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Preschool teachers' self-efficacy and children's motivation on science

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ABSTRACT
This study focuses on two critical factors in science education: Teachers' self-efficacy beliefs and children's motivation. The purpose is to examine the relationship between preschool teachers' self-efficacy beliefs towards science education and children's science motivation, while also exploring potential variations based on specific variables. The sample for this quantitative research included 298 children aged between 60 and 72 months (149 girls, 149 boys) and their 149 teachers. The participant children are randomly selected from each teacher's class, with an equal representation of girls and boys. Data were collected using the Self-Efficacy Scale for Preschool Science Education, the Science Motivation Scale for Preschool Children, and a Personal Information Form. According to the results of the analysis, there is a positive correlation between preschool teachers' self-efficacy beliefs in science education and their professional experience and educational qualifications. Furthermore, the study revealed that children's science motivation was not affected by their age and gender. Moreover, there was a positive relationship between the frequency of hands-on science activities and both teachers' self-efficacy beliefs and children's science motivation. Above all, a significant positive relationship was found between children's science motivation and teachers' self-efficacy perceptions towards science. In conclusion, this study suggests that more time should be allocated to science activities in preschool education and that programs that support the development of preschool teachers' self-efficacy in science should be included. In this way, teachers' confidence and competence in teaching science can be increased and positive effects can be created on children's interest and motivation in science from an early age.

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INTRODUCTION

Children try to understand and learn what is happening around them by asking various questions and making observations about many objects, situations, or events they encounter in their daily lives. In the preschool period, children need opportunities to keep their curiosity alive, make inquiries by establishing cause-effect relationships, and make predictions by putting forward various ideas (Uğraş, Uğraş, & Çil, 2013). These opportunities can be offered to children through a quality science education in early childhood. Science activities applied in kindergartens must contain some elements to be considered qualified. Components such as enjoying learning science, showing interest in science-related activities, self-confidence in science, and motivation towards science are behaviors important for science education (Osborne, Simon, & Collins, 2003). The development of these positive behaviors towards science occurs by exposing children to different science studies, spending enough time on research and exploration, and making associations and

inferences as a result of observation. Science-related experiences that children accumulate before starting primary school shape their perceptions of science (Eshach & Fried, 2005). Additionally, preschool children's early motivational beliefs about science predict their participation in primary school and their future interest (Leibham, Alexander, & Johnson, 2013). The levels of enjoyment and self-confidence, which are considered the two main components of learning and achievement motivation in a particular subject, largely depend on children's previous experiences in that subject (Oppermann, Brunner, and Anders 2019). Therefore, the behaviors, interests, and attitudes that children develop in early childhood regarding science are important for their future lives. In this context, an effective science education process is needed so that children in early childhood, who are trying to get to know the environment and life, can discover ways to access scientific knowledge, develop their creativity, find realistic solutions to problems, and acquire many skills and attitudes, such as making inferences independently in a relational context.

One of the important factors in the science education process is the self-efficacy perceptions of preschool teachers in this field. The fact that teachers have low self-efficacy perceptions in science activities and that children are given little opportunity to learn concepts and subjects related to science affects children's beliefs and attitudes towards science, reducing their science motivation (Mantzicopoulos, Patrick, & Samarapungavan, 2013; Mantzicopoulos, Samarapungavan, & Patrick, 2009). In addition, teachers' self-efficacy perceptions affect the way they implement science activities, their action plans, their level of effort, their ability to cope with the difficulties they encounter during the activities, and their determination and success (Haatainen, Turkka, & Aksela, 2021). Studies show that there are many factors that have significant relationships with preschool teachers' self-efficacy beliefs. Some of these factors include classroom management skills (Bay, 2020; Semerci & Uyanık Balat, 2018), professional experience (Bullock, Coplan & Bosacki, 2015; Koç & Sak, 2017), participation in activities such as seminars, conferences, congresses, courses, symposiums related to the preschool education program (Koç & Sak, 2017), effective problem-solving approaches (Kesgin, 2006), democratic attitudes in the learning and teaching process (Kırkıç & Çetinkaya, 2020), personality traits (Bullock, Coplan & Bosacki, 2015), commitment to work (Baezat, Aflakifard, & Shahidi, 2014), sense of community (perceptions of staff collaboration and its effects on decision making) (Guo, Justice, Sawyer & Tompkins, 2011), and school climate (Kim & Kim, 2010). Additionally, according to a study conducted by Skaalvik and Skaalvik (2010), teachers' self-efficacy beliefs were found to be associated with emotional exhaustion and depersonalization, meaning that low teacher self-efficacy beliefs cause feelings of burnout, while teachers with high self-efficacy beliefs experience high job satisfaction. Moreover, it has been observed that as preschool teachers' self-efficacy beliefs increase, their feelings and thoughts about making a meaningful difference in children's lives develop, and teachers exhibit more passion and positive energy in their profession (Lipscomb, Chandler, Abshire, Jaramillo, & Kothari, 2021). In addition, Guo, Justice, Sawyer, and Tompkins (2011) concluded that preschool teachers' self-efficacy beliefs are predicted by the interaction between children's participation and teachers' sense of cooperation.

