**Preschool Teachers’ Attitudes towards the Implementation of Science and Technology Studies in Preschool**

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Abstract

This study examines attitudes of Israeli preschool teachers towards the teaching of science and technology (S&T) in preschools in general and towards the Israel Ministry of Education’s S&T program in particular. Ninety preschool teachers responded to an attitudes questionnaire assessing their attitudes regarding teaching S&T to preschool children. We also interviewed eight of these teachers regarding the content, methods, and application of the S&T program in their preschools.

The results show that most of the preschool teachers are engaged in teaching scientific content in the preschool, despite time constraints. All the surveyed teachers expressed positive attitudes towards teaching S&T in preschool, attributed great importance to it, and said it is appropriate for children of that age. However, they admitted that they do not fully apply the official S&T teaching program in their preschools. Further, they teach mainly according to their personal knowledge, rather than the professional program. Many said they lack sufficient knowledge of teaching sciences, and their familiarity with the materials in the S&T program is not satisfactory. They stated that professional development could improve utilization of time and resources, increase cooperation with other educators, and promote positive attitudes towards teaching S&T in preschool. We therefore conclude it is important to promote continuing education for teaching sciences in general and the official S&T program in particular, in order to improve its implementation in preschools in Israel.

Keywords: Preschool teachers’ attitudes, science and technology education, preschool.

Introduction

A program for teaching science and technology (S&T) in preschools was first published by the Israeli Ministry of Education in 2009 and its final version was issued in 2015. The program details the scientific contents and topics to be taught in preschool, and outlines the skills, competencies, attitudes, and values ​​regarding science and the environment to be developed among the children. The program aims to instill thinking and skills regarding scientific research, technological design, solving technological problems, and understanding scientific concepts.

Preschool teachers encounter various difficulties in teaching S&T, including lack of scientific knowledge, lack of self-confidence in teaching scientific content, and time constraints. As a result, they often express dissatisfaction and lack of self-gratification (Spektor-Levy, Kesner-Baruch & Mevarech, 2011). The current study examines attitudes of Israeli preschool teachers towards teaching science in preschool in general, and towards the official S&T program in particular. It assesses whether there is a connection between the teachers’ attitudes and their implementation of the program, and examines the difficulties they expressed regarding the implementation of the S&T program in their preschools.

1. Literature Review

1.1. Teaching S&T in Preschool

The importance of science and technology education for young children is widely agreed upon by educators around the world ([Furtado,](https://www.proquest.com/indexinglinkhandler/sng/au/Furtado,+Leena/$N?accountid=41238" \o "Click to search for more items by this author) 2010; Spektor-Levy, Kesner-Baruch & Mevarech, 2011). Researchers no longer debate how early science education should begin (Gerde, Schachter, & Wasik, 2013) but rather seek the most effective ways to teach it. Currently, S&T education is considered appropriate for young children (Anderson & Gulberg, 2014; Eshach, 2006; Gelman & Brenneman, 2004) and a crucial part of their learning ([Oppermann,](https://www.proquest.com/indexinglinkhandler/sng/au/Oppermann,+Elisa/$N?accountid=41238" \o "Click to search for more items by this author) [Hummel](https://www.proquest.com/indexinglinkhandler/sng/au/Hummel,+Theresia/$N?accountid=41238) & [Anders,](https://www.proquest.com/indexinglinkhandler/sng/au/Anders,+Yvonne/$N?accountid=41238) 2021). Exposing young children to scientific activities contributes to the development of their intelligence and abstract thinking skills (Eshach & Fried, 2005). Young children have the cognitive abilities to understand scientific concepts and can acquire and apply the skills relevant to scientific research processes, such as using research strategies, developing research questions and hypotheses, making observations, conducting experiments, predicting results, summarizing the findings, presenting the results, and drawing conclusions (Eshach, 2006; Eshach & Fried, 2005; Gelman & Brenneman, 2004; Gerde, Schachter, & Wasik, 2013).

Well-designed teaching methods can help young children understand basic scientific concepts pertaining to common phenomena in nature (Eberbach & Crowley, 2009; Kampeza & Ravanis, 2006). Involving preschool children in scientific research processes develops the skills that will enable them to later understand more complex scientific ideas (Eshach & Fried, 2005; Gerde et al., 2013; Plummer, 2014; Roychoudhury, 2014), improves their readiness for school, and develops their interest in and positive attitudes towards science (Eberbach & Crowley, 2009; Hastürk & Özdemir, 2021). Encouraging children’s positive attitudes towards and interest in science, and motivating them to achieve in this field improves the likelihood of their short-term and long-term interest and success in the sciences (Eberbach & Crowley, 2009).

Researchers and educators are seeking ways to improve the teaching of S&T in preschool. In the United States, for example, it has been found that despite the abundance of programs, information, and literature on teaching science in preschools, children living in the U.S. enter elementary school with little knowledge of science and underdeveloped scientific skills, and their readiness in science is weak in comparison to other areas such as math, language and literacy, and the arts (Greenfield, Jirout, Greenberg, Maier, & Fuccillo, 2009).

One of the accepted assumptions in education, relevant to all age levels, is that the children’s knowledge, understanding, skills, and attitudes are greatly influenced by the way they are taught (Andersson & Gullberg, 2011; Spektor-Levy et al., 2014). The difficulties in teaching science in preschool can therefore be attributed to the low efficiency of science educators, lack of educational resources, and scarcity of programs that offer a variety of high-quality scientific experiences to young children (Andersson & Gullberg, 2014).

