Mathematical Competencies of Children in Various Early Childhood Education Programmes in Slovenia Before Entering Primary School

Darja Antolin Drešar, Maruša Laure,
Sabina Ograjšek, Marta Licardo
Univetrsity of Maribor, Faculty of Education, Maribor, Slovenia
darja.antolin@um, marusa.laure@um.si, sabina.ograjsek@um.si, marta.licardo@um.si

This research explores the mathematical competencies of children in various Slovenian early childhood programmes. The study includes 955 pre-school children, with a balanced gender distribution and a homogeneous age structure. The majority are enrolled in full-day programmes, with fewer in half-day and shorter programmes. Approximately 300 early childhood teachers completed the "KOM5 Competency assessment tool for early childhood children" for each child. The study demonstrates that children's mathematical skills, as assessed by early childhood teachers, significantly improve throughout short programmes. However, when comparing children's competencies in full-day, half-day, and short programmes, it is evident that children in short programmes consistently score lower in mathematical competencies than those in full-day and half-day programmes. Furthermore, the comparison between full-day and half-day programmes reveals no significant differences. The study results are relevant for formulating early childhood education, advocating for a balanced approach that considers both the quality and duration of Slovenian early childhood education.

DOI
https://doi.org/10.18690/um.pef.2.2024.16

ISBN
978-961-286-899-4

Keywords:
early childhood programmes, mathematical competencies, early childhood education, programme duration, instructional quality

University of Maribor Press

DOI
https://doi.org/10.18690/um.pef.2.2024.16

ISBN
978-961-286-899-4

MATEMATIČNE KOMPETENCE OTROK V RAZLIČNIH PROGRAMIH PREDŠOLSKEGA IZOBRAŽEVANJA V SLOVENIJI PRED VSTOPOM V OSNOVNO ŠOLO

DARJA ANTOLIN DREŠAR, MARUŠA LAURE, SABINA OGRAJŠEK, MARTA LICARDO
Univerza v Mariboru, Pedagoška fakulteta, Maribor, Slovenija
darja.antolin@um.si, marusa.laure@um.si, sabina.ograjsek@um.si, marta.licardo@um.si

Ključne besede:
programi predšolske vzgoje, mathematične kompetence, predšolska vzgoja, trajanje programov, kakovost vzgoje in izobraževanja

Z raziskavo želimo zapolniti vrzel v obstoječih raziskavah o matematičnih kompetencah otrok, ki obiskujejo različne programe predšolske vzgoje v Sloveniji. Raziskava vključuje 955 predšolskih otrok z uravnoteženo razporeditvijo glede na spol in homogeno starostno strukturo. Večina je vpisana v celodnevne programe, manj v poldnevne in krajše programe. Približno 300 vzgojiteljev je za vsakega otroka izpolnilo Pripomoček za ocenjevanje kompetenc predšolskih otrok KOM5. Ugotovitve kažejo, da se matematične kompetence otrok glede na vzgojiteljeve ocene znatno izboljšajo skozi trajanje krajših programov. Vendar pa primerjava kompetenc otrok v celodnevnih, poldnevnih in krajših programih kaže, da otroci v krajših programih dosegajo nižje rezultate v matematičnih kompetencah kot tisti v celodnevnih in poldnevnih programih. Primerjava med celodnevnimi in poldnevnimi programi ne razkriva statističnih razlik. Rezultati raziskave so pomembni za oblikovanje strategij v predšolski vzgoji, saj poudarjajo potrebo po uravnoteženem pristopu, ki upošteva tako kakovost kot trajanje programov predšolske vzgoje.

Univerzitetna založba Univerze v Mariboru

1 Introduction

The development of mathematical skills in early childhood is a critical factor in shaping a child's educational trajectory, with a significant emphasis on future academic success. Early exposure to mathematics not only lays a crucial foundation for cognitive development, including skills, such as problem-solving, logical reasoning, and analytical thinking (Sarama and Clements, 2009), but also serves as a strong predictor of later academic achievement across various subjects. This viewpoint is further supported by an array of studies, which collectively indicate that early mathematics skills possess a significant predictive power for later academic success. These skills are also found to be as effective, if not more so, in forecasting reading abilities compared to domain-specific precursors of reading, as demonstrated by researchers, such as Claessens and Engel (2013), Duncan et al. (2007), LeFevre et al. (2010), Morgan et al. (2019), Pagani et al. (2010), Ten Braak et al. (2022), and Watts et al. (2014). This underscores the significance of early mathematical proficiency, as highlighted by the National Mathematics Advisory Panel (2008), which links it to enhanced academic performance, particularly in STEM (Science, Technology, Engineering, and Mathematics) subjects. A multitude of research findings, including those by Gashaj et al. (2023) and Daker et al. (2021), demonstrate that a solid early foundation in mathematics not only correlates with reduced math anxiety but also enhances competence in STEM areas, thereby improving academic performance and readiness for advanced studies.