It is noteworthy that starting from primary school, children generally use the phrase "difficult" when describing science, and children with this idea gradually distance themselves from science (Oppermann et al., 2018). Considering that these negative perceptions are related to the motivation about science-related subjects in previous periods, it is possible to attribute these characterizations in primary school to the preschool period. The main reason for the negative perspectives is the negative beliefs that children typically have about science-related subjects and their lack of experience in learning science until then (Mantzicopoulos, Patrick, & Samarapungavan, 2008). In other words, the motivation of children who are not given sufficient opportunities to learn science and perform scientific activities in the preschool period suffers a significant decline when they come to primary school and even later. In this context, the experiences of children through science activities seem to significantly affect their interest and competence in scientific subjects. In a study conducted by Dilek, Taşdemir, Konca, and Baltacı (2020), children's science process skills

and science motivation were examined during inquiry-based STEM activities; according to the findings, which included 14 children aged 60-72 months, positive changes were observed in children's motivation towards science by using at least one of their scientific process skills and frequently participating in STEM activities and accepting science as an activity area. In another study conducted by Yılmaz (2021), it was found that the levels of self-confidence and enjoyment for science, which are sub-dimensions of children's motivation, are effective in the relationship between teachers' pedagogical content knowledge and children's scientific concept-skill understanding. Also, it was determined that there is a positive relationship between children's scientific concept-skill understanding and teachers' proficiency in science activities.

In a study conducted by Patrick, Mantzipoulos, Samarapungavan, and French (2008), three factors were determined to examine whether preschool children have different motivational profiles regarding science: perceived proficiency in science, enjoyment, and ease of learning. According to the findings, children with low perceived efficacy in science but a high level of enjoyment for science reported that they had less teacher support for learning compared to children with high motivational beliefs. It has been revealed that the nature and frequency of observed teacher-child interactions differ according to their motivation profiles (Patrick et al., 2008). Another study conducted by Patrick, Mantzipoulos, and Samarapungavan (2009) with 162 preschool children showed that some children participated in the Scientific Literacy Project for five weeks, while others attended for ten weeks. An increase was observed in the science motivation of all boys and girls participating in the project, and there was no gender difference in this increase. Moreover, children who participated in the project for 10 weeks reported more proficiency than those who participated for 5 weeks (Patrick et al., 2009). In another study conducted by Oppermann, Brunner, Eccles, and Anders (2018) to reveal motivational beliefs about learning science in early childhood, it was reported that children's science motivation may differ in terms of self-confidence and pleasure in science. In addition, it was found that children who are older than their peers were more motivated for science, and no significant gender difference was detected. Also, it was determined that children who continue their education in kindergartens based on scientific activities have higher science motivation (Oppermann et al., 2018).