1.2 Program for Teaching S&T in Preschools in Israel

A program for teaching S&T to preschool children was developed by the Israel Ministry of Education in 2009 and published in 2015-2016. The program defines the learning objectives, contents, skills, and methods for developing children’s knowledge and positive attitudes towards S&T (Israel Ministry of Education, 2013, p. 17). The program’s primary goal is developing literacy in S&T, which includes knowledge of scientific concepts and development of the lower- and higher-order thinking skills, such as those that enable the synthesis and organization of concepts. The program takes into consideration the developmental level of the children, the characteristics of the preschool teachers’ work, and the resources available to them. Since only a few topics can be included in the program, the chosen topics are familiar to children’s everyday lives and their world (Roychoudhury, 2013), such as weather, heavenly bodies, the human body, and the human-made products in our environment. The first topics emphasize science, and the last focuses on technology.

1.3 Preschool Teachers’ Attitudes Regarding Teaching S&T in Preschools

It is important to examine all the factors that influence preschool teachers’ work, since they are the primary educators in the preschool (Spektor-Levy et al., 2011). Positive attitudes towards the field of science in preschool constitute a significant factor influencing the frequency and quality of science teaching in preschool classes (Furtado, 2010; Greenfield et al., 2009; Saçkes, 2014; Spektor-Levy et al., 2011). Children who study with preschool teachers who have positive approaches towards teaching science and who apply quality practices in teaching science have been found to receive higher scores on measures of curiosity, attitudes, knowledge, and scientific abilities, as compared to children who study with preschool teachers who do not engage in quality science education (Spektor-Levy et al., 2011).

In one study, preschool children who completed an inquiry unit for teaching science (N = 65) were found to be more successful on all measures of scientific learning as compared to a control group who did not complete the unit (N = 35). The students who completed the unit were able to discuss the results of their investigation with their peers. They demonstrated greater knowledge of biological concepts related to the specific subject of their study and greater familiarity with scientific concepts such as making a hypothesis, using tools (magnifying glass), making observations and recording them in a notebook, and using empirical evidence to expand and develop their knowledge (Samarapungavan, Mantzicopoulos, & Patrick, 2008).

The attitudes of preschool teachers towards science education are of great importance to their educational practice ([Hastürk](https://www.proquest.com/indexinglinkhandler/sng/au/Hast$fcrk,+Gamze/$N?accountid=41238" \o "Click to search for more items by this author) & [Özdemir,](https://www.proquest.com/indexinglinkhandler/sng/au/$d6zdemir,+Oguzhan/$N?accountid=41238) 2021). The vast majority of preschool teachers express the opinion that one should introduce scientific subjects in early childhood, and say that young children are able to engage in research activities; correspondingly, most preschool teachers report that each week they engage in math and science in preschool (Spektor-Levy et al., 2011). Most science education in preschools focuses on topics relevant to children’s daily lives such as gardening, plants, animals, the seasons, the weather, and sometimes environmental education. Some preschool teachers introduce use of measurement tools and scientific measurement methods.

Studies have found a significant positive relationship between teachers’ attitudes towards and enthusiasm for science and the extent to which they incorporate science topics in preschool: the more importance teachers attribute to scientific activity in preschool, the more they tend to implement such activities (Spektor-Levy et al., 2011). It was also found that effective vocational training and professional development of preschool teachers is related to the development of positive attitudes towards teaching science in preschool and consequently to a greater and more effective engagement of scientific topics in the class (Maier, Greenfield, & Bulotsky-Shearer, 2013; Pendergast, Lieberman-Betz, & Vail, 2017). However, even though in recent years preschool teachers express more confidence and comfort in incorporating scientific activities into their work, and say they better understand the benefits of teaching science to young children than was the case in the past, they continue to indicate feelings of inadequacy and anxiety about their own scientific knowledge and their ability to promote scientific learning among preschool children (Pendergast, Lieberman-Betz, & Vail, 2017).

According to Hastürk and Özdemir (2021), preschool teachers’ positive attitudes towards science education will lead to more effective classroom practices and science teaching. The importance of having positive attitudes towards science among preschool teachers led researchers to examine the links between parameters such as the self-efficacy, beliefs, and perceptions of the preschool teachers regarding their educational practice of science in class (Furtado, 2010; Hastürk & Özdemir, 2021; Oppermann, Hummel & Anders, 2021; Saçkes, 2014; Yagmur-Kolcu, & Öztuna-Kaplan, 2020).

Professional development, availability of science-related instructional materials in the classrooms, and above all the teachers’ perceptions of children’s capacity for learning and the teachers’ belief in their own ability to teach sciences influence the frequency of teaching science subjects (Saçkes, 2014). However, most of them say they feel their knowledge for teaching the subject is inadequate and they are not interested in the field of science (Yagmur-Kolcu & Öztuna-Kaplan, 2020). The consequences are poor science teaching leading to students’ weak knowledge of science. It was found that preschool teachers often include science activities in their programs, but they cannot be creative in designing diverse activities, and they neither know nor question why they conduct such activities (Yagmur-Kolcu & Öztuna-Kaplan, 2020). In addition, it was observed that preschool teachers lack of knowledge in the field of science and this can lead to the development of scientific misconceptions among the students.

Hence, the question arises regarding whether the S&T program in preschools in Israel is being implemented to the required and expected level. In this study, we examine the attitudes of preschool teachers regarding science teaching in general and the implementation of the program for S&T in particular. We asked teachers to suggest ways to promote positive attitudes towards science teaching, and to improve the implementation of science teaching programs in preschool.

