and urban/rural preschools, a Pearson's Chi-squared test was performed.

To evaluate the differences in the time of task execution, a single factor analysis of variance (ANOVA) and the Student's *t*-test for independent samples were employed. In all of the analyzed cases, the level of statistical significance adopted was p=0.05. The statistical analysis was performed using STATISTICA v. 13.1.

Research Results

With reference to the whole population of the children studied, the percentages of correct answers and incorrect answers per individual preschools located in the city and in the countryside were calculated.

Table 2. Answers given by children from individual preschools (*n*=352).

Task	Preschool	Answers correct		Answers incorrect		*p*
		Number of participants	%	Number of participants	%	
Task 1.	P. No. 1 city (*n*=52)	36	69.23	16	30.77	.94
	P. No. 2 city (*n*=80)	54	67.50	26	32.50	
	P. No. 3 city (*n*=122)	90	73.77	32	26.23	
	P.1. countryside (*n*=70)	48	68.57	22	31.43	
	P.2. countryside (*n*=28)	18	64.29	10	35.71	
χ^2 =0.79; *df*=4						
Task 2.	P. No. 1 city (*n*=52)	42	80.77	10	19.23	.001*
	P. No. 2 city (*n*=80)	42	52.50	28	47.50	
	P. No. 3 city (*n*=122)	88	72.13	34	27.87	
	P.1. countryside (*n*=70)	26	37.14	44	62.86	
	P.2. countryside (*n*=28)	12	42.86	16	57.14	
χ^2 =18.62; *df*=4						
Task 3.	P. No. 1 city (*n*=52)	46	88.46	6	11.54	.51
	P. No. 2 city (*n*=80)	68	85.00	12	15.00	
	P. No. 3 city (*n*=122)	106	86.89	16	13.11	
	P.1. countryside (*n*=70)	52	74.29	18	25.71	
	P.2. countryside (*n*=28)	24	85.71	4	14.29	
χ^2 =3.29; *df*=4						
Task 4.	P. No. 1 city (*n*=52)	46	88.46	6	11.54	.82
	P. No. 2 city (*n*=80)	74	92.50	6	7.50	
	P. No. 3 city (*n*=122)	112	91.80	10	8.20	
	P.1. countryside (*n*=70)	60	85.71	10	14.29	
	P.2. countryside (*n*=28)	24	85.71	4	14.29	
χ^2=1.53; *df*=4						
Task 5.	P. No. 1 city (*n*=52)	36	69.23	16	30.77	.26
	P. No. 2 city (*n*=80)	60	75.00	20	25.00	
	P. No. 3 city (*n*=122)	68	55.74	54	44.26	
	P.1. countryside (*n*=70)	44	62.86	26	37.14	
	P.2. countryside (*n*=28)	12	50.00	12	50.00	
χ^2=5.30; *df*=4						
Task 6.	P. No. 1 city (*n*=52)	24	46.15	28	53.85	.001*
	P. No. 2 city (*n*=80)	18	22.50	62	77.50	
	P. No. 3 city (*n*=122)	44	36.07	78	63.93	
	P.1. countryside (*n*=70)	50	71.43	20	28.57	
	P.2. countryside (*n*=28)	10	35.71	18	64.29	
χ^2 =20.03; *df*=4						

Note: P. No. 1; P. No. 2; P. No. 3 – abbreviations representing the name of preschools in a city; P.1; P.3 – abbreviations representing the name of preschools in the countryside; The numbering was adopted solely for the research objectives, to serve the purpose of anonymization of the studied environments.

* significant variability at $p < .05$

The results presented in Table 2 show that the geometric skills of children, based

on the correct answers to individual tasks, are not equivalent. The research revealed differences between the preschools. Statistically significant differences were observed in the answers provided to Task 2 (finding and pointing at a triangle) and Task 6 (finding and pointing at two different-sized squares). Thus, it ought to be stated that children's skills in the field of recognizing plane shapes pose the greatest difficulties with respect to triangles. In addition, as far as the comparative analysis is concerned, the hardest turned out to be identifying two squares of different sizes.

Next, a comparative analysis of the test outcomes was performed (rural preschool children vs urban preschool children). The children were divided into two groups: 1 – children in urban preschools; 2 – children in rural preschools.

Table 3. Answers in the city vs countryside division (n=352).