It is evident that there are a limited number of studies on how teachers' self-efficacy, together with science education and practices in early childhood, are related to children's motivation to understand and learn about science-related concepts and processes. A study dealing with the relationship between preschool teachers' self-efficacy and children's science motivation has not been found in Turkey. However, a study dealing with these factors was found in Germany, which is the research conducted by Oppermann, Brunner, and Anders (2019). In this study, it has been revealed that the science motivation of children is related to the self-efficacy of preschool teachers in the field of science. Nevertheless, more studies are needed to make a judgment about whether teachers' perceptions of science self-efficacy shape their science motivation. Additionally, children's motivation in science in the preschool period affects their science motivation and, accordingly, their performance in science after early childhood (OECD, 2017; Tao, Oliver, & Venville, 2012). From this perspective, it is extremely valuable for children to have high motivation for science in order to raise individuals who are deeply interested in science. Furthermore, understanding the different motivation profiles of children towards science in the preschool period (in other words, revealing the levels of enjoyment for science and self-confidence in the scientific field) is important in terms of identifying the factors that adapt them to various subjects and the factors that negatively affect the adaptation process (Patrick et al., 2008). Hence, determining the motivation for science helps individuals to discover the paths to their choices, to create and develop their expectations, while at the same time forming an idea about how children's career choices will be in the future (Patrick, Mantzipopoulos, & Samarapungavan, 2009). Accordingly, the aim of this study is to examine whether preschool teachers' self-efficacy beliefs towards science education and children's science motivation differ according to some variables, and whether there is a relationship between teachers'

self-efficacy beliefs towards science education and children's science motivation. In this direction, answers to the following research questions were sought:

1. Do preschool teachers' self-efficacy beliefs in science education differ according to their professional experience and educational status?
2. Do teachers' self-efficacy beliefs in science activities differ depending on the frequency of science activities in a month?
3. Do children's science motivation and its sub-dimensions - which are self-confidence and enjoyment - differ according to the age and gender of the children?
4. Do children's science motivation and its sub-dimensions - which are self-confidence and enjoyment - differ depending on the professional experience of teachers?
5. Are children's science motivation and its sub-dimensions - which are self-confidence and enjoyment - affected by the frequency of science activities?

What is the relationship between preschool teachers' self-efficacy beliefs in science education and children's science motivation?

METHODS

In this section, the research model, participants, data collection tools, and data analysis are explained.

The Research Model

In this study, a relational survey model, which is one of the quantitative research design types, was used to examine the relationship between preschool teachers' self-efficacy perceptions towards science education and science motivation in children. Relational research is carried out to obtain clues about cause and effect by defining the relationships between two or more variables in quantitative research (Büyüköztürk et al., 2020).

Participants

A total of 149 teachers (142 female, 7 male) and 298 children (randomly selected from each teacher's class; one girl and one boy per class, aged 60-72 months) from official independent kindergartens in Turkey, Adana, participated in the current study. The preschool teachers' ages ranged from 25 to 48, with an average age of 35.60. The average age of the children was 65.37 months. The teachers' professional experience varied between 1 and 25 years, with an average of 11.44 years. Additionally, 141 teachers had undergraduate academic degrees, and eight teachers had graduate degrees.

Necessary permissions were obtained for the current study, and the voluntary participation of the teachers was taken into consideration. The research commenced after obtaining written permissions from the teachers and parents through the teacher information form and the parent consent form. Informed consent was also obtained from the children. The current study followed APA's ethical guidelines for conducting research with human participants.

Data Collection Tools

Personal Information Form, Self-efficacy Scale for Science Education in Preschool Education, and Preschool Children's Science Motivation Scale were used to collect data in the study.

Personal Information Form: This form collected variables such as teachers' age, gender, duration of professional experience, class size, number of science activities performed in a month, and birth dates of children.

Self-efficacy Scale for Science Education in Preschool Education: This scale, developed by Buldur and Alisinanoğlu (2020), was used to determine the self-efficacy of preschool teachers in science education. The scale is Likert-type and has a five-point rating. It consists of 16 items, and a higher score indicates that teachers have high self-efficacy in science education. The scale has demonstrated sufficient validity and

reliability to measure preschool teachers' self-efficacy in science education. Respondents typically take 10-15 minutes to complete the scale. The Cronbach's Alpha internal consistency coefficient for the reliability of the scale was calculated as .92 in the study by Buldur and Alisinanoğlu (2020), and in the current study, the Cronbach's Alpha reliability coefficient was .89.