The study objectives were:

A. To examine the attitudes of preschool teachers towards teaching S&T in preschools

B. To examine what the preschool teachers report on their implementation of the S&T program in the preschool.

The research questions were:

A. What are the attitudes of preschool teachers towards teaching S&T in preschool in terms of the importance of the program, their confidence in applying it, and the actual implementation?

B. What do the preschool teachers report regarding the extent to which they are familiar with the S&T program and how they implement it?

C. What are the difficulties in implementing the S&T program as expressed by the preschool teachers?

2. Methodology

2.1. Study Population

The study population included 90 teachers in preschools for ages 3-6. Most of the teachers worked in the southern region of Israel. Most of them (85.7%) worked in the secular-state educational system, and the rest worked in the religious-state educational system. About two-thirds (63%) of the preschool teachers had a teaching certificate and a bachelor’s degree, and the others had a master’s degree. About 74% worked in the country’s geo-social peripheral regions, and about a quarter (26%) in preschools in urban areas. Their years of experience ranged from five years to over twenty years. Of the preschool teachers who participated in the first part of the study, eight agreed to be interviewed in the second part.

2.2. Research Methods, Tools and Procedure

The study combined quantitative and qualitative methodologies. The attitudes of the teachers were examined in two stages. In the first stage, preschool teachers answered an online questionnaire (Table 1) with 31 statements regarding teaching S&T in the preschool. We translated the questionnaire developed by Maier et al. (2013) into Hebrew and adapted it for preschool teachers in Israel. The internal reliability of the questionnaire was very good (Cronbach’s alpha **=** 0.91). The surveyed teachers were asked to indicate the degree of their agreement with each of the 31 statements according to a 4-point Likert scale in which 1= strongly disagree, 2 = slightly agree, 3 = strongly agree, and 4 = strongly agree.

In the second phase of the study, we conducted semi-structured personal interviews with eight of the preschool teachers who had completed the questionnaire. The interviews lasted about 30-45 minutes. The interview, developed by Israeli researchers (Spektor-Levy et al., 2011), examined the preschool teachers’ attitudes regarding their application of S&T program, including scientific content, teaching methods and activities. To the original questionnaire, we added questions regarding the frequency of scientific activities in the preschool, the learning environment, scientific equipment used, familiarity with the scientific educational materials used, implementation of the program goals, and difficulties arising while teaching the program.

Table 1: S&T Education Questionnaire Statements with Means and Standard Deviations

|  |  |  |  |
| --- | --- | --- | --- |
|  |  | **Mean** | **Standard**  **Deviation** |
| 1 | Science activities in early childhood stimulate children’s interest in science at a later age. | 3.69 | .512 |
| 2 | I feel confident planning and demonstrating in-class activities related to the physical sciences and energy, such as gravity and physical states (solid, liquid and gas). | 3.09 | .944 |
| 3 | Scientific topics should be introduced at an early age. | 3.80 | .429 |
| 4 | The time devoted to studying science is inadequate, due to other requirements. | 2.84 | .947 |
| 5 | Children learn best through practical experience with physical objects and materials. | 3.91 | .286 |
| 6 | Science-related activities improve approaches to learning in early childhood learning. | 3.51 | .640 |
| 7 | I discuss ideas and topics related to studying science with other teachers. | 2.43 | .960 |
| 8 | I use all types of materials in scientific activities, for example toys and containers. | 3.20 | .864 |
| 9 | Preparing to teach science takes longer than preparing to teach other fields. | 2.57 | .912 |
| 10 | I use books to get ideas for science activities for young children. | 2.92 | .951 |
| 11 | I feel confident doing scientific activities in my preschool. | 3.29 | .811 |
| 12 | I feel confident planning and demonstrating in-class activities related to biology (e.g., living things, plants, animals). | 3.07 | .946 |
| 13 | Science-related activities in early childhood improve children’s math skills. | 3.23 | .875 |
| 14 | Early childhood science-related activities improve children’s language skills. | 3.48 | .674 |
| 15 | I do not have enough scientific knowledge to teach science to young children. | 2.89 | .953 |
| 16 | I do not feel confident talking to children about scientific methods (e.g., hypothesizing, predicting test results, conducting an experiment). | 3.58 | .793 |
| 17 | I use the internet to find ideas for science activities for young children. | 3.47 | .810 |
| 18 | Young children cannot learn science until they learn to read. | 1.07 | .361 |
| 19 | I get ideas for science activities from what the children do, say, and want. | 3.21 | .786 |
| 20 | Science-related activities are too difficult for children in preschool. | 3.67 | .636 |
| 21 | I include sections from science books during story time in preschool. | 2.07 | .922 |
| 22 | Science-related activities in early childhood improve children’s social skills. | 2.97 | .841 |
| 23 | I enjoy doing science-based activities with the preschool children. | 3.32 | .805 |
| 24 | I’m afraid that children might ask a question about scientific phenomena or principles that I cannot answer. | 3.28 | .948 |
| 25 | I demonstrate scientific processes (e.g., comparing objects to see if they will float or sink in water). | 3.61 | .575 |
| 26 | Designing and conducting scientific activities is a difficult task. | 3.02 | .874 |
| 27 | Young children are curious about scientific principles and phenomena. | 3.73 | .536 |
| 28 | I do not have enough materials for teaching science. | 3.01 | 1.011 |
| 29 | I try to incorporate scientific activities every day. | 2.31 | 1.013 |
| 30 | I feel confident planning and presenting to the class activities related to Earth sciences (e.g., Sun, Moon, stars and weather). | 2.97 | .965 |
| 31 | I collect materials and objects to use in teaching science. | 3.03 | .880 |

2.3 Analysis of the Findings

The 31 statements were grouped into four categories, which were found to be reliable via a factor analysis using the varimax method with orthogonal rotation, as shown in Table 2. Seven statements refer to the preschool teachers’ attitudes regarding the importance of teaching science to preschool children. Fourteen statements refer to the teachers’ confidence in teaching science. Nine statements refer to the teachers’ implementation of science-based activities in preschool. Seven statements refer to the preschool teachers’ attitudes regarding difficulties and challenges in teaching science in preschool. This categorization differs from the three-category arrangement of the original questionnaire (Maier et al., 2013) in that an additional category was added pertaining to preschool teachers’ attitudes regarding their implementation of scientific activities. Four statements were omitted from the original questionnaire due to low Cronbach’s alpha values. Cronbach’s alpha values ​​for each category are shown in Table 2.