These insights, emphasizing the integral role of mathematics in early education, are particularly relevant to our study. We aim to explore how various early childhood environments in Slovenia contribute to the development of these foundational mathematical skills. This exploration is crucial as it examines the impact of early mathematical competencies on the children's immediate educational outcomes and their broader academic journey. By focusing on different early childhood settings, our study seeks to enhance the understanding of how early experiences in mathematics can lay a strong foundation for later schooling.

1.1 Mathematical competencies in early childhood education

Defining mathematical competencies in early childhood involves a comprehensive understanding of the range of skills and knowledge that children acquire during their formative years. These skills are not just foundational for future mathematical

understanding but are also crucial for overall cognitive development. The National Council of Teachers of Mathematics (NCTM) (2000) asserts that early mathematical competencies encompass fundamental number sense, pattern recognition, spatial relationships, measurement, and problem-solving abilities. These competencies are the essential building blocks for more complex mathematical concepts and operations.

The Slovenian National Kindergarten Curriculum (Kurikulum za vrtce, 1999) embraces a holistic approach to early mathematical education, where mathematics is defined as one of several equal areas of activity within kindergarten settings. These activities are not conducted in isolation but are interwoven with other curriculum areas. Thus, mathematics holds equal importance to areas, such as movement, language, nature, society, and art, and should be equally represented in activities. However, some studies (e.g., Antolin Drešar, 2010) indicate that mathematics lags behind other areas in kindergartens. The global objectives of mathematics in kindergarten include acquainting children with mathematics in everyday life, developing mathematical expression, thinking and skills, and fostering an experience of mathematics as an enjoyable activity (Kurikulum za vrtce, 1999).

1.2 Factors influencing the development of mathematical skills in early childhood

The development of mathematical skills in early childhood is significantly influenced by a combination of various factors, creating a complex landscape for early learning, in the nurturing thereof parents, often referred to as children's first teachers, play an indispensable role. The home environment, where early learning initiates, is crucial in influencing a child's mathematical development (LeFevre et al, 2009). Leffel and Suskind (2013) emphasize the profound impact of parental engagement and language use at home on developing children's cognitive and mathematical skills. Further supporting this view, the study by Skwarchuk et al. (2014) demonstrates a strong link between informal numeracy activities at home and the enhancement of early numeracy skills. A handful of studies illuminate how parental beliefs, attitudes, and practices profoundly shape the cultivation of early mathematical skills (Muenks et al., 2015; Musun-Miller & Blevins-Knabe, 1998; Silver et al., 2021; Silver et al., 2023; Sonnenschein et al., 2012). These findings highlight the importance of both the frequency and quality of parental engagement in math-related activities. They

illustrate that a positive parental attitude towards mathematics, combined with active involvement in math-related discussions and activities, creates a supportive environment conducive to children's mathematical growth.

Moving beyond the home environment, the quality of early childhood education and the pedagogical approaches employed are also key in shaping a child's mathematical competencies. Ginsburg et al. (2008) highlight the essential role of early childhood educators in introducing structured mathematical concepts and creating an environment that encourages mathematical exploration and learning. Sarama and Clements (2009) further assert that effective instructional strategies in early childhood significantly enhance mathematical understanding and ability. The National Early Literacy Panel (2008) reinforces the impact of early childhood education settings on mathematical development, emphasizing the importance of early experiences in early childhood settings for children's overall academic readiness and mathematical skills.

As indicated by many previous research studies, the development of mathematical skills in early childhood is significantly influenced by the quality of early education settings. The impact of different early childhood settings, such as full-day and half-day programmes, on children's learning, particularly in mathematics, is a subject of significant educational interest. Full-day programmes, as detailed in studies like those of Walston and West (2004), offer extended opportunities for structured learning and practice. These programmes often provide a more comprehensive curriculum, including a broader range of mathematical activities that can enhance number sense, problem-solving skills, and mathematical reasoning. Children in full-day settings may benefit from a more consistent and in-depth exposure to mathematical concepts, which can lead to stronger foundational math-related skills (Lee et al., 2006; Pelletier & Corter, 2019; Walston & West, 2004). Conversely, half-day programmes, while shorter in duration, can still significantly impact mathematical learning, especially when they are well-structured and focused. Magnuson et al. (2004) suggest that the quality of the respective programme, regardless of its duration, is a critical factor in determining its impact on learning. In half-day settings, focused and intensive teaching of mathematics can foster key competencies, although the limited time available may restrict the breadth of concepts covered. Research indicates that the choice between full-day and half-day early childhood programmes may also interact with other factors, such as family background, socio-economic status, and parental

engagement in education. Loeb et al. (2007) note that the benefits of either programme can be maximized when complemented by a supportive home environment in which children engage in additional learning activities.