Preschool Children's Science Motivation Scale (PCSMS): This scale, originally named "Young Children's Science Motivation Scale," was developed by Oppermann, Brunner, Eccles, and Anders (2018) in Germany. The scale was adapted for use in Turkey by authors (2021). The PCSMS focuses on intrinsic values by associating children's self-confidence in science-related activities with their outcome expectation beliefs. It assesses children's interest in science based on an innate curiosity to learn rather than future career or other potential benefits. The scale consists of 28 items, covering life sciences and physical science content areas, divided into two sub-dimensions: Self-Confidence (consisting of eight items in life sciences and seven items in physical sciences) and Enjoyment (consisting of seven items in life sciences and six items in physical sciences). The scale uses a four-point response scale, ranging from "very little/no" to "very/very good." The response process involves children's verbal responses and a diagram with sections labeled 1 to 4 (Oppermann et al., 2018). An example item from the scale is as follows: "Have you ever looked at plants in detail? For example, at a leaf, a blossom, or a root? Kora/Momo already knows a lot about plants. Kiki/Bodo does not yet know much about plants. How about you? Please show me how much you already know about plants. Do you know very much, quite a lot, not that much, or very little?"

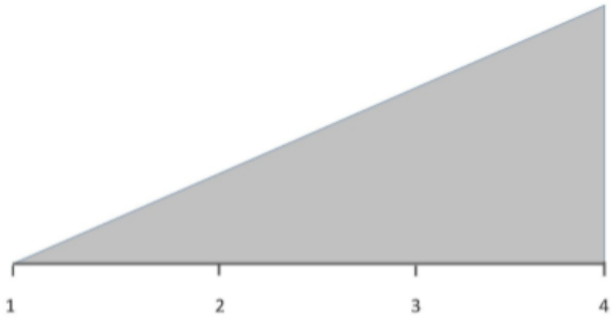

Figure 1. The diagram of the PCSMS

The scale PCSMS involves children's verbal responses and a diagram with sections labeled 1 to 4. Therefore, the scale uses a four-point response scale, ranging from "very little/no" to "very/very good."

While the scale items are verbally directed to the children, puppets are used as intermediaries. To prevent children from feeling sympathy or antipathy, the researchers use puppets that are identified with the gender of the child. If the child is a girl, two puppets named Kiki and Kora are used, and if the child is a boy, puppets named Bodo and Momo are used. The procedure for applying the scale involves the researcher getting to know the child, providing basic information about the process (briefly explaining the purpose of the study and introducing the puppets), and then proceeding with the exercise items and the scale items, respectively. Furthermore, the Cronbach Alpha values of the scale were calculated as .86 for the first factor, Self-Confidence, .85 for the second factor, Enjoyment, and .85 for the total scale in the study conducted by authors (2021). In the current study, Cronbach's Alpha reliability coefficient values were determined as .81 for the Self-Confidence dimension, .89 for the Enjoyment dimension, and .89 for the overall scale.

Data Analysis

In the analysis of the data, the skewness and kurtosis values obtained from the normality test were considered. It was observed that these values were between -1.5 and +1.5, indicating that the data showed a normal distribution (Tabachnick & Fidell, 2013). Data were analyzed using the Independent Groups t-Test to

test whether the differences observed between the groups were statistically significant (Büyüköztürk, 2020). Additionally, Pearson Correlation Analysis was used to examine the relationship between two continuous variables with a normal distribution (Büyüköztürk, 2020). Descriptive analyses utilized values such as frequency, percentage, mean, median, and standard deviation. The reliability of the scales was assessed using Cronbach's Alpha coefficient.

RESULTS

In this section, the differences in teachers' self-efficacy and children's science motivation are examined based on the information obtained from the demographic information form. Subsequently, the findings on the relationship between teachers' self-efficacy and children's science motivation are presented.

The descriptive statistical analysis regarding the frequency of science activities applied by preschool teachers in a month is summarized in Table 1.

