Attitudes and beliefs of Greek preschool teachers on the teaching of Science

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Abstract

Introducing science activities in early childhood is very important for children's scientific development. Young children will need teachers who feel competent to teach science. This study explores teachers' attitudes and beliefs about teaching science and the relationship between teachers' qualifications and their attitudes and beliefs about science. The investigation was conducted using the specialized questionnaire P-TABS and the sample consisted of 269 Greek preschool teachers. The results showed that the teachers who participated in the survey have generally positive attitudes and a high level of self-efficacy beliefs, which are influenced by the number of science/science education courses they have taken during their undergraduate studies and their professional development (postgraduate studies, science education training programs). These results largely confirm the results of similar international studies and offer evidence to support the hypothesis that current teachers display improved attitudes and self-efficacy beliefs compared to their colleagues twenty years ago.

Keywords

Attitudes and self-efficacy beliefs, science teaching, early childhood teachers, P-TABS

Résumé

L'introduction d'activités scientifiques dans la petite enfance est très importante pour le développement scientifique des enfants. Les jeunes enfants auront besoin d'enseignants qui se sentent compétents pour enseigner les sciences. Cette étude explore les attitudes et les croyances des enseignants à l'égard de l'enseignement des sciences et la relation entre les qualifications des enseignants et leurs attitudes et croyances à l'égard des sciences. La recherche a été menée à l'aide du questionnaire spécialisé P-TABS et l'échantillon était composé de 269 enseignants grecs du préscolaire. Les résultats ont montré que les enseignants qui ont participé à l'enquête ont généralement des attitudes positives et un niveau élevé de croyances en l'efficacité personnelle, qui sont influencées par le nombre de cours de sciences/éducation scientifique qu'ils ont suivis au cours de leurs études de premier cycle ainsi que par leur développement professionnel (études de troisième cycle, programmes de formation à l'enseignement des sciences). Ces résultats confirment largement ceux d'études internationales similaires et apportent des preuves à l'appui de l'hypothèse selon laquelle les enseignants actuels affichent de meilleures attitudes et croyances en l'efficacité personnelle par rapport à leurs collègues d'il y a vingt ans.

Mots clés

Attitudes et croyances en l'efficacité personnelle, enseignement des sciences, enseignants au niveau préscolaire, P-TABS

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Introduction

Children's exploration of the natural world is a way to satisfy their innate curiosity. By acting in the family and school environment, they gain experience and their initial conceptions of the world around them. Children's interest in exploring the natural world has received increasing attention in recent years from supranational organizations and national educational systems, while it has also raised awareness within the educational community of higher education, both internationally and in Greece, towards the education and training of preschool teachers in natural sciences (Boilevin et al., 2022; Fleer, 2015; Koliopoulos, 2022; Ravanis, 2005, 2022). The changes in the education of future preschool teachers, with the introduction of science courses at both undergraduate

and postgraduate levels, concern both their theoretical formation and their practical training in kindergartens.

Along with the creation of these programs, scientific research has been developed on professional development and particularly on the views and attitudes of in-service, mainly, preschool and primary school teachers and teachers on various issues of science teaching at these educational levels (Andersson & Gullberg, 2015; Jimoyiannis, 2002; Kalleri & Psillos, 2001; Koliopoulos, 2003; Saçkes, 2014; Park et al., 2017; Pendergast et al., 2017). Part of this research is concerned with investigating teachers' and teachers' attitudes and self-efficacy beliefs (Gerde et al., 2018; Tzovla et al., 2022), their origins (Simsar & Davidson, 2020) and/or the evaluation of programs aimed at improving their attitudes and beliefs (Bautista, 2011; Kefala, 2018). Two commonly used tools for measuring attitudes and beliefs are used internationally: the "Science Teaching Efficacy Beliefs Instrument", developed by Riggs & Enochs (1990) and used or adapted primarily on samples of teachers coming from primary education and the "Preschool Teacher Attitudes and Beliefs toward Science Teaching" (P-TABS), developed by Maier et al. (2013) to specifically measure the attitudes and beliefs of in-service preschool teachers. This second instrument, apart from being specifically designed for preschool teachers, contains questions that directly address the content of science, i.e., the three components of school science knowledge: conceptual, methodological and cultural (Koliopoulos, 2006). This last feature of the P-TABS makes it fully compatible with the research current of Science Education within which the author team of the present study is working and according to which the educational process including the attitudes, beliefs and conceptions of teachers on the teaching of science are conceptualized not through general pedagogical principles that concern the whole range of teaching subjects, but rather through the mental constitution of scientific knowledge itself when it becomes an object to be taught (Ravanis & Boilevin, 2009).