1.3 Early childhood education programmes in Slovenia

In Slovenia, the organisational structure and types of programmes offered in kindergartens are governed by the Kindergarten Act (Zakon o vrtcih, 1996). This Act stipulates a range of program options to cater to the varying needs of children and their families. It includes daily programmes designed to last between six to nine hours and scheduled for morning, afternoon, full-day, or on a rotating basis; half-day programmes, spanning four to six hours, also available in morning, afternoon, or rotating schedules; and short programmes, specifically for children from remote and demographically endangered areas, lasting from 240 to 600 hours annually. While the daily and half-day programmes are aimed at children from their first year until school entry, encompassing aspects of education, care, and nutrition, the short programmes target children from three years of age up to school entry, focusing on education, care, and optionally nutrition. The Act mandates that both daily and half-day programmes must be conducted by a combination of early childhood teachers and early childhood assistants, whereas short programmes are exclusively led by a pre-school teacher.

2 Research problem

The primary aim of this research is to explore the mathematical competencies of children in Slovenian pre-school settings, a relatively under-researched area despite extensive international focus on early childhood mathematical development. This study, part of a national evaluation study entitled "Analysis of the Needs, Conditions, and Possibilities for Mandatory Inclusion of Children in One of the Pre-school Education Programmes from the Perspective of Reducing Social, Economic, and Cultural Inequalities" (Licardo et al., 2024), compares the perceptions of early childhood teachers on the mathematical competencies of children in full-day, half-day, and shorter programmes, as well as at the beginning and end of shorter programmes.

This study is driven by two key research questions: "How do early childhood teachers perceive the development of children's mathematical competencies at the start and end of the shorter programmes?" and "How do early childhood teachers' opinions on the mathematical competencies of children differ across full-day, half-day, and shorter early childhood programmes?" Addressing these questions aims to reveal differences in early mathematical skills based on the length and structure of the respective programme, offering significant contributions to early childhood education research.

3 Methodology

3.1 Sample

The sample for the study was selected from public kindergartens that had previously confirmed their participation in a national evaluation study (Licardo et al., 2024). An invitation to participate in the competency assessment of children in short, half-day, and full-day programmes was extended and was responded to by 105 kindergartens. This study specifically focused on children transitioning to the 1st grade of primary school in September 2023. Three children were randomly selected by early childhood teacher per class to participate therein.

Table 1: Number (f) and structural percentages (f%) of children who were included in the math competencies assessment

Variable	Category	f	f%
Gender	Girl	496	52,2
	Boy	455	47,8
Age	M = 5,89, SD = 0,34		
Slovene as Mother Tongue	Yes	895	94,2
	No	55	5,8
Type of Programme	Full-day Programme	896	93,9
	Half-day Programme	24	2,5
	Shorter Programme	34	2,6
	Total	955	100,0

The sample included 955 pre-school children, with a relatively balanced gender distribution of 52.2% girls and 47.8% boys, as seen in Table 1. The average age of the children in the study was 5.89 years, with a standard deviation of 0.34 years, indicating a homogeneous age structure within the sample. As far as their mother

tongue is concerned, a significant majority (94.2%) spoke Slovene as their first language. Most of the children (93.9%) were enrolled in full-day programmes, with a smaller number attending half-day (2.5%) and shorter programmes (3.7%).

Approximately 300 early childhood teachers also participated in this part of the study by completing the "KOM5 Competency assessment tool for early childhood children" for each child. Although the assessment tool included the code of the respective kindergarten, it did not specify the individual teachers' codes, making it impossible to determine the exact number of participating teachers. Based on the guidelines provided to the teachers, it is estimated that around 300 early childhood teachers were involved in this segment of the study. Assistant early childhood teachers were not included.

3.2 Data collection

As previously noted, the research presented in this paper forms part of a national evaluation study (Licardo et al., 2024). Consequently, the data collection for our study was carried out within the framework of this larger national evaluation.

3.2.1 KOM5 Competency assessment tool for early childhood children

In Slovenia, there has been a noticeable absence of tools designed for educators to assess the competencies of children prior to their school entry. To address this gap, the KOM5 Assessment tool for evaluating early childhood children's competencies was developed. This comprehensive tool encompasses various competency domains that educators can observe in children before they transition to primary school:

- Social and Emotional domain
- Cognition
- Language
- Mathematics
- Social Studies
- Natural Sciences
- Physical Development and Motor Skills
- Art

Each domain within the tool is accompanied by detailed descriptors or explanations, facilitating a more accurate evaluation of a child's developmental competencies.

Early childhood teachers rated each child on a scale from 1 (not applicable) to 7 (fully applicable), based on observations conducted over a minimum period of three days. These ratings were founded on the child's performance during this specific observational timeframe. For the assessment, educators selected various segments of daily routines or structured activities that provided opportunities for the child to exhibit the respective competencies.

The reliability or internal consistency of the scale for each content section of the questionnaire was determined using Cronbach's alpha coefficient (α). Our analysis confirmed the reliability of the scales across all content domains, with alpha coefficients exceeding 0.7.