Table 1. The Situation of Teachers to Apply Science Activities in a Month

Number of Science Activities	N (Teacher)	%
1-2	55	36.9
3-4	44	29.6
5-6	8	5.4
7-8	28	18.8
9 and above	14	9.5

When examining Table 1, it becomes evident that the majority of teachers (66.5%) applied science activities no more than four times a month. Additionally, 24.2% of teachers included 5 to 8 science activities per month, while 9.5% of them conducted 9 or more science activities monthly. On average, the number of science activity applications performed in a month was calculated as 4.42.

Table 2 presents the results of the Independent Samples t-Test, which was conducted to determine whether the teachers' self-efficacy in science activities differs based on the frequency of science activities they perform in a month.

Table 2. Independent Samples t-Test Results of Teachers' Self-Efficacy Based on the Frequency of Involving Science Activities in a Month

Amount of Science Activities	n	$\bar{X}$	Median	Min.	Max.	sd	t	p
4 and below	99	3.92	3.94	2.00	5.00	0.51		
5 and above	50	4.21	4.19	3.19	5.00	0.44	-3.38	0.001*

* $p < .05$

Regarding Table 2, it is seen that preschool teachers' self-efficacy differed significantly according to the number of science activities they perform in a month. Thus, the self-efficacy of teachers who applied five or more activities per month was higher than the self-efficacy of teachers who applied science activities four times a month or less. Therefore, it was revealed that the self-efficacy of teachers who performed science activities on average once a week is lower. Concordantly, it was determined that the self-efficacy of those who performed science activities more than once a week increased.

Table 3 presents the results of the Independent Samples t-Test, which was conducted to investigate the relationship between preschool teachers' self-efficacy in science activities and their professional experience.

Table 3. Independent Samples t-Test Results on Teachers' Self-Efficacy in Science Activities According to Their Professional Experience

Experience (Year)	n	$\bar{X}$	Median	Min.	Max.	sd	t	p

11 and below	72	3.87	3.87	3.00	4.88	0.43		
12 and above	77	4.16	4.25	2.00	5.00	0.53	-3.63	0.000*

* p < .05

According to Table 3, a statistically significant difference was observed in the self-efficacy of teachers in science activities based on their professional experience. It was concluded that teachers with 12 years and more of professional experience had higher self-efficacy compared to teachers with 11 years or less of professional experience.

Table 4 displays the results of the Independent Samples t-Test, which was conducted to assess whether preschool teachers' self-efficacy in science activities differed significantly based on their educational status.

Table 4. Independent Samples t-Test Results on Teachers' Self-Efficacy in Science Activities by Educational Status Independent Samples t-Test Results on Teachers' Self-Efficacy in Science Activities by Educational Status

Educational Status	n	$\overline{X}$	Median	Min.	Max.	Sd	t	p
Bachelor degree	141	3.99	4.00	2.00	5.00	0.50		
Master's degree	8	4.46	4.53	3.50	4.88	0.43	-2.61	0.010*

* p < .05

As observed in Table 4, the self-efficacy of post-graduate preschool teachers is significantly higher than the self-efficacy of undergraduate preschool teachers.

Table 5 provides the results of the Independent Samples t-Test, which aimed to examine whether science motivation, self-confidence, and enjoyment in children differ based on their age.

Table 5. Independent Samples t-Test Results on the Means of Self-Confidence (SC), Enjoyment (E), and Science Motivation (SM) According to Children's Ages (Months)

	Age (Month)	n	$\overline{X}$	Median	Min.	Max.	sd	t	p
SC	65 and below	151	2.87	2.93	1.27	3.87	0.57		
	66 and above	147	2.91	2.93	1.63	3.87	0.53	-0.68	0.495
E	65 and below	151	3.39	3.62	1.69	4.00	0.62		
	66 and above	147	3.55	3.69	1.62	4.00	0.53	-2.44	0.015*
SM	65 and below	151	3.11	3.18	1.68	3.89	0.51		
	66 and above	147	3.21	3.29	1.75	3.93	0.46	-1.76	0.080

* p < .05

According to Table 5, it was found that children's science motivation and self-confidence levels did not differ based on age. However, there was a significant difference in the level of enjoyment depending on age. Specifically, the level of enjoyment among children aged 66-72 months was higher than among children aged 60-65 months.