Theoretical framework

The attitudes and beliefs of preschool teachers on the teaching science in international and Greek literature

The importance of teaching science in preschool education (Koliopoulos et al., 2022) engages more and more teachers to organize teaching activities on this topic. Young children will need competent teachers to guide their interests, their everyday experiences and to explore in a scientific way issues related to the natural and technological environment. But how do teachers themselves conceive the competences they need to have to carry out this task? What are these competences and what are the factors that determine them?

The issue of self-efficacy beliefs in particular has been particularly studied by Bandu-

ra (1977; 1994) whose theoretical framework has been used extensively by researchers working on this issue. According to this researcher, an individual's self-efficacy denotes the competence beliefs that he or she expresses about his or her abilities and the way he or she organizes and performs a task. Self-efficacy has two aspects: one refers to the expectation of competence and the other to the expected outcome. In short, the expectation of competence is the view one has of one's knowledge and abilities to perform a task successfully. The outcome expectation refers to the individual's assessment that this task is performed successfully. He has also studied the effects of competence beliefs on the cognitive process. In a related article (Bandura, 1993), he discusses how teachers' competence beliefs can influence not only the educational process itself but, among other things, the cognitive development of students, making specific reference to the fields of mathematics and language.

In addition to Bandura's theoretical framework, other "theoretical umbrellas" have been developed under which teachers' and teachers' attitudes and beliefs are examined and indeed are relevant to the field of science. Fleer et al. (2014), for example, use cultural-historical theory to explore early childhood teachers' attitudes towards school science knowledge and the implications this has for designing appropriate science learning environments.

Some research is of particular interest in the context of Science Education research as it has focused on investigating the attitudes and beliefs of in-service early childhood teachers on specific conceptual sections that constitute science teaching, the factors that influence them and the relationship between these attitudes and beliefs and the frequency of introducing relevant teaching activities in the classroom (Aslan et al., 2016; Erden & Sönmez, 2011; Johnson, 2020; Lloyd, 2016; Oppermann et al., 2019; Pendergast et al., 2017). The survey by Erden & Sönmez (2011), in which 292 preschool teachers participated, showed that on the one hand, the participating teachers expressed relatively positive attitudes towards science teaching on the issues of teaching comfort, lesson preparation and science content (concepts, methodology), but on the other hand that the correlation of these attitudes with the frequency of implementation of teaching activities in the classroom was weak. Similar results emerged from Johnson's (2020) study, which found that teachers who report higher levels of comfort in teaching science are more likely to implement relevant activities in the learning process, use inquiry-based teaching methods, and feel comfortable answering children's questions related to science issues. Furthermore, the most relevant research that we have reviewed reports that teachers' comfort level in planning activities and identifying instructional materials for teaching science is influenced by their educational level (Aslan et al., 2016; Aydogdu & Peker, 2016; Johnson, 2020; Lloyd, 2016). The also weak correlation between expectation of competence and expected outcome indicates the level of difficulties teachers may face in teaching by demonstrating inadequacy, fear

or anxiety about their science knowledge and ability to support children's learning (Andersson & Gullberg, 2014; Pendergast et al., 2017).

Research questions

The investigation of the attitudes and beliefs of pre-service or/and in-service preschool teachers about the teaching natural sciences (science) is an issue that seems to have not been sufficiently studied especially in Greece. In this paper we are going to present a first approach to this issue for a sample of in-service Greek preschool teachers using a version of the P-TABS adapted to the Greek reality. More specifically, we are going to present data on the three dimensions of attitudes and beliefs that are included in this measurement tool and what factors may influence them. The corresponding research questions, based on the review of the literature presented previously, were:

RQ1. What is the level of attitudes and beliefs of Greek preschool in-service teachers about teaching science?