The quantitative analysis examined the link between the preschool teachers’ reported attitudes towards teaching science and their attitudes regarding the practical implementation of science teaching. A t-test was performed to compare averages in two independent samples in order to examine whether and how the preschool teachers’ background data (education, position in the preschool, age, locality of the preschool) affects their attitudes towards importance of teaching science in preschool. A Pearson test was conducted to examine the relationship between the four categories of the questionnaire.

The data obtained from the semi-structured personal interviews were processed through content analysis. We performed a categorical analysis using a sorting process in which data belonging to the same phenomenon were combined to create content units, which are statements from the analyzed content. The product of the analysis is thematic categories. In the first stage, a preliminary analysis was conducted by selecting statements by the preschool teachers that relate to the research questions. Subsequently, the data were divided according to criteria and the initial categories were reduced to categories identified as core categories. In the final step, we conducted a mapping analysis that revealed links between the categories. After the mapping analysis, a new order of categories was created:

1. Preschool teachers’ attitudes towards the importance of the S&T education program in preschools.
2. The teachers’ level of confidence in teaching science in preschool.
3. The teachers’ description of their implementation of science-based activities and the S&T program in preschools.
4. Difficulties the teachers described regarding implementation of the S&T program.

3.Results

3.1. Preschool Teachers’ Attitudes towards Teaching S&T in Preschool

A summary of the preschool teachers’ attitudes towards engaging in science in the preschool appears in Table 2.

Table 2: Reliability and Distribution of Continuous Variables in the Sample Population (N = 90).

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Variable** | **Number of statements** | **M** | **SD** | **Cronbach’s α** |
| General average in the questionnaire | 31 | 3.07 | 0.35 | 0.88 |
| Importance of teaching S&T in preschools | 7 | 3.49 | 0.41 | 0.74 |
| Teachers’ level of confidence in teaching science in preschool | 7 | 3.14 | 0.60 | 0.82 |
| Teachers’ implementation of science-based activities in preschool | 8 | 2.99 | 0.53 | 0.77 |
| Teachers’ difficulties in teaching science in preschool | 9 | 2.77 | 0.24 | 0.46 |

The highest score is for the category “Importance of teaching S&T in preschool” (3.49), reflecting responses by the preschool teachers indicating that they find science teaching to be important and appropriate for young children, and that it can also improve their mathematical and language skills. All the preschool teachers agreed that they should start addressing scientific topics from an early age, that studying science in preschool is extremely important, and that it contributes to the children’s long-term development. The category “Teachers’ sense of confidence teaching science in preschool” (Table 2, line 3) assessed the assumption that teachers’ feeling of confidence in teaching science has an impact on their implementation of science-based activities in preschool; that is, that teachers who feel more confident teaching science will be more likely to implement activities in this field, leading their students to be more interested and develop greater curiosity in the field of science. In this category, the average score was 3.14, showing that most preschool teachers feel confident teaching science. Most of the surveyed teachers (over 80%) reported that they enjoy engaging in science education and feel confident conducting various scientific activities in the preschool. Over 70% of the surveyed teachers said they feel confident planning and demonstrating activities and processes related to the fields of physics and biology. The average scores for the items related to using science books in their teaching and sharing science education practices with other teachers were relatively low (close to 2.00), indicating that the teachers less frequently engage in these activities.

For the group of statements included in the category “Teachers’ implementation of science-based activities in preschool,” an average score of 2.99 was obtained (Table No. 2, line 4), indicating most of the surveyed preschool teachers say they are engaged in scientific activities in the preschool. Most (79%) said they receive ideas for practical activities from the children’s own actions and words, or online. The vast majority (97%) said they demonstrate physical processes to children. At the same time, the scientific activity in the preschool is limited. For example a considerable percentage of the preschool teachers (58%) said they do not make an effort to include scientific activities every day and do not integrate (80%) sections from scientific books during story time in the classroom.

The category “Teachers’ difficulties in teaching science in preschool” (Table No. 2, line 5) shows a relatively low average of2.77, apparently indicating that the teachers do not think they face difficulties in teaching science in preschool. However, closer inspection of each statement individually reveals significant heterogeneity in attitudes towards difficulties in dealing with challenges, and the Cronbach’s alpha for this category is low. While some preschooler teachers said they are able to overcome the challenges, others said they find it difficult to cope with the challenges of teaching science in preschool. For example, a significant proportion of the surveyed preschool teachers (61.5%) agreed or strongly agreed that the time devoted to studying science is insufficient due to other teaching requirements. In fact, the main problem that the preschool teachers repeatedly raised was the lack of time resources; most said they cannot devote adequate time to teaching science in preschool. About 44.2% said that preparing for science teaching takes longer than for other fields. Even if about two-thirds (67.4%) said that they have sufficient scientific knowledge, the remaining third (32.6%) said that their scientific knowledge is not sufficient to teach science in preschool. Moreover, although more than half of the surveyed teachers said that they were not afraid that they would not be able to answer the children’s questions about phenomena or scientific principles, over a quarter (28%) said they definitely faced this fear.