Table 6. Independent Samples t-Test Results on Children's Self Confidence (SC), Enjoyment (E), and Science Motivation (SM) by Gender

	Gender	n	$\overline{X}$	Median	Min.	Max.	sd	t	p
SC	Girl	149	2.80	2.87	1.27	3.87	0.57		
	Boy	149	2.98	3.07	1.60	3.87	0.52	-2.91	0.004*
E	Girl	149	3.47	3.69	1.69	4.00	0.56		
	Boy	149	3.46	3.69	1.62	4.00	0.60	0.16	0.872
SM	Girl	149	3.11	3.18	1.68	3.93	0.50		
	Boy	149	3.21	3.29	1.82	3.93	0.47	-1.66	0.099

* p < .05

Table 6 presents the results of the Independent Samples t-Test, which was carried out to investigate whether children's self-confidence, enjoyment, and science motivation levels differ based on their gender.

According to Table 6, it was observed that boys' self-confidence levels were significantly higher than girls' self-confidence levels. However, there was no statistically significant difference in the level of enjoyment between girls and boys. Furthermore, although boys' science motivation was higher than that of girls, the difference was not found to be statistically significant.

Table 7 displays the results of the Independent Samples t-Test, which aimed to investigate whether there are differences in the dimensions of children's science motivation, self-confidence, and enjoyment based on the professional experience of the teachers.

Table 7. Independent Samples t-Test Results on Teachers' Professional Experiences and Children's Self-Confidence (SC), Enjoyment (E), and Science Motivation (SM)

	Experience (Year)	n	$\bar{X}$	Median	Min.	Max.	sd	t	p
SC	11 and below	72	2.80	2.80	1.67	3.64	0.41		
	12 and above	77	2.98	3.03	1.54	3.74	0.42	-2.66	0.009*
E	11 and below	72	3.39	3.44	2.39	4.00	0.46		
	12 and above	77	3.54	3.69	2.00	4.00	0.43	-2.10	0.037*
SM	11 and below	72	3.07	3.13	2.22	3.77	0.38		
	12 and above	77	3.24	3.34	1.75	3.79	0.38	-2.72	0.007*

* $p < .05$

As shown in Table 7, statistically significant differences were found between the professional experience of teachers and children's self-confidence, enjoyment, and science motivation. Specifically, it was determined that the self-confidence and enjoyment dimensions, as well as the science motivation of children in the classes of teachers with 12 years or more of professional experience, were higher compared to those with 11 years or less of professional experience.

Table 8 presents the results of the Independent Samples t-Test, which aimed to explore whether children's self-confidence, enjoyment, and science motivation levels differ based on the amount of science activity applied in a month.

Table 8. Independent Samples t-Test Results of Children's Self-Confidence (SC), Enjoyment (E), and Science Motivation (SM) Depending on the Amount of Science Activities Performed During a Month

	Amount of Science Activities	n	$\bar{X}$	Median	Min.	Max.	sd	t	p
SC	4 and below	99	2.80	2.80	1.54	3.64	0.44		
	5 and above	50	3.07	3.10	2.26	3.74	0.33	-3.86	0.000*
E	4 and below	99	3.39	3.46	2.00	4.00	0.46		
	5 and above	50	3.63	3.77	2.39	4.00	0.39	-3.14	0.002*
SM	4 and below	99	3.07	3.09	1.75	3.77	0.04		
	5 and above	50	3.33	3.41	2.33	3.79	0.04	-4.33	0.000*

* $p < .05$

According to Table 8, significant differences were found in children's self-confidence, enjoyment, and science motivation levels based on the number of science activities conducted in a month. It was concluded that the self-confidence and enjoyment dimensions, as well as science motivation of children in classrooms where science activities were performed five times or more per month, were higher than those in classrooms where four or fewer activities were performed.

Table 9 presents the results of the Pearson Correlation Analysis, which was used to examine the relationship between the self-efficacy of preschool teachers and the levels of self-confidence, enjoyment, and science motivation of the children (for girls, boys, and all children) in their classrooms.