RQ2. How are these attitudes and beliefs correlated with teachers' significant demographic characteristics?

Methodology

As already mentioned, the survey method was used to investigate the attitudes and beliefs of in-service teachers of preschool education (Cohen et al., 2000) and specifically the questionnaire based on the P-TABS attitude and belief instrument which was designed according to the Greek standards (translation into Greek and linguistic adaptation to the specificity of the Greek educational system). The questionnaire was administered electronically to a sample of teachers randomly selected from all over the country ("convenient sampling"). Appropriate guidelines were followed to conduct the survey and to maximize the participation of the participants (Lavidas et al., 2022a). The procedure required participants to go to a web link, give their consent to participate in the research following the General Data Protection Regulation (GDPR) and complete the questionnaire. Participants were fully informed about the purpose of the study by sending them an informative email. A total of 269 preschool teachers participated in this survey (Table 1).

The questionnaire was divided into two sections. The first section concerned the personal data of the sample: age, educational background, postgraduate studies, number of science and science education courses taken during the undergraduate program and attendance of training programs. The second section was the P-TABS tool adapted to Greek conditions as taken from the work of Maier et al. (2013). The use of this tool was licensed by one of the tool designers (namely Michelle Maier). According to the authors, this tool is characterized by satisfactory structural validity and reliability. Moreover, these satisfactory psychometric properties of the tool have recently been confirmed in research

conducted to study the attitudes as well as beliefs of tomorrow's kindergarten teachers about teaching mathematics (Lavidas et al., 2023). This tool consists of three sections/ factors that influence teachers' beliefs and attitudes (Maier et al., 2013, p. 370):

(a) The "Teacher Comfort" factor consists of fourteen (14) statements that assess the teacher's comfort in planning and introducing various science activities.

(b) The "Child Benefit" factor includes ten (10) statements that assess teachers' attitudes and beliefs about how science in early childhood education promotes children's interest in science and improves their school readiness skills.

(c) Finally, the "Challenges" factor includes seven (7) statements that assess teachers' negative attitudes and beliefs about teaching science, including their discomfort and concern about their ability and the time required to carry out related activities.

TABLE 1

Demographic characteristics of preschool teachers (N=269)

	Absolute frequency	Relative frequency (%)
Age		
Up to 30	19	7,1
31-40	51	19
41-50	86	32
51 and over	113	42
Previous teaching experience		
Up to 10	49	18,2
11-20	106	39,4
21-25	50	18,6
26 and over	64	23,8
Postgraduate Studies		
No	159	59,1
Yes	110	40,9
Number of science/science education courses (Undergraduate Studies)		
None	68	25,3
1-3	167	62,1
4 and over	34	12,6
Attendance of training programs for science education		
No	140	52
Yes	129	48

As the designers of the questionnaire state, the questions were designed to examine various aspects of teachers' attitudes and beliefs about science teaching: competence beliefs (self-efficacy); cognitive aspects (appropriateness, importance and difficulty of teaching science); affective aspects (interest, satisfaction, pleasure, anxiety or fear about teaching science); behavioral aspects (how they currently intend to teach science); and aspects related to teaching conditions (time, resources and effort required to teach science). All the questionnaire statements can be found in Tables 2, 3 and 4 in the next section.

Results

Teachers' attitudes and beliefs

Table 2 illustrates the results of the respondents on the first part of the questionnaire ("Teacher comfort"). It is evident from the teachers' responses that more than 60% of them introduce natural science concepts and phenomena (physics, biology, astronomy and meteorology) into the educational process and feel comfortable planning related activities and carrying out mainly experimental procedures but less narrative teaching methods (questions A1, A5, A6, A9, A10, A11, A13). Also, most teachers get ideas for practical science activities using what children say, do and ask in class, consult a relevant book or the internet, and use and/or collect all kinds of materials for their teaching (questions A3, A4, A7 and A14). However, fewer teachers discuss their ideas on science issues with other teachers (question A2), which can easily be explained by the absence of a culture of collaboration in the Greek public school. Finally, less than half of teachers try to include science activities in their teaching every week (question A12). From the above, an overall assessment of the factor "Teacher Comfort" can be concluded that the majority of teachers in the sample demonstrate positive attitudes and beliefs regarding their comfort in planning and introducing various science activities, while a small percentage (<= 10%) with negative attitudes or beliefs appears.