This initial version of the instrument, developed collaboratively with multidisciplinary experts, constitutes a significant step towards obtaining a validated and reliable measurement tool for early childhood children's competencies.

3.3 Data analysis procedures

The data collected from survey questionnaires and children's competency assessments were processed using the IBM SPSS Statistics (version 27.0) statistical software. In our data analysis, descriptive statistical methods, including the calculation of frequencies, arithmetic means, and standard deviations, were employed. To determine the reliability of the various questionnaires, Cronbach's alpha coefficient was calculated. Additionally, our data processing included comparative analyses, utilizing the Kruskal-Wallis test as well as the non-parametric Wilcoxon test.

4 Results

This section presents the findings of our study, focusing on the comparison of early childhood teachers' opinions regarding the mathematical competencies of children in various early childhood education programs before entering primary school. The results are divided into two main parts: firstly, the comparison of teachers' views on

children's mathematical competencies at the beginning and end of the shorter programmes, and, secondly, an analysis of these opinions on children's mathematical competencies across different pre-school programmes.

4.1 Comparison of early childhood teachers' opinions on children's competencies at the beginning and end of short programme implementation

The results of comparing early childhood teachers' views on children's mathematical competencies at the beginning and end of the shorter programmes were analysed using the non-parametric Wilcoxon test. This particular test was selected on account of the variables failing to meet the prerequisites for a parametric paired t-test. In the subset of mathematical items, the reliability measure (Cronbach's alpha coefficient) on the data sample for the shorter programmes was also analysed.

Table 2: Differences in educators' opinions on children's competencies in the short programme at the beginning and end of the programme, for mathematics

Math Competencies	N	M1	SD1	Sum of Pos. Ranks	M2	SD2	Sum of Neg. Ranks	Z	P
Counts	29	4.31	1.89	238.5	4.72	2.0	91.5	-3.94	0.150
Uses names for numbers	30	4.07	2.24	253.5	4.53	2.18	75.5	-4.22	0.105
Classifies	35	4.49	1.98	365.5	5.17	1.72	128.5	-4.37	0.054
Adds	23	2.78	1.98	200.0	3.7	2.24	21.0	-3.86	0.013
Subtracts	23	2.57	1.85	177.5	3.43	2.23	20.5	-3.94	0.026
Measures	18	3.0	1.81	110.0	3.89	2.17	16.0	-3.42	0.064
Names basic geometric shapes and solids	24	3.67	1.95	214.5	4.58	1.84	19.5	-4.04	0.009
Understands graphical representations	17	2.82	2.3	75.0	3.41	2.32	0.0	-3.62	0.039
Uses terms for orientation and location	26	3.62	2.12	264.0	4.42	1.98	32.0	-4.15	0.003
Appropriately uses terms for quantities	20	3.65	2.28	87.0	4.0	2.15	32.0	-3.70	0.161
Appropriately continues a pattern	27	4.81	1.92	266.0	5.67	1.24	34.0	-4.30	0.004

The results regarding the early childhood teachers' assessment of the differences in children's competencies at the beginning and end of the short programme implementation, particularly for the set of mathematical competencies ($\alpha = 0.99$), show that there are statistically significant differences in 7 out of 11 statements. These differences indicate higher early childhood teacher ratings at the end of the short programmes. Specifically, improvements were noted in classifying ($z = -4.37$; $p = 0.054$), adding ($z = -3.86$; $p = 0.013$), subtracting ($z = -3.94$; $p = 0.026$), naming basic geometric shapes and solids ($z = -4.04$; $p = 0.009$), understanding graphical representations ($z = -3.62$; $p = 0.039$), using expressions for orientation and location ($z = -4.15$; $p = 0.003$), and in appropriately continuing a pattern ($z = -4.30$; $p = 0.004$). A trend of differences was also observed in measuring ($z = -3.42$; $p = 0.064$).

It should be noted that the number of children (N) who participated in the assessment process varied for each math competency.

4.2 Comparison of early childhood teachers' opinions on children's competencies in full-day, half-day, and shorter programmes

The competencies of children in full-day, half-day, and shorter programmes were compared utilizing data obtained from the KOM5 questionnaire completed by early childhood teachers for children in groups selected through the random sampling process. Data for the full-day and half-day programmes were collected in April, May, and June 2023, whereas data for the children in shorter programmes were gathered at the end of the implementation thereof (between March and August 2023).

Our research reveals that half-day programs consistently exhibited the highest mean values across all math competencies, except in the case of the »Appropriately continues a pattern« competency, while short programs had the lowest mean values. The results indicate statistically significant differences in early childhood teachers' opinions on children's math competencies across full-day, half-day, and shorter programs for all items as pertaining to mathematics.