Table 9. Pearson Correlation Analysis Results on the Relationship between Teachers' Self-Efficacy (SEF) and Children's Self-Confidence (SC), Enjoyment (E) and Science Motivation (SM)

		SEF	SC	E	SM
Girl	SEF	1	0.402**	0.299**	0.401**
	SC		1		
	E			1	
	SM				1
Boy	SEF	1	0.474**	0.350**	0.486**
	SC		1		
	E			1	
	SM				1
Total (All Children)	SEF	1	0.555**	0.420**	0.555**
	SC		1		
	E			1	
	SM				1

** p < .01

Based on Table 9, the results indicate a positive and significant relationship between teachers' self-efficacy in science activities and children's self-confidence in science for girls, boys, and all children. Furthermore, it was found that there is a positive and significant relationship between teachers' self-efficacy in science activities and children's enjoyment of science for girls, boys, and all children. Finally, it was determined that there is a positive and significant relationship between teachers' self-efficacy in science activities and children's science motivation for girls and boys.

These findings suggest that when preschool teachers have higher self-efficacy in science education, it positively influences children's self-confidence, enjoyment, and motivation in science, regardless of gender.

DISCUSSION AND CONCLUSION

This study explored the relationship between preschool teachers' self-efficacy in science activities and various factors such as their professional experience, educational background, and frequency of science activity practice. The results indicated that teachers' self-efficacy in science activities was positively correlated with their professional experience, educational background, and frequency of science activity practice. These findings align with previous studies by Oppermann, Hummel, and Anders (2021) and Koç and Sak (2017).

However, contrasting results were also found in the literature. For instance, Walan and Chang Rundgren (2014) reported that teachers had significant deficiencies in science education but still had high self-efficacy, mainly due to their extensive professional experience. Other studies by Elmas and Kanmaz (2015), Gerde et al. (2018), Orkunoğlu (2016), Tuncer et al. (2019), Uğraş, Uğraş, et al. Çil (2013), and Ültay, Ültay, and Yılmazer (2019) did not find a significant relationship between preschool teachers' science teaching self-efficacy beliefs and their professional experience. Doğan and Ünüsan (2015) even reported a decrease in science-related practices with an increase in professional experience, attributing it to the avoidance of effective teaching methods in science activities. These discrepancies may be due to the generally high self-efficacy averages among teachers in science education, which may influence the results.

Regarding teachers' self-efficacy in science activities according to their educational status, the study found that teachers with a master's degree had higher self-efficacy than those with a bachelor's degree. While this result is supported by Oppermann, Hummel, and Anders (2021) and Koç and Sak (2017), other studies by Gerde et al. (2018), Oppermann, Hummel, and Anders (2021), and Tuncer et al. (2019) did not find a significant relationship between teachers' self-efficacy in science education and their educational level. It is

worth noting that in all these studies, preschool teachers' self-efficacy averages for science education were generally high, which might contribute to the divergent findings.

Regarding children's science motivation and self-confidence levels based on age, the study did not find any differences, but the level of enjoyment for science increased with age. In contrast, Oppermann, Brunner, Eccles, and Anders (2018) found that older children were more motivated for science. In terms of gender, the study revealed that girls' self-confidence levels towards science were lower than boys', which is consistent with studies by Leibham et al. (2013). However, there were no significant differences in liking for science and science motivations between genders, which aligns with the findings of Oppermann et al. (2018) and Patrick et al. (2008).

A noteworthy finding was the positive relationship between the frequency of applying science activities in preschool and teachers' self-efficacy. Teachers with higher self-efficacy in science education tended to engage in more science activities with children each month. This result supports previous studies on the subject (Gerde et al., 2018; Oppermann et al., 2019; Oppermann et al., 2021). Furthermore, an increase in the frequency of science activities was associated with a significant rise in children's science motivation, while children in classrooms with fewer science activities had lower science motivation. This finding is consistent with studies by Dilek et al. (2020), Mantzicopoulos et al. (2008, 2009, 2013), Oppermann et al. (2018, 2019), and Patrick et al. (2009).

The study also found a positive relationship between teachers' science self-efficacy and children's science motivation. These results align with the research conducted by Oppermann, Brunner, and Anders (2019). Moreover, it was found that girls' motivation for science had a stronger relationship with teachers' self-efficacy, while boys' science-related motivations had a stronger relationship with teachers' activity practices. This highlights the importance of teachers' self-efficacy in science education and their implementation of effective science practices for fostering science motivation in both girls and boys.