Table 3 shows the participants' responses for the second part of the questionnaire ("Child Benefit"). The data collected show that the vast majority of teachers agree that science contributes to children's cognitive progress in science, to their interest in science and the improvement of their mathematical, language and social skills (questions B1, B4, B5, B6, B9). It is also evident that teachers believe that young children have an innate curiosity about exploring nature and can engage in scientific activities despite not being able to read (questions B7, B10). Teachers attach particular importance to experimental activities when children themselves are involved in them, possibly recognizing the Piagetian idea of constructing knowledge when children explore and understand the natural environment by acting on objects and materials provided (question B3). Finally, they agree that more science should be taught in kindergarten (question B2).

TABLE 2

Teachers' attitudes and beliefs about how comfortable they feel introducing science activities ("Teacher Comfort") (N=269)

	1	2	3	4	5
A1. I am comfortable planning and demonstrating classroom activities related to physics and energy (e.g. light, solubility, melting and cooling).	1,0%	10,0%	28,3%	32,3%	28,3%
A2. Discuss ideas and issues in science teaching with other teachers	3,3%	13,4%	32,3%	31,2%	19,7%
A3. I use all kinds of materials in the classroom (e.g. blocks, toys, boxes) for science activities	0,4%	5,6%	21,9%	31,6%	40,5%
A4. I use relevant books to get ideas about science activities for preschool children	1,9%	3,3%	12,6%	41,3%	40,9%
A5. I feel comfortable doing science activities in my classroom	1,1%	6,7%	23,0%	35,3%	33,8%
A6. I feel comfortable planning and demonstrating classroom activities related to life science topics (e.g. living beings, plants, and animals)	0,4%	5,9%	24,5%	37,5%	31,6%
A7. I use the Internet to get ideas about science activities for preschool children	1,1%	1,1%	11,2%	38,3%	48,3%
A8. I get ideas for practical activities from what my students do, say and ask for	0,7%	3,0%	23,8%	39,4%	33,1%
A9. While telling stories I also use some science books	6,3%	14,1%	33,8%	30,9%	14,9%
A10. I like to do science activities with my students	1,1%	3,7%	16,0%	39,0%	40,1%
A11. I demonstrate experimental activities (e.g. comparing objects to see if they sink or float) in my classroom	0,4%	1,9%	7,4%	33,1%	57,2%
A12. I make efforts to include some science activities throughout the week	4,5%	16,4%	35,7%	29,4%	14,1%
A13. I feel comfortable planning and demonstrating classroom activities related to astronomy and meteorology topics (e.g. sun, moon, stars, weather)	2,2%	9,7%	22,3%	36,1%	29,7%
A14. Collect materials and objects for use in science teaching	1,1%	8,6%	21,2%	34,2%	34,9%

TABLE 3

Teachers' attitudes and beliefs about the child's benefits from science teaching ("Child Benefit") (N=269)

	1	2	3	4	5
BI. Science activities in early childhood help to increase children's interest in science in the older grades	15%	1,5%	13,4%	34,2%	49,4%
B2. More science should be taught in Kindergarten	0,0%	0,0%	8,2%	34,9%	56,9%
B3. Young preschool children learn best when they experiment with materials and objects	0,0%	0,0%	0,7%	13,8%	85,5%
B4. Science-related activities contribute to improving the learning function of preschool children	0,0%	0,0%	4,5%	27,1%	68,4%
B5. Science-related activities contribute to improving the mathematical skills of preschool children	0,0%	0,0%	5,6%	38,7%	55,8%
B6. Science-related activities contribute to improving the language skills of preschool children	0,0%	0,4%	8,9%	40,1%	50,6%
B7. Young children cannot learn science until they can read	78,8%	16,7%	1,9%	2,2%	0,4%
B8. Science-related activities are very difficult for preschool children	55,0%	30,1%	13,0%	1,5%	0,4%
B9. Science-related activities contribute to improving the social skills of preschool children	0,0%	1,5%	20,4%	40,1%	37,9%
BI0. Young children are curious about scientific concepts and phenomena	0,0%	0,0%	3,0%	27,1%	69,9%