In the comparison test using a t-test between the background variables of the preschool teachers, (their years of experience, education, their age, age of their students, and the type of locality in which the preschool where they teach is located), and the preschool teachers’ attitudes, we found no significant differences.

In the Pearson test (Table 3) that examined correlation between categories, significant positive correlations of low to high intensity were found between each of the categories of the questionnaire items, and all the other categories:

A positive correlation was found between the importance that teachers attribute to teaching science in preschool and their confidence in teaching sciences (0.470). An even stronger correlation was found between the perceived importance of teaching science and teachers’ implementation of science-based activities (0.608). The more importance that teachers attribute to science education, the more likely they are to say that they feel confident doing so, and in fact implement this type of learning. A relatively high positive correlation was found between the teachers’ level of confidence in teaching science in preschool and their actual implementation of science-based activities (0.730).

A negative correlation was found between the teachers’ level of confidence and perceived difficulties in teaching science in preschool (greater difficulty is associated with a lower feeling of confidence in teaching science). Negative correlations were found between the teachers’ difficulty in dealing with the challenges of teaching science and the importance that they attribute to teaching this subject. The implementation of science-based activities and the importance that the teacher attributes to the subject both decreased as the teachers’ perceived difficulties in teaching science in preschool increased.

Table 3: Pearson’s Correlations Between the Four Study Variables (Importance, Confidence, Implementation, and Difficulties)

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | Importance of teaching science in preschool | Teachers’ level of confidence teaching science in preschool | Implementation of science-based activities in preschool | Teachers’ difficulties in teaching science in preschool |
| Importance of teaching science in preschool | 1 | .470\*\* | .608\*\* | .237\* |
| Teachers’ level of confidence teaching science in preschool |  | 1 | .730\*\* | .366\*\* |
| Implementation of science-based activities in preschool |  |  | 1 | .273\*\* |
| Teachers’ difficulties in teaching science in preschool |  |  |  | 1 |

\* p < 0.05, \*\* p < 0.01 (two-tailed)

Table 4: Correlations between Categories of Teachers’ Attitudes (N = 42); Level of Significance is 0.01



|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | Importance of teaching science in preschool | Teachers’ level of confidence teaching science in preschool | Implementation of science-based activities in preschool | Teachers’ difficulties in teaching science in preschool |
| Importance of teaching science in preschool | 1 | 0.542 | 0.579 | 0.412- |
| Teachers’ level of confidence teaching science in preschool | 0.542 | 1 | 0.954 | 0.570- |
| Implementation of science-based activities in preschool | 0.579 | 0.954 | 1 | 0.485- |
| Teachers’ difficulties in teaching science in preschool | 0.412- | 0.570- | 0.485- | 1 |



In order to examine the hypothesis that differences will be found among the categories of questionnaire items among the first and second groups of preschool teachers, t-tests were performed on independent samples for each of the categories of questionnaire items. No differences were found between the averages of the two groups for any of the questionnaire categories: Importance of teaching science in preschool (t(88) = .12, p = .900); teachers’ level of confidence teaching science in preschool (t(88) = .007, p = .995); teachers’ implementation of science-based activities in preschool (t(88) = .48, p = .633); and teachers’ difficulties in teaching science in preschool (t(88) = .55, p = .580). The results of this analysis are shown in Table 5. For each comparison, critical t-values and degrees of freedom are presented.

Table 5. Means and Standard Deviations for the Four Categories of Questionnaire Items, according to the Division of Study Population; Group 1 (N = 42) Group 2 (N = 48) t-test (independent)

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | M  group 1  N = 42 | SD  group 1 | M  group 2  N = 48 | SD  group 2 | Degree of Freedom | t-value |
| Importance of teaching science in preschool | 3.49 | 0.39 | 3.48 | 0.43 | 88 | .12 |
| Teachers’ level of confidence teaching science in preschool | 3.14 | 0.62 | 3.14 | 0.58 | 88 | .01 |
| Teachers’ implementation of science-based activities in preschool | 2.96 | 0.56 | 3.02 | 0.51 | 88 | .48 |
| Teachers’ difficulties in teaching science in preschool |  | 0.22 | 2.78 | 0.27 | 88 | .58 |

\* p < 0.05, \*\* p < 0.01 (two-tailed)

The Teachers’ Familiarity with the TOHL in the S&T and its goals

In the second part of the study, we interviewed eight preschool teachers in order to examine their attitudes and experiences regarding the S&T program, as expressed in their own words. The questionnaire used in the first part of the study did not address the official program specifically. The first five questions interview questions dealt with the general teaching of S&T in preschool, followed by five questions pertaining to the official program and the preschool teachers’ implementation of it (see Appendix 1). When the teachers were asked the extent to which they were familiar with the Ministry of Education’s S&T program, all responded that they knew about it, but only a minority said they were familiar with it to a great extent and used it to plan their teaching curriculum.

The teachers’ primary use of the published S&T program pertained to the selection of the designated learning contents and skills. Most of the interviewed teachers reported a low degree of familiarity with the program, saying, for example: “I read the program, but it was a long time ago“ “I know less about the program itself“ (3), “I know it in general“ (4), “I know it somewhat” (5), “Yes, more or less“ (7), and “I do not really know the program, I have not seen it yet” (8).