In conclusion, science motivation in early childhood is of great importance for future interest in science and a positive attitude towards the subject (Parlakyıldız & Aydın, 2011; Leibham, Alexander & Johnson, 2013; Oppermann, Brunner & Anders, 2019; Dilek et al., 2020). Motivational beliefs are crucial for children's future academic success, and early experiences play a significant role in developing science motivation (Aschbacher, Li, & Roth, 2010; Daniels & Meece, 2007; Wigfield et al., 1997). Preschool teachers play a pivotal role in shaping children's attitudes towards science, fostering their interest, understanding of scientific concepts, and application of scientific processes. Therefore, increasing the motivation of children in the early years is essential for their eagerness to learn and academic development.

Two critical factors defining science motivation are children's self-confidence in scientific subjects and their enjoyment of learning about science (Eccles & Wigfield, 2002). These motivational profiles develop over time through experiences and relate to children's engagement in science activities (Sonnenschein & Munsterman, 2002; Stipek, Feiler, Daniels, & Milburn, 1995; Valeski & Stipek, 2001). Providing children with positive experiences and opportunities in science is crucial for maintaining their interest and confidence in the subject (Lazarides & Watt, 2015; Meece & Daniels, 2007; Wigfield et al., 1997).

In light of the findings, it is evident that science motivation in early childhood is significantly influenced by teachers' self-efficacy and the frequency of science activity implementation in the classroom. Encouraging teachers to have higher self-efficacy in science education and to engage in frequent and effective science activities with children can foster a positive attitude towards science and enhance their motivation for learning in the future. To promote a passion for science, it is crucial to provide children with ample opportunities to explore and discover science in their early years, setting the stage for their future academic success.

Recommendations

Based on the findings of this study, several recommendations can be made to enhance science education in preschool settings:

Professional Development for Teachers: Training programs and workshops should be organized to support the professional development of preschool teachers in the field of science education. These programs can focus on enhancing teachers' self-efficacy in science activities, providing them with effective teaching strategies, and promoting hands-on learning experiences.

Peer Collaboration and Sharing Best Practices: Encouraging collaboration among preschool teachers can facilitate the sharing of best practices in science education. Regular meetings and peer discussions can lead to the exchange of ideas, innovative approaches, and successful teaching methods.

Increase the Frequency of Science Activities: Preschool teachers should be encouraged to incorporate science activities more frequently in their classrooms. Regular engagement in science activities can boost children's interest and motivation in science, contributing to their overall academic development.

Supportive Learning Environment: Creating a supportive and stimulating learning environment is essential for fostering children's interest in science. Providing access to science-related materials, resources, and tools can enrich their learning experiences.

Curriculum Enhancement: Preschool curriculums can be enriched with science-related content and activities. Providing well-structured and age-appropriate science activities can nurture children's curiosity and enthusiasm for scientific exploration.

Teacher-Child Interaction: Encouraging positive teacher-child interactions during science activities can contribute to children's self-confidence and enjoyment of science. Teachers should provide encouragement, praise efforts, and foster a safe space for children to ask questions and explore scientific concepts.

Parental Involvement: Involving parents in science-related activities and initiatives can further reinforce children's motivation for science. Collaborating with parents to promote scientific exploration at home can have a positive impact on children's attitude towards science.

Longitudinal Studies: Conducting longitudinal studies can provide valuable insights into the long-term effects of preschool teachers' self-efficacy in science and its impact on children's science motivation and academic achievements. Longitudinal research can help identify the factors that influence science motivation from early childhood to later educational stages.

In summary, by focusing on enhancing preschool teachers' self-efficacy in science education and providing ample opportunities for science exploration, children's science motivation can be significantly increased. These recommendations can contribute to shaping a generation of curious and enthusiastic learners with a strong foundation in science, setting the stage for their future academic success.

Limitations

Science motivation was not found for all children in teachers' classrooms. Instead, the sample was formed by randomly selecting two children, one girl and one boy, from each class.

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