Table 4 presents the respondents' answers to the third part of the questionnaire ("Challenges"). The very positive picture that emerges for the previous two factors that influence their views on science teaching shows a relative decline in this factor. First of all, it can be observed that 43% of the teachers state that they have sufficient knowledge of science to teach science to young children, while about one-third of them give a neutral opinion, but at the same time state that they have confidence in themselves when it comes to responding adequately to children's questions or referring to issues of scientific method (questions C3, C4, C5). Around the same proportion state that there is a lack of appropriate materials to carry out science activities (question C7). Several teachers (about one-third) mention problems they encounter during teaching such as insufficient time for preparation and daily teaching (questions C1, C2). However, there are several teachers (45%)

who consider that planning and demonstrating hands-on science activities is not a difficult task (question C6).

TABLE 4

Teachers' attitudes and beliefs about the difficulties they encounter when teaching science activities ("Challenges") (N=269)

	1	2	3	4	5
C1. Given other commitments, there is not enough time in a day to teach science	9,3%	21,2%	33,8%	23,4%	12,3%
C2. Preparation for teaching science takes more time than in other areas	6,7%	15,6%	34,6%	29,0%	14,1%
C3. I do not have enough scientific knowledge to teach science to preschool children	16,7%	26,8%	32,7%	17,5%	6,3%
C4. I am not comfortable talking to preschoolers about the scientific method (e.g., hypothesizing, predicting, experimenting)	48,7%	27,1%	14,9%	8,6%	0,7%
C5. I am afraid that children may ask me a question about science concepts and phenomena that I cannot answer	23,0%	29,4%	24,2%	15,2%	8,2%
C6. Planning and demonstrating hands-on science activities is a difficult task	18,6%	26,0%	30,9%	19,7%	4,8%
C7. I don't have enough materials to do science activities	11,2%	19,3%	27,1%	27,1%	15,2%

Testing the impact of demographic characteristics on the attitudes and beliefs of teachers

The results in this section are based on the confirmatory factor analysis of the instrument measuring the attitudes and beliefs of the sample teachers, which was conducted as part of a postgraduate thesis by one of the authors of the article (Balabani, 2021).

As we have already pointed out and as shown by the mean value (M=3.96) of the quantitative approach of the first factor of attitudes and beliefs "Teacher Comfort" (Table 5), several teachers of the sample seem to feel competent planning and introduce activities from different fields of science in their teaching. From the correlation of this dimension of the questionnaire with the four demographic characteristics of the sample of teachers, it appears that teachers' attitudes and beliefs are significantly influenced by (a) whether they have attended relevant training programs and (b) the

number of science/science education courses that they had attended during their undergraduate degree programme, since for these two demographic items there are significant statistical differences.

More specifically, the independent samples t-test revealed that the mean value of those who have attended science education training programs (M=4.17, SD=0.57) is higher than those who have not attended such programs (M=3.76, SD=0.67). A two-sided test of independent samples revealed that this difference is statistically significant, t(266)=5.406, p=0.001.

From the analysis of variance (one way ANOVA, Tukey's criterion was used for multiple comparisons), to test the effect of undergraduate science/science education course selection on the specific factor of attitudes and beliefs, there appear to be statistically significant differences F(6,6 , 108,2)=8,085, p=0,001. Also, those participants who indicated that they had not chosen any science/science education course (M=3.83, SD=0.58) or one to three courses (M=3.93, SD=0.68) felt less comfortable teaching science courses than those who had selected four or more undergraduate science courses (M=4.35, SD=0.52).