Table 3: Differences in early childhood teachers' opinions on children's math competencies in full-day, half-day, and shorter programmes

Math competencies	Programme	N	Mean (M)	Standard Deviation (SD)	R^{-}	Kruskal-Wallis U
Counts	Full-day	897	6.64	0.94	485.83	65.10**
	Half-day	24	6.83	0.48	516.38	
	Short	31	4.74	2.00	205.82	
Uses names for numbers	Full-day	891	6.24	1.33	479.54	29.25**
	Half-day	24	6.58	1.18	558.88	
	Short	31	4.61	2.19	264.10	
Classifies	Full-day	896	6.66	0.80	486.26	51.61**
	Half-day	24	6.83	0.48	531.50	
	Short	34	5.18	1.75	234.66	
Adds	Full-day	870	5.93	1.54	463.94	21.09**
	Half-day	23	6.35	0.88	504.41	
	Short	24	3.83	2.30	236.58	
Subtracts	Full-day	863	5.61	1.73	459.57	19.24**
	Half-day	23	6.13	1.22	524.26	
	Short	24	3.58	2.30	243.31	
Measures	Full-day	812	5.56	1.59	428.56	11.99*
	Half-day	23	6.17	1.07	520.78	
	Short	19	4.05	2.22	269.45	
Names basic geometric shapes and solids	Full-day	889	6.06	1.17	477.78	19.44**
	Half-day	22	6.14	0.83	460.07	
	Short	28	4.57	1.97	263.05	
Understands graphical representations	Full-day	835	5.72	1.44	445.49	23.43**
	Half-day	22	5.95	0.95	453.93	
	Short	21	3.43	2.23	186.10	
Uses terms for orientation and location	Full-day	887	6.05	1.27	476.64	25.96**
	Half-day	23	6.13	1.42	517.22	
	Short	28	4.29	1.98	234.07	
Appropriately uses terms for quantities	Full-day	879	5.94	1.25	471.38	30.60**
	Half-day	23	6.17	0.98	506.54	
	Short	26	3.92	1.98	194.83	
Appropriately continues a pattern	Full-day	894	6.50	0.93	485.10	26.68**
	Half-day	24	6.46	0.78	446.40	
	Short	33	5.52	1.37	277.41	

Note: *p < 0.05; **p < 0.001

Table 4: Comparative analysis of mathematical competencies across different Slovenian early childhood programmes

Math competencies	Comparison	Test Statistic	Std. Error	Std. Test Statistic	Adj. Sig.	Effect Size
Counts	Short programme - full-day programme	264.227	32.799	8.056	< 0.001	0,26
	Short programme - half-day programme	291.140	48.762	5.971	< 0.001	0,81
	Full-day programme - half-day programme	-26.912	37.127	-0.725	1.000	0,02
Uses names for numbers	Short programme - full-day programme	209.069	39.487	5.295	< 0.001	0,17
	Short programme - half-day programme	278.578	58.697	4.746	< 0.001	0,64
	Full-day programme - half-day programme	-69.509	44.696	-1.555	0.360	0,05
Classifies	Short programme - full-day programme	242.307	32.524	7.450	< 0.001	0,24
	Short programme - half-day programme	275.842	49.567	5.565	< 0.001	0,73
	Full-day programme - half-day programme	-33.535	38.489	-0.871	1.000	0,03
Adds	Short programme - full-day programme	216.232	47.066	4.594	< 0.001	0,15
	Short programme - half-day programme	246.000	66.311	3.710	0.001	0,54
	Full-day programme -	-29.768	48.050	-0.620	1.000	0,02

Math competencies	Comparison	Test Statistic	Std. Error	Std. Test Statistic	Adj. Sig.	Effect Size
	half-day programme					
Subtracts	Short programme - full-day programme	205.033	48.439	4.233	< 0.001	0,14
	Short programme - half-day programme	259.967	68.236	3.810	< 0.001	0,56
	Full-day programme - half-day programme	-54.935	49.451	-1.111	0.800	0,04
Measures	Short programme - full-day programme	155.755	51.518	3.023	0.008	0,10
	Short programme - half-day programme	231.628	68.762	3.369	0.002	0,52
	Full-day programme - half-day programme	-75.873	46.945	-1.616	0.318	0,06
Names basic geometric shapes and solids	Short programme - full-day programme	181.156	67.659	2.677	0.022	0,09
	Short programme - half-day programme	206.615	45.628	4.528	< 0.001	0,64
	Half-day programme - full-day programme	25.459	51.296	.496	1.000	0,02
Understands graphical representations	Short programme - full-day programme	246.251	50.406	4.885	< 0.001	0,17
	Short programme - half-day programme	248.957	69.542	3.580	0.001	0,55
	Full-day programme -	-2.706	49.278	-.055	1.000	0,002