Task	Preschool	Answers correct		Answers incorrect		*p*
		Number of participants	%	Number of participants	%	
Task 1.	Urban preschools (*n*=254)	180	70.87	74	29.13	.65
	Rural preschools (*n*=98)	66	67.35	32	32.65	
χ^2=0.21; *df*=1						
Task 2.	Urban preschools (*n*=254)	172	67.72	82	32.28	.001*
	Rural preschools (*n*=98)	38	38.78	60	61.22	
	χ^2=12.31; *df*=1					
Task 3.	Urban preschools (*n*=254)	220	86.61	34	13.39	.14
	Rural preschools (*n*=98)	76	77.55	22	22.45	
	χ^2=2.17; *df*=1					
Task 4.	Urban preschools (*n*=254)	232	91.34	22	8.66	.26
	Rural preschools (*n*=98)	84	85.71	12	14.29	
χ^2=1.22; *df*=1						
Task 5.	Urban preschools (*n*=254)	164	64.57	90	35.43	.51
	Rural preschools (*n*=98)	58	59.18	30	40.82	
χ^2=0.44; *df*=1						
Task 6.	Urban preschools (*n*=254)	86	33.86	168	66.14	.001*
	Rural preschools (*n*=98)	60	61.22	38	38.78	
	χ^2=10.91; *df*=1					

* significant variability at $p < .05$

The results presented in Table 3 demonstrate that in the case of five tasks,

numbered 1 through 5, the urban preschool children performed better. In the last task, number 6, children from rural preschools performed significantly better than their urban preschool peers. The statistical analysis showed marked differences between the rural and urban preschool children in the answers provided to two tasks: task number 2 and task number 6.

Yet another objective was the analysis of children's mathematic achievements in the field of geometry having regard for the period of preschool education of children in the cities and in the countryside. In this case, the study included 130 children aged 7 who, within a few months, were to graduate from preschools and start primary school education. The research findings show that 41 children in the 7-year-old group attended preschools only for 1 year, i.e. only for the year preceding the school education. These were children living in the countryside. The remaining eighty-nine children aged 7 have been in preschools for two or three years. Hence, two groups were identified in order to compare answers to individual tasks: the first group included children who attended preschool only 1 year, in the countryside, whereas the second group encompassed children who attended preschool for more than a year. The results obtained are demonstrated in Table 4.

Table 4. Answers provided by the years of preschool education.

Task	Education group	Correct answers		Incorrect answers		*p*
		Number of participants	%	Number of participants	%	
Task 1.	2-3edu (*n*=89)	70	78.65	19	21.35	.32
	1edu (*n*=41)	29	70.73	12	29.27	
Task 2.	2-3edu (*n*=89)	66	74.16	23	25.84	.001*
	1edu (*n*=41)	15	36.59	26	63.41	
Task 3.	2-3edu (*n*=89)	83	93.26	6	6.74	.03*
	1edu (*n*=41)	33	80.49	8	19.51	
Task 4.	2-3edu (*n*=89)	83	93.26	6	6.74	.90
	1edu (*n*=41)	38	92.68	3	7.32	
Task 5.	2-3edu (*n*=89)	77	86.52	12	13.48	.03*
	1edu (*n*=41)	29	70.73	12	29.27	
Task 6.	2-3edu (*n*=89)	64	71.91	25	28.09	.04*
	1edu (*n*=41)	22	53.66	19	46.34	

* significant variability at $p < .05$

Data presented in Table 4 and the results of the Chi-squared test indicate that the children who started their preschool education earlier, i.e. attended preschools for two or three years, answered correctly to substantially more questions across all tasks. Significant statistical differences were noted in four tasks: Task 2, 3, 5, and 6.

Conclusions

On the basis of the analysis of the conducted research, conclusions have been drawn which will expand the area of academic research regarding the multi-dimensional nature of preschool education in the context of mathematical skill development in children. The conducted research has confirmed that, on the basis of geometric tasks, there are differences in the level of mathematical skills between children attending rural preschools and those attending urban ones. It is presumed that one of the reasons behind the differences may be the length of preschool education of the studied children. Preschool education of the selected group of 6- and 7-year-olds in the rural area started and lasted one year only. Unsatisfactory geometric performance diagnosed not only in rural but also in urban children at the stage of preschool education should be an important message to the teachers, above all, with respect to reflections upon the methods used when implementing the core curriculum. This is a practical tip for individualized exercises focusing on the development of children's intellectual potential.

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