TABLE 5

Teachers' beliefs and attitudes about how comfortable they feel introducing science activities ("Teacher Comfort")

		Min.	Max.	Mean	SD
"Teacher Comfort"		1,90	5,00	3,96	0,65
Have you attended training programs in science education? *	No	1,90	5,00	3,76	0,67
	Yes	2,50	5,00	4,17	0,57
During your undergraduate studies, how many courses did you take in the field of science/science education? *	None	2,50	5,00	3,83	0,58
	1-3	1,90	5,00	3,93	0,68
	>=4	3,10	5,00	4,35	0,52
Have you done postgraduate studies?	No	2,40	5,00	3,91	0,66
	Yes	1,90	5,00	4,02	0,64
Your teaching experience is:	<=10	2,30	4,90	3,91	0,57
	11-20	1,90	5,00	3,89	0,71
	21-25	2,50	5,00	4,01	0,66
	>=26	2,90	5,00	4,06	0,60

* Statistically significant differences

As we have already pointed out and as shown by the mean value (M=4.50) of the quantitative approach of the second factor of attitudes and beliefs "Child Benefit" (Table 6), the majority of the teachers in the sample seem to believe that science in preschool education promotes children's interest in science and improves their school readiness skills. From the correlation of this dimension of the questionnaire with the four demographic characteristics of the sample of teachers, it appears that teachers' attitudes and beliefs are significantly influenced by (a) the number of science/science education courses that they had taken in their undergraduate curriculum and (b) whether they had pursued postgraduate studies, since for these two demographics there are significant statistical differences.

More specifically, from the analysis of variance (one-way ANOVA, Tukey's criterion was used for multiple comparisons) to test the effect of undergraduate science/science education course selection on the specific factor of attitudes and beliefs, there appear to be statistically significant differences F(1,3 , 48,1)=3.574, p=0.029. Also, those participants who stated that they had not chosen any science/science education courses (M=4.48, SD=0.42) believed that children did not benefit from being taught topics from the science area, compared to those who had chosen four or more courses (M=4.68, SD=0.36).

At the same time, the independent samples t-test revealed that the mean of those who have pursued postgraduate studies (M=4.58, SD=0.40) is higher than those who have not chosen to pursue postgraduate studies (M=4.44, SD=0.44). A two-sided test of independent samples revealed that this difference is statistically significant t(267)=2.465, p=0.014.

TABLE 6

Teachers' beliefs and attitudes about the child's benefit from science teaching ("Child Benefit")

		Min.	Max.	Mean	SD
"Child Benefit"		3,38	5,00	4,50	0,43
Have you attended training programs in science education?	No	3,50	5,00	4,46	0,44
	Yes	3,38	5,00	4,54	0,42
During your undergraduate studies, how many courses did you take in the field of science/science education? *	None	3,63	5,00	4,48	0,42
	1-3	3,38	5,00	4,47	0,44
	>=4	3,75	5,00	4,68	0,36
Have you done postgraduate studies? *	No	3,38	5,00	4,44	0,44
	Yes	3,50	5,00	4,58	0,40
Your teaching experience is:	<=10	3,88	5,00	4,55	0,37
	11-20	3,50	5,00	4,51	0,42
	21-25	3,38	5,00	4,44	0,47
	>= 26	3,38	5,00	4,48	0,47

* Statistically significant differences

Finally, as Maier et al. (2013, p. 374) point out, the "Challenges" factor is difficult to measure because of, among other things, the higher variation in teacher responses. In particular, they note that "because science is a required school readiness domain, teachers may feel uncomfortable admitting there are barriers to teaching it, such as how difficult it is to teach, that they do not have time for it, or that they do not feel they have enough content knowledge in science ... The items may potentially be assessing a diverse set of challenges associated with teaching science that may or may not be experienced by different teachers". These may partly explain the qualitative dimension of the results presented in the subsection "Teachers' attitudes and beliefs".

However, treating this factor at the quantitative level like the previous two factors, we can claim that, as shown by the mean value (M=2.70) (Table 7), the teachers in the sample seem to recognize difficulties in performing their teaching tasks related to the adequacy of their knowledge, their cognitive interaction with children or other 'external' difficulties (e.g., time, materials) without feeling very uncomfortable with them. By correlating this dimension of the questionnaire with the four demographic characteristics of the teachers' sample, it appears that teachers' attitudes and beliefs are significantly influenced by all of them except the fourth characteristic (teaching experience).