Math competencies	Comparison	Test Statistic	Std. Error	Std. Test Statistic	Adj. Sig.	Effect Size
	half-day programme					
Uses terms for orientation and location	Short programme - full-day programme	237.223	45.121	5.258	< 0.001	0,17
	Short programme - half-day programme	264.780	66.085	4.007	< 0.001	0,56
	Full-day programme - half-day programme	-27.557	49.639	-0.555	1.000	0,02
Appropriately uses terms for quantities	Short programme - full-day programme	261.060	47.443	5.503	< 0.001	0,18
	Short programme - half-day programme	288.522	68.180	4.232	< 0.001	0,60
	Full-day programme - half-day programme	-27.462	50.353	-0.545	1.000	0,02
Appropriately continues a pattern	Short programme - full-day programme	156.259	57.165	2.733	0.019	0,09
	Short programme - half-day programme	196.523	37.817	5.197	< 0.001	0,69
	Half-day programme - full-day programme	40.263	44.114	0.913	1.000	0,03

Table 4 presents a detailed statistical comparison of mathematical competencies among children enrolled in various Slovenian early childhood programmes. The findings reveal significant statistical differences in all areas of mathematics between children in short programmes and those in full-day programmes, with effect sizes ranging from small to moderate according to Cohen (1992). Notably, children in

short programmes consistently exhibit lower competencies compared to their peers in full-day programmes.

Further, pairwise comparisons between children in short programmes and those in half-day programmes also show significant differences in mathematical competencies, with effect sizes being large. Specifically, children in short programmes demonstrate notably lower competencies than those in half-day programmes, highlighting the substantial impact of the respective programme duration on mathematical skill development.

In contrast, comparisons between full-day and half-day programmes across all mathematical competencies reveal no significant statistical differences. This suggests similar levels of mathematical development in these two programme types, indicating that factors other than programme duration might play a pivotal role in the development thereof.

5 Discussion

This study explored differences in early childhood teachers' perceptions of children's mathematical competencies across various early childhood education programs. Two key aspects were examined: the comparison of teachers' opinions of mathematical competencies across different programs and the changes therein from the beginning to the end of shorter programmes.

The findings indicate that children's mathematical competencies, as perceived by early childhood teachers, significantly improve throughout the duration of short programmes. This improvement was evident in several key areas, such as classifying, adding, subtracting, naming basic geometric shapes and solids, understanding graphical representations, using expressions for orientation and location, and appropriately continuing a pattern. These results suggest that short programmes, despite their limited duration, positively impact the development of key mathematical skills in children, resonating with Clements and Sarama's (2007) research on the significant gains in mathematical understanding achievable through focused early childhood education programmes.

However, in comparing children's competencies in full-day, half-day, and short programmes, a more nuanced picture emerges. Children in short programmes consistently scored lower in mathematical competencies than those in full-day and half-day programmes, contrasting with studies like Weiland and Yoshikawa (2013) and Leak et al. (2010), which suggested limited differences in learning outcomes based on programme duration. Our findings imply that the duration and perhaps the intensity of the programme significantly impact mathematical skill development, aligning with Cooper et al.'s (2010) research on the importance of programme duration in early learning.

Interestingly, the comparison between full-day and half-day programmes revealed no significant differences in mathematical competencies, aligning with Jenkins et al.'s (2016) conclusions that the quality of instructional time might outweigh the quantity. This suggests that the effectiveness of early childhood programmes in mathematics may hinge more on curriculum, teaching methods or other external factors than the programme length.

When reflecting on the implications of our findings, it's essential to recognize potential limitations in our research design. One such consideration is whether the same early childhood teachers who provided assessments also conducted the early childhood education programs for the children they assessed. Despite efforts to reduce bias and ensure objectivity in the assessment process, it's important to acknowledge that the possibility of teacher bias cannot be entirely eliminated. Additionally, it is worth noting that besides different programs, various other external factors may have influenced the observed outcomes. These may include social factors such as the socioeconomic and academic status of families, which warrant further investigation and could be connected with other studies in the field.

Our study contributes to the body of research by highlighting the effectiveness of short programmes in improving mathematical competencies, albeit to a lesser extent than the longer ones. This underscores the need for a balanced approach in early childhood education, where both quality and duration are crucial in children's developmental outcomes. It also highlights the need for further research to explore how different aspects of early childhood programmes interact to influence learning outcomes in mathematics.

6 Conclusion

This research holds significant relevance in the Slovenian context, offering insights into the various early childhood education programmes in terms of young children's mathematical competencies. Our findings have implications for early childhood education in Slovenia, shedding light on how programme lengths and structures contribute to the development of foundational mathematical skills.

It was observed that short programmes effectively enhance mathematical competencies, showing improvements over their duration. However, the lower performance in mathematical competencies among children in short programmes compared to those in full-day and half-day programmes suggests a need to refine these condensed educational experiences in Slovenia.

The absence of significant differences in mathematical skills between children in full-day and half-day programmes is particularly relevant to the Slovenian context, emphasizing quality over quantity in early childhood education. This insight aligns with national educational goals and can guide Slovenian educators and policymakers in developing curricula that emphasize rich, engaging, and comprehensive mathematical learning, regardless of programme length.