The preschool teachers said they use the program little or not at all. In their opinion, working with the published document does not help while teaching because “the program is not clear and not detailed enough“ (5) and “If I knew the plan better, then I would probably use it more“ (5). The preschool teachers stated that they did not know the goals of the program well, and three out of eight said they did not know the goals at all. Some teachers said they knew some of the goals and even implement them, but as one teacher said: “Some I do not apply, or not enough. For example, I do not know what should be taught according to the astronomy curriculum,“ (4).

The interviewed teachers attributed great importance to the application of the program in preschools and stated that the program should definitely be implemented, defining it as “an important program, a good program that can help the teacher in her work“ (4), “It should be implemented both at young ages and later. The program addresses important topics like scientific language, phenomena ... “ (6), “It’s good to have a plan. The program gives ideas and can help. Obviously, it needs to be implemented“ (3).

This is in line with the results from the first part of the study, in which it was found that all the preschool teachers expressed a positive attitude in favor of teaching science in preschool. Even if a minority of preschool teachers expressed some doubts about the program, they still considered it important and added that “the program is good. The program should be implemented intelligently and regularly“ (1), “The program should be well known and implemented“ (7) or “It probably should be applied“ (5).

Analysis of the interviews shows that all the preschool teachers were engaged in teaching scientific content in the preschool, even if not according to the program. Four reported that they deal with scientific content on all three topics listed in the program, while the four other teachers reported that they address only two of the three topics.

3.3. Frequency of Science-based Activities in Preschool

Four of the interviewed preschool teachers reported that they engage every day in some science-based activity in the preschool; for example one said with great enthusiasm that she does so “each and every day.” Science-based activities are done in the classroom, the school courtyard, on field trips, and even at home. As one preschool teacher proudly said, the children “bring from home things that are related to the teaching“ (7). Several said that the parents share with them the children’s interest in science and continued learning at home. The teachers stated that they also combine mathematics, literacy, and sustainability/environmental education in the teaching of science. Some had difficulty defining the frequency of science-based educational activities in their preschool. Two said they conduct science-based activities twice a week and two others said they do so twice a month. Some said they think they do not spend enough time teaching science: “It’s not enough, not to the extent I would like” (5), “Not the frequency I would like it to be” (8), and “No time. I have birthdays and other parties, there is not time for everything” (4).

3.4 Methods of Teaching Science in Preschool

All of the interviewed teachers said that they use various methods for teaching science, such as learning by doing practical science-based activities, problem-solving, and research activities. For example: “Extraction of olive oil was a very interesting experience. I brought them olives. They crushed them, felt the oil ...” (7). Or: “Snails: That’s something that really interests them. We gave the snails food. At the end of the day we cleaned their container. The children were involved in the whole process. We checked what they ate and what they did not eat ...” (5). “Sometimes we do group experiments as well. This is how we did the evaporation experiment using a kettle” (1).

Most said they often teach using verbal lessons, even though they agree that this method is sometimes less appropriate for preschool children. They do this due to lack of time and limited ability to teach individually. As one teacher described: “There are a lot of activities I have to do during the day. I do not have enough time to do so much in groups” (2). Another teacher expressed concern and frustration that she could not always use teaching methods that she thought were appropriate for science-based activities: “I have about an hour each day that I can do this [teach science]. I try to work in small groups ... If I teach the whole class ... the science activity loses ... all its value... especially where there are two age groups. The younger ones are ... not sitting still. On the other hand, the older students, it is clear that they understand. I should do the scientific activity only with them. In the end everything is squandered and it’s a pity ... every time I try, but that’s the way it is“ (6). “In the sciences, I do not know how to build it gradually. Where do I start? How should I continue? I do use tools, but what is better to start with? What is the order? Maybe it is not worth it at all” (8).

3.5. Teachers’ Difficulties in Implementing the Science Curriculum

An analysis of the interviews shows that there are a number of factors that make it difficult to implement the S&T program. The interviewed teachers reported six main factors: a) workload and time constraints, b) lack of staff and assistance for teaching science, c) lack of knowledge and skills to teach science to young children, d) lack of teaching materials adapted to and appropriate for the level of a preschool child, e) lack of familiarity with the program.

Quotes for each category include:

a) **Workload and lack of time**: The preschool teachers said that they cannot devote enough time to teaching science: “I do not always have time ... there are many activities I have to do during the day. I do not have enough time to do so much in groups” (2). “I have birthdays and other parties, there is no time for everything.” (4) “I do engage in science, but not enough, not to the extent I would like. There are a lot of plans, a lot of demands. Not enough time to do everything” (5). “I am so busy…” (7).

b) **Lack of staff and assistance for teaching science**. The teaches complained that they do not receive sufficient assistance in teaching S&T: “Who will help me? An assistant would help“ (2), ”Sometimes parents cooperate .... Besides, my assistant helps me in the process ... otherwise I have no help“ (4). “Lack of staff “ (7). “We have no one, no related classes, nothing“ (5). “Every day I am alone” (8).

c) **Lack of knowledge and skills to teach science to young children**: “I have never undergone advanced training. In mathematics yes, but in science - no. The truth is, I really want … practical training” (2). “In science I do not know how to build [the program]. Where to start? How to proceed? What is the order? … What process does the child go through in building this knowledge? I do not know where to start, what comes next…” (8). “I lack knowledge and tools. I use my intuition” (5). “I don’t know, mostly what comes up. It’s not planned” (1).

d) **Lack of teaching materials adapted to and appropriate for the level of a preschool child**: “We have test tubes that I brought from some factory. I have a magnifying glass, a terrarium like this, an aquarium. What else do I have? That’s it” (3). “I have nothing. A magnifying glass. (Laughs). I really have nothing” (8). “The truth is I don’t have that much scientific equipment. I don’t have any kit. I try to improvise every time. I don’t have scales. I have magnifying glasses. I don’t have binoculars ... I don’t have a budget” (7).

e) **Lack of familiarity with the program**: “I am less familiar with the program itself. I have been exposed to many programs, apart from that of the Ministry of Education” (3).