More specifically, the independent samples t-test revealed that the mean of those teachers who have not attended training programs in science education (M=2.89, SD=0.79) is higher than those who have attended such programs (M=2.50, SD=0.78). A two-sided test of independent samples revealed that this difference is statistically significant t(267)=4.011, p=0.001. Also, the same test revealed that the mean of those who have not pursued postgraduate studies (M=2.8, SD=0.8) is higher than those who have pursued postgraduate studies (M=2.56, SD=0.79). A two-sided test of independent samples revealed again that this difference is statistically significant t(267)=2.441, p=0.015. Finally, from the analysis of variance (one way ANOVA, Tukey's criterion was used for multiple comparisons), to test the effect of the choice of undergraduate science/science education courses seems to show statistically significant differences F(4,4 , 169)=3.429, p=0.034. Also, participants who stated that they had not selected any undergraduate science/science education course (M=2.8, SD=0.78) perceived that they had more difficulties in teaching science than those who had selected four or more undergraduate science/science education courses (M=2.38, SD=0.73).

TABLE 7

Teachers' beliefs and attitudes about the difficulties they face in teaching science ("Challenges")

		Min.	Max.	Mean	SD
"Challenges"		1,00	4,83	2,70	0,80
Have you attended training courses in science education? *	No	1,17	4,67	2,89	0,79
	Yes	1,00	4,83	2,50	0,78
During your undergraduate studies, how many courses did you take in the field of science/science education? *	None	1,33	4,83	2,80	0,78
	1-3	1,00	4,67	2,73	0,81
	>=4	1,00	4,17	2,38	0,73
Have you done postgraduate studies? *	No	1.33	4,83	2,80	0,80
	Yes	1,00	4,67	2,56	0,79
Your teaching experience is:	<=10	1,33	4,67	2,77	086
	11-20	1,17	4,83	2,83	0,77
	21-25	1,00	4,00	2,57	0,77
	>=26	1,00	4,33	2,54	0,80

* Statistically significant differences

DISCUSSION - CONCLUSIONS

Regarding research question RQ1, the results of the present study show a picture that generally confirms the positive results, both qualitatively and quantitatively, of similar international studies conducted with the same research tool regarding the three factors that influence the attitudes and beliefs of preschool teachers on the teaching of science. More specifically, the teachers in our sample do equally well on the factors "Teacher Comfort" and "Child Benefit", while approximately the same attitudes are observed for the factor "Challenges" (Johnson, 2020; Lloyd, 2016; Maier et al., 2013; Pendergast et al., 2017). These results also seem to be consistent with the results of other international studies which are derived from the use of similar research instruments (Erden & Sönmez, 2011; Saçkes, 2014). At the same time, it seems that the various indicators of the results of the present study are improved in comparison with corresponding indicators of previous similar studies investigating attitudes and beliefs of preschool teachers in Greece (Kalleri & Psillos, 2001; Minadopoulou & Partsali, 2001; Zografou-Tsantaki, 2001). This is a rather expected outcome given, on the one hand, the changes that have emerged in recent years in the official curricula of preschool education where science is now introduced as an autonomous cognitive area (Birbili, 2014; Penteri et al., 2021) and, on the other hand, the upgraded field of education, training and research of preschool teachers on science education issues as shown, among other things, by their numerous participation in the work of the series of conferences

"Natural Sciences in Preschool Education" (https://12sece.nured.uowm.gr/praktika-palioteron-synedrion/).