References

Antolin Drešar, D. (2020). Planned mathematical activities in Slovenian kindergartens. In A. Lipovec, J. Batič, & E. Kranjec (Eds.), *New horizons in subject-specific education: Research aspects of subjects specific didactics* (1st ed., pp. 253–269). University Press: Faculty of Education. https://press.um.si/index.php/ump/catalog/view/481/590/989-1. https://doi.org/10.18690/978-961-286-358-6.12

Claessens, A., & Engel, M. (2013). How important is where you start? Early mathematics knowledge and later school success. *Teachers College Record*, *115*(6).

Clements, D. H., & Sarama, J. (2007). Early childhood mathematics learning. In F. K. Lester (Ed.), *Second handbook of research on mathematics teaching and learning* (pp. 461–555). Information Age Publishing.

Cohen, J. (1992). A power primer. *Psychological bulletin, 112*(1), 155–159.

Cooper, H., Allen, A. B., Patall, E. A., & Dent, A. L. (2010). Effects of full-day kindergarten on academic achievement and social development. *Review of Educational Research*, *80*(1), 34–70. https://doi.org/10.3102/0034654309359185

Daker, R. J., Gattas, S. U., Sokolowski, H. M., Green, A. E., & Lyons, I. M. (2021). First-year students' math anxiety predicts STEM avoidance and underperformance throughout university, independently of math ability. *NPJ Science of Learning, 6*(1), 17.

Duncan, G. J., Dowsett, C. J., Claessens, A., Magnuson, K., Huston, A. C., Klebanov, P., Pagani, L. S., Feinstein, L., Engel, M., Brooks-Gunn, J., Sexton, H., Duckworth, K., & Japel, C. (2007). School readiness and later achievement. *Developmental Psychology, 43*(6), 1428–1446. https://doi.org/10.1037/0012-1649.43.6.1428

Gashaj, V., Thaqi, Q., Mast, F. W., & Roebers, C. M. (2023). Foundations for future math achievement: Early numeracy, home learning environment, and the absence of math anxiety. *Trends in Neuroscience and Education, 33,* 100217. https://doi.org/10.1016/j.tine.2023.100217

Ginsburg H. P., Lee J. S., & Boyd, J. S. (2008). Mathematics education for young children: What it is and how to promote it. *Social Policy Report: Giving child and youth development knowledge away*, *22*(1), 1–23.

Jenkins, J. M., Watts, T. W., Magnuson, K., Gershoff, E. T., Clements, D. H., Sarama, J., & Weiland, C. (2016). Do high-quality kindergarten and first-grade classrooms mitigate preschool fadeout? *Journal of Research on Educational Effectiveness, 9(*4), 410-432. doi: 10.1080/19345747.2018.1441347.

Kurikulum za vrtce [Kindergarten Curriculum]. (1999). Ljubljana: Ministrstvo za šolstvo in šport, Urad RS za šolstvo.

Leak, J., Duncan, G. J., Li, W., Magnuson, K. A., Schindler, H. S., & Yoshikawa, H. (2010). *Is timing everything?: How early childhood education program impacts vary by starting age, program duration and time since the end of the program* . University of California, Irvine, School of Education.

Lee, V. E., Burkam, D. T., Ready, D. D., Honigman, J., & Meisels, S. J. (2006). Full-day versus half-day kindergarten: In which program do children learn more? *American Journal of Education, 112*(2), 163–208.

LeFevre, J.-A., Fast, L., Skwarchuk, S.-L., Smith-Chant, B. L., Bisanz, J., Kamawar, D., & Penner-Wilger, M. (2010). Pathways to mathematics: Longitudinal predictors of performance. *Child Development, 81*, 1753–1767. https://doi.org/10.1111/j.1467-8624.2010.01508.x

LeFevre, J.-A., Skwarchuk, S.-L., Smith-Chant, B. L., Fast, L., Kamawar, D., & Bisanz, J. (2009). Home numeracy experiences and children's math performance in the early school years. *Canadian Journal of Behavioural Science / Revue canadienne des sciences du comportement, 41*(2), 55–66. https://doi.org/10.1037/a0014532

Leffel, K., & Suskind, D. (2013). Parent-directed approaches to enrich the early language environments of children living in poverty. *Seminars in Speech and Language, 34*(4), 267–278. https://doi.org/10.1055/s-0033-1353443

Licardo, M., Laure, M., Ograjšek, S., Mithans, M., Hmelak, M., Jurgec, A. T., Kranjec, E., Kozjek Varl, K., Bednjički Rošer, B., & Sraka Petek, B. (2024). *Nacionalna evalvacijska študija: Analiza potreb, pogojev in možnosti obveznega vključevanja otrok v enega izmed programov predšolske vzgoje z vidika zmanjševanja socialne, ekonomske in kulturne neenakosti [National evaluation study: Analysis of the needs, conditions, and possibilities for mandatory inclusion of children in one of the pre-school education programs from the perspective of reducing social, economic, and cultural inequalities]*. Maribor: University of Maribor, Faculty of Education..