Each of the preschool teachers talked about at least one of the above six factors that cause difficulties in their ability to teach science. All eight of the teachers said that they have not undergone any training in science education in the last five years.

3.6 Preschool Teachers’ Attitudes towards Teaching Science and Implementation of the Program.

All the preschool teachers who spoke about their positive attitude towards science also spoke about their enthusiasm and desire for conducting science-based educational activities in their classrooms. Yet their words indicate there is a gap between this desire for teaching science and their actual implementation of an S&T educational program.

The teachers expressed positive attitudes towards science, such as: “Science is one of my favorite fields. Through science you can teach a whole world and impart knowledge to children in all fields. It is a really deep experience because children deal with something real, tangible. I introduce science in almost each of my educational activities... through connecting to the animal and plant world, the children develop. Both in terms of cognition and in terms of sensitivity to nature. They learn important things, perhaps the most important things to know” (7). Another teacher said: “I strongly believe that science education should be practiced ... I saw how happy they are to do all the processes. To experience it. It is very important. I know how significant it is for children ...” (6).

The results obtained from the quantitative analysis show that there is a correlation between the preschool teachers’ attitudes towards teaching science in preschool and the application of scientific activities, meaning that preschool teachers with positive attitudes towards science teaching indeed reported that they conducted more science lessons in class. Expressing confidence teaching science was strongly linked to actually implementing some sort of science teaching. But implementation of the program itself is different. Five of the interviewed teachers expressed a positive attitude towards the implementation of the S&T curriculum in preschools. They defined the program as “an important program, a good program that can help the teacher in her work” (4). “It should be implemented both at young ages and later. The program addresses important topics like scientific language, phenomena ... it was wisely developed” (6). “It’s good to have a plan. The program gives ideas and can help. Obviously, it needs to be implemented” (3).

In contrast, three teachers expressed their positive attitude with some reservations, adding that “The plan is good. The plan should be implemented intelligently” (1), “One should be familiar with the plan. It is worth incorporating in class” (7), “Apply that parts that are relevant to children” (7) or “We probably need to apply it” (5). The teachers explained that “the plan is too general, not clear and detailed enough” (8).

We also found that even preschool teachers who have strongly positive attitudes toward science education say that they do not implement the program to the extent that they wished. Those teachers spoke of teaching science in their classes at least several times a week, but not according to the S&T program. Examples: “... do not know exactly, but certainly implement something”, (4), “I do not know. Maybe yes, intuitively” (8). “ I still try to bring in the matter of the sciences, because I think it’s very important. I’m sure I will continue to do ... If it was up to me, I would be more engaged ... In my class, I would do it all the time” (6). “The majority is not what the Ministry of Education wanted me to do“ (1). “I include science in every subject ... it’s in my head all the time ... I was not really able to teach according to what was written in the booklets ... but I am aware of things ... I might fulfill the intention” (7).

4**.** Discussion and Recommendations

In this study, the attitudes of preschool teachers in relation to three main issues were examined: a. the importance of teaching science in preschool b. application of Israel Ministry of Education’s S&T program in their class, and c. teachers’ difficulties in implementing science teaching in general and the S&T program in particular.

The results indicate that the basic attitude of preschool teachers towards teaching science in preschool is positive. They say it is important to teach science in early childhood. These results are consistent with the results of previous studies examining preschool teachers’ attitudes toward teaching science in preschool, which also found that most preschool teachers say that science education should begin in early childhood, that young children can perform science-based activities, and that science education has a long-term positive impact on children’s later access to the field of science (Hastürk & Özdemir, 2021; Spektor-Levy et al., 2011).

This study found positive correlations between the attitudes of preschool teachers regarding the importance of teaching science to young children and their confidence in engaging in this teaching, as well as their implementation of science-based activities. This means that the more positive attitudes teachers have about the importance of teaching science in preschool, the more comfortable and confident they are in doing so, and the more likely they were to actually implement the teaching of science in preschool. Additionally, we found negative correlations between the level of difficulty the preschool teachers said they have in dealing with the challenges of science teaching in preschool and the importance they see in teaching science and the application of teaching. That is, the more difficult preschool teachers find the challenges of science teaching, the less important they consider it, and the less likely they are to implement science-based activities in their lessons. Although preschool teachers feel a great responsibility to meet the children’s needs (Maier, Greenfield, & Bulotsky-Shearer, 2013), and say it is important to teach science in preschool, the extent to which teachers act on these attitudes is influenced by their personal level of confidence in teaching this subject and the difficulties they face in teaching science (Saçkes, 2014).

The results of the study reveal a complex picture regarding science teaching in preschool. Most teachers include science activities in theirteaching and say that they must have adequate knowledge of the chosen field and the pedagogical skills necessary to teach scientific content and ideas to young children (Andersson & Gullberg, 2014; Thulin & Redfors, 2017). However, about a quarter of them said they worry that they will not know how to answer children’s questions about scientific phenomena or principles, and about a third of them do not feel confident in planning and presenting science-related activities in class. These teachers said they lack training or sufficient knowledge in science teaching and as a result, they experience a lack of confidence, discomfort, stress, or fear in teaching certain science content. These results are also consistent with previous studies (Greenfield et al., 2009; Spektor-Levy et al., 2011; Yagmur-Kolcu & Öztuna-Kaplan, 2020) showing that even teachers who are strongly supportive of early childhood science education may feel they have insufficient scientific and pedagogic knowledge. The result is that children finish preschool with a lower level of knowledge about scientific subjects than desired.