Regarding the research question RQ2, the results show that three out of the four demographic characteristics examined in this study influence teachers' attitudes and beliefs about science teaching. More specifically, regarding the results of the research on the correlation of the attitudes and beliefs of the teachers' sample with several demographic data that refer to their education, training and experience, the findings are also in general agreement with the international picture presented in the works that were documented by us. More specifically, it appears that teachers' professional development through science education training programs can enhance their sense of confidence in their abilities regarding science topics and make them feel more comfortable with planning and engaging in science activities which was also highlighted in the research of Pendergast et al. (2017) and Oppermann et al. (2021). A statistically significant correlation is also found for the factor "Challenges" which is not highlighted in the research of Pendergast et al. (2017). In contrast, teachers' beliefs and attitudes about the child's benefit from science teaching did not seem to be particularly influenced by whether teachers had participated in training programs. The number of science/science education courses attended by the participating teachers in the study is the characteristic that influenced all three dimensions of teachers' attitudes and beliefs. The studies also by Johnson (2020), Mavrikaki and Athanasiou (2010) [on a sample of future teachers/teachers], Oppermann et al. (2021), Saçkes (2014), indicated the existence of a strong correlation between attending science/science education courses during the undergraduate programme and teachers'/teachers' efficacy beliefs. The research findings in the above two correlation categories are consistent with the view of broadening and strengthening both basic education and in-service training of Greek early childhood teachers in science teaching with the overarching goals of developing basic skills in planning activities, understanding children's ways of thinking, and overcoming difficulties in implementing instruction (Kalogiannakis, 2018; Koliopoulos, 2006; Pantidos, 2019; Zogza & Ergazaki, 2013).

Regarding the correlation between the demographic characteristic "postgraduate studies" and the factors that influence teachers' attitudes and beliefs, it seems to be statistically significant for the factors "Child Benefit" and "Challenges", but not for the factor "Teacher Comfort". The latter result, i.e. the absence of a statistically significant correlation between teachers' education level and the "Teacher Comfort" factor is also found in other international studies such as those by Erden and Sönmez (2011), Gerde et al. (2018) and Oppermann et al. (2021). At the same time, the result is rather expected for the factor "Child Benefit" given the pedagogical content of the various Greek programs which have started to focus on the constructivist approach to teaching and learning in science, i.e. the approach that takes into account children's mental representations of phenomena and concepts in science.

Finally, the correlation results showed that teachers' prior teaching experience did not affect their beliefs and attitudes about competence in teaching science on any of the three factors. These results are consistent with the research of Erden and Sönmez (2011), Gerde et al. (2018), Saçkes (2014), according to which teachers' years of experience were not significantly related to their attitudes and beliefs about science activities or the frequency of introducing such topics in the educational process. In contrast, Johnson (2020) reported significant correlations between this characteristic and the three attitude and belief factors. This result in our study is unexpected, mainly empirically. Nevertheless, it could be interpreted firstly because of the convenience of the sample (in all likelihood, the sample consisted of teachers who are involved with or favorably disposed towards science teaching).

The above findings of this research may lead to some practical implications in terms of the education and training of preschool teachers. From the generally positive results of the questionnaire analysis, the need to continue and strengthen teacher education at the undergraduate level emerges, since this factor seems to have a significant impact on teachers' attitudes and practices regarding science teaching. The model of professional development of preschool education teachers in Greece, where undergraduate studies are conducted in autonomous Departments of Preschool Education, favours this planning specifically for each such Department and more generally at the national level. At the same time, these results indicate that there is a need to strengthen the training of teachers during their professional life in order to develop skills (a) in the management of anxiety and fear due to their lack of expertise in science and science teaching, (b) in handling of material and technical infrastructure for science teaching and (c) in the use of information and communication technologies and AI for educational purposes. Finally, it appears that postgraduate studies particularly influence teachers' views on the "Child Benefit" and "Challenges" factors. The improvement of the already existing postgraduate science teaching courses and the development of new programmes in the direction of professional development (Teachers development programs) where the link between pedagogical research and teaching practice is to be highlighted, we believe, will contribute to further improve the attitudes and competency beliefs of preschool teachers.

Some limitations arise from the investigation of the issue. First, it is not possible to draw generalized conclusions about the general population of preschool teachers in Greece. This is because the sample used was collected using the convenience sampling technique and the number of teachers sampled was small compared to the total number of teachers in the country. Generalized and more valid conclusions from such a survey can be drawn based on greater participation of teachers from all regions of Greece and random sampling.

In addition, the fact that this study used self-reported data runs the risk of cap-

turing socially desirable responses that may lead to measurement bias (Lavidas et al., 2022b). In future research it is possible to use mixed methods of data collection, such as observations of science teaching practices accompanied by teachers' conceptions of science concepts, methodology and curriculum, to contrast subjective attitudes and beliefs with objective cognitive conceptions and thus reveal a clearer picture of the Greek teacher's profile on the teaching of science in this particular educational level.

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