Loeb S., Bridges M., Bassok D., Fuller B., & Rumberger, R. W. (2007). How much is too much? The influence of preschool centers on children's social and cognitive development. *Economics of Education Review*, *26*, 52–66. http://doi.org/br26m4

Magnuson K. A., Meyers M. K., Ruhm C. J., & Waldfogel, J. (2004). Inequality in Preschool Education and School Readiness. *American Educational Research Journal 41*(1), 15–158.

Morgan, P. L., Farkas, G., Hillemeier, M. M., Pun, W. H., & Maczuga, S. (2019). Kindergarten children's executive functions predict their second-grade academic achievement and behavior. *Child Development, 90*(5), 1802–1816. https://doi.org/10.1111/cdev.13095

Muenks, K., Miele, D. B., Ramani, G. B., Stapleton, L. M., & Rowe, M. L. (2015). Parental beliefs about the fixedness of ability. *Journal of Applied Developmental Psychology, 41*, 78–89. doi: 10.1016/j.appdev.2015.08.002

Musun-Miller, L., & Blevins-Knabe, B. (1998). Adults' beliefs about children and mathematics: how important is it and how do children learn about it? *Early Development and Parenting, 7*, 191–202. doi: 10.1002/(sici)1099-0917(199812)7:4<191::Aid-edp181>3.0.Co;2-i

National Council of Teachers of Mathematics (NCTM). (2000). *Principles and standards for school mathematics*. NCTM.

National Mathematics Advisory Panel. (2008). *Foundations for success: The final report of the National Mathematics Advisory Panel*. U.S. Department of Education.

Pagani, L. S., Fitzpatrick, C., Archambault, I., & Janosz, M. (2010). School readiness and later achievement: A French Canadian replication and extension. *Developmental Psychology, 46*(5), 984–994. https://doi.org/10.1037/a0018881

Pelletier, J. P., & Corter, J. E. (2019). A longitudinal comparison of learning outcomes in full-day and half-day kindergarten. *The Journal of Educational Research, 112*(2), 192–210. https://doi.org/10.1080/00220671.2018.1486280

Sarama, J., & Clements, D. H. (2009). *Early childhood mathematics education research: Learning trajectories for young children*. Routledge.

Silver, A. M., Chen, Y., Smith, D. K., S., C., Cabrera, N., & Libertus, M. E. (2023). Mothers' and fathers' engagement in math activities with their toddler sons and daughters: The moderating role of parental math beliefs. *Frontiers in Psychology, 14*, 1124056. https://doi.org/10.3389/fpsyg.2023.1124056

Silver, A. M., Elliott, L., & Libertus, M. E. (2021). When beliefs matter most: Examining children's math achievement in the context of parental math anxiety. *Journal of Experimental Child Psychology, 201*, 104992. https://doi.org/10.1016/j.jecp.2020.104992

Skwarchuk S.-L., Sowinski C., & LeFevre, J. (2014). Formal and informal home learning activities in relation to children's early numeracy and literacy skills: The development of a home numeracy model. *Journal of Experimental Child Psychology*, *121*, 63–84.

Sonnenschein, S, Galindo, C., Metzger, S. R., Thompson, J.A., Huang, H. C., & Lewis, H. (2012). Parents' beliefs about children's math development and children's participation in math activities. *Child Development Research Journal Online,* doi:10.1155/2012/851657

Ten Braak, D., Lenes, R., Purpura, D. J., Schmitt, S. A., & Størksen, I. (2022). Why do early mathematics skills predict later mathematics and reading achievement? The role of executive function. *Journal of Experimental Child Psychology, 214*, 105306. https://doi.org/10.1016/j.jecp.2021.105306

Walston, J.T., & West, J. (2004). *Full-day and Half-day Kindergarten in the United States: Findings from the Early Childhood Longitudinal Study, Kindergarten Class of 1998–99 (NCES 2004–078)*. U.S. Department of Education, National Center for Education Statistics. U.S. Government Printing Office.

Watts, T. W., Duncan, G. J., Siegler, R. S., & Davis-Kean, P. E. (2014). What's past is prologue: Relations between early mathematics knowledge and high school achievement. *Educational Researcher, 43*, 352–360. https://doi.org/10.3102/0013189X14553660

Weiland, C., & Yoshikawa, H. (2013). Impacts of a Prekindergarten Program on Children's Mathematics, Language, Literacy, Executive Function, and Emotional Skills. *Child Development*, *84*(6), 2112–2130. http://www.jstor.org/stable/24029681

Zakon o vrtcih [Kindergarten Act]. (1996). Uradni list Republike Slovenije, št. 12/1996, 100/05 – uradno prečiščeno besedilo, in njegove spremembe 25/08, 98/09-ZIUZGK, 36/10, 62/10-ZUPJS, 94/10-ZIU, 40/12-ZUJF, 14/15-ZUUJFO, in 55/17.