According to the teachers, they ~~do not~~ implement scientific activities such as demonstrating experiments and research activities, as Spektor-Levy (2013) also describes. At the same time, teachers choose the content and methods of teaching science intuitively, based on their knowledge and personal experience, not based on the program or its goals. In fact, only a small part of the official program is implemented in the preschools. All the surveyed teachers said that they teach scientific content, and most said they follow the spirit of the S&T program and sometimes use the teaching methods described in it. However, they are aware that they sometimes use less appropriate teaching methods due to lack of time and inability to reach each child individually. This is due to the low self-efficacy of the preschool teacher (Greenfield et al., 2009; Oppermann et al., 2021) and the multiple requirements placed on them.

The personal interviews gave the teachers the opportunity to detail difficulties that may prevent them from applying the S&T program. One of these is lack of familiarity with the Ministry of Education’s program. Even if the teachers know about the program, they do not know its goals and content, so they do not implement it as they do with curricula for mathematics, language, arts, and current events. The lack of knowledge of the S&T program indicates the teachers consider it a lower priority and have an ambivalent attitude towards the official program. In order for preschool teachers to be familiar with the program, the supervisory bodies must increase awareness of it, and ensure appropriate training and professional development for preschool teachers to promote its implementation.

Another notable difficulty is the lack of time allocated by the teachers to science lessons. Similar results have been obtained in previous research (Greenfield et al., 2009), indicating that a work overload is a consistent challenge. There is often a conflict between the need to carry out activities planned in the preschool curriculum and the desire to address current events and unpredictable features common to life in a preschool life ( ).

It has been found that in order to develop research skills and problem-solving abilities among young children, a long-term time investment is required (Visone, 2009). Preschool teachers must adapt the activities to the age and developmental level of all the children in their classes. Teachers often have difficulty achieving everything required of them. Similarly, preschool teachers in the U.S. (Greenfield et al., 2009) reported low self-efficacy in science teaching and difficulty finding time to teach science, due to the burden placed on them in all subject areas. The tuhal in MOT does not refer to the amount of time or frequency required for teaching science in preschool and the teacher must determine both. It is possible that a dictated minimum time and frequency of activities could help teachers in planning the overall curriculum for the preschool, and the teaching of the sciences in particular.

The surveyed preschool teachers reported having little knowledge in the field of science in terms of content, and feel they lack skills for teaching science to young children. The results are consistent with the findings of others (Spektor-Levy et al., 2011; Yagmur-Kolcu & Öztuna-Kaplan, 2020) which indicate that only a minority of teachers feel confident about their personal knowledge in the sciences. The preschool teachers said they did not receive proper training during their studies, or afterwards. They asserted that effective professional development would lead to a significant improvement in their sense of confidence in teaching science, reflecting the findings of previous research indicating that professional training in science greatly advanced science teaching in preschools (Furtado, 2010; Greenfield et al., 2009; Piasta et al., 2015; Spektor-Levy et al., 2011; Visone, 2009). Such advanced training provides teachers with the confidence, knowledge, and principles that are necessary for them to teach science and perform science experiments in preschools in a way that is appropriate to children of that age (Andersson & Gullberg, 2014). Professional training can also promote cooperation with other educators and thus overcome another difficulty noted by the surveyed teachers.

Another problem expressed by the surveyed teachers is the lack of teaching materials and equipment for scientific research. They said that they often use non-scientific tools to teach these lessons. It may be that strengthening teachers’ positive attitudes toward science teaching, as part of their training process will encourage them to devote more resources to purchasing scientific aids and equipment. The preschool teachers asked for greater exposure to the Department of Education’s national publications and to meet professional trainers for scientific work in the preschool, in order to establish a more positive attitude towards teaching science.

One of the limitations of this study is that it is conducted among a small sample of preschool teachers teaching in the south of the country.

In conclusion, this study shows a gap between the desire of preschool teachers to teach science and their recognition of the importance of the field on the one hand, and the way in which this is manifest in their work in the classrooms. The factors that create this gap must be reduced so that the positions stated by the preschool teachers do not remain mere words.

The main recommendations arising from this study regarding the promotion and application of S&T program in preschools are as follows:

First, extensive training should be conducted for preschool teachers in order to explain the contents and goals of the Ministry of Education’s S&T program in specific and the field of science in general. Second, the staff in the Ministry of Education should be updated in order to address recommended schedules and integration of the S&T program with other core programs in the preschool. Third, preschool teachers should be provided with appropriate teaching materials and equipment for conducting scientific research activities, as required by the program. Fourth, networks for professional advancement and social support of preschool teachers should be established, through which professional training will be held on scientific education and other topics. Networks of this type will promote teaching in preschools in general and science teaching in particular. Such improvement will benefit the preschool children -- the next generation of citizens.

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Appendix 1

Questions for personal interviews

Personal details (name, seniority, education, details of the preschool)

1. What scientific content have you taught in preschool in recent years?

2. Please give details and descriptions of the teaching methods and procedures that you use in teaching scientific content.

3. Describe in detail the learning environment in your classroom and what kind of scientific equipment it has.

4. Who are your educational partners in the classroom environment?

5. What is the average frequency of scientific activities in your preschool during the year?

6. Are you familiar with the S&T program for preschools?

7. Are you familiar with the goals of the program?

8. What do you think about tuhal in the preschool?

9. Do you think that the tuhal should be applied in the preschool?

10. What are your main difficulties in applying a tuhal in your preschool?