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Early childhood teacher candidates` qualifications in science teaching

Fatma Alisinanoglu[1], Hatice Zeynep Inan[2,*], Saide Ozbey[1], Muhammed Usak[3]

[1]*Gazi University, Ankara, Turkey*
[2]*Dumlupinar University, Kutahya, Turkey*
[1]*Gazi University, Ankara, Turkey*
[3]*Zirve University, Gaziantep, Turkey*

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Abstract

In recent years, researchers and educators have been paying more attention to science education in early ages of children. Children's innate curiosity and interest in science, as well as the development and learning benefits of early childhood science instruction, are encouraging researchers and educators to study how to raise the quality of science education in early childhood education centers. Since the 'teacher' is one of the factors that either increases or decreases the quality of education, educators and researchers are looking for the ways to support early childhood teachers in science content and science education. To accomplish that, it is essential to determine the strengths and weaknesses of teachers in science teaching. The study is conducted to see if teacher candidates are qualified enough to teach science. In other words, the current study is interested in understanding early childhood education teacher candidates' qualifications in teaching young children science content and helping them develop science process skills. The results of the study are stated in the paper.

Keywords: Teacher candidates; Early childhood; Science; Qualifications

1. Introduction

In recent years, researchers and educators have been paying more attention to science education in early ages of children in Turkey. As kindergarten becomes compulsory in some cities in Turkey, researchers and educators are more involved in constructing an effective science education program for young children [1-3]. Early childhood educators and researchers are looking for the essential qualities of early childhood science education.

Young children make sense of the outside world by actively using their five senses. It is essential to create opportunities in which children can make observations, experience the natural world around them, use their creative thinking skills in their science explorations, and develop an understanding of nature and so on. As a result, they can use these experiences and skills in their daily lives [1, 4-8]. As children actively use their senses, they develop their

[*]Corresponding author, Tel: +90-506- 560 0049, fax: +90-274- 265-2057.
E-mail address: haticezeynep@hotmail.com (H. Z. Inan).

cognitive skills, such as analyzing data and creating hypotheses. Science process skills and creative thinking skills usually help children resolve the problems they face in their daily lives so they can take control of their own lives. Early childhood science education plays an important role in helping children gain those skills [2, 8]. Instead of getting children to memorize facts without having a real understanding, science education in early years aims to equip children with science skills including posing questions, gathering facts, exploring possibilities, conducting research and thinking through discoveries. This requires proving children concrete examples and experiences with materials [1, 9].

Children's innate curiosity and interest in science, as well as the development and learning benefits of early childhood science instruction, are encouraging researchers and educators to study how to improve the quality of science education in early childhood education centers. Since the 'teacher' is one of the factors that either increases or decreases the quality of education, Turkish Higher Education has put an emphasis on teacher education and teacher qualification, which are composed of *knowledge, skill and competence* [10]. In addition, educators and researchers are looking for ways to support early childhood teachers in science content and science education. To accomplish that, it is essential to discover the strengths and weaknesses of teachers in science teaching. Accordingly, the current study aims to examine teacher candidates' qualifications for teaching science, determine the shortcomings of science activities led by early childhood teachers and then provide necessary recommendations for improving the quality of science education in early childhood centers.

2. Importance of the role of the teacher in teaching young children science

Various research stresses the importance of the role of the teacher for effective science teaching in ECE centers. Grieshaber and Diezmann [11] state that adults provide children with conceptual support by stating what is known, paraphrasing, redirecting, questioning ideas and approaches, providing information and assisting with problem solving. Based on her observations in a Head Start classroom, Mooney [12] states that scaffolding, interaction, conversation, and experimentation helped children learn about both science processes and contents. She states that those children increased their skills gradually and accomplished their goals in science.

Fleer [13] points out socially constructed scientific knowledge and states, "it is not the scientific knowledge, but the whole science genre in which this 'content' knowledge is placed, that must be taught to children. In sharing this cultural knowledge with children, emphasis must be placed on the social context through giving attention to the interactions between the adult and the child" (pp. 16-17). Fleer indicates that this socially constructed way of learning is more meaningful to children and transferable to everyday language. Based on the research conducted with 4 year-old children, Fleer states, "Within a framework which started with the children's questions, children were moved towards scientific understanding. The teacher modeled the investigation process (based on the children's questions), and over time, the children took on the investigation process themselves. The children connected up the circuit, initially in collaboration with the teacher, but after a period of time, less teacher assistance was given" (p. 20). Those children were able to easily connect up the circuit and express the scientific way of current flow even after three months later in the study. This supports creating a social context in which a child learns about science with the assistance of a teacher or a competent peer through scaffolding.

Moreover, Grieshaber and Diezmann [11] state that teachers provide with children materials and equipment, as well as conceptual support, during a scaffolding process. Since the teacher is one of the important factors that increases or decreases the quality of science

education in early childhood centers, it is essential to determine the shortcomings of science activities led by early childhood teachers and then provide necessary recommendations to support them in science content and science education.

3. Research on teachers' qualifications concerning science in Turkey

In the last 35 years, pedagogical content knowledge has been one of the main reserach issues in teacher education. Research studies on PCK have included a wide variety of ages, from elementary school to higher education [14-18]. A review of international literature on PCK targeting early childhood level included the focus of kindergarten teachers' attitudes and PCK in the context of science and related children's literature [19], prekindergarten PCK in the discipline of math [20], PCK of prekindergarten and kindergarten teachers [21], and teacher philosophy and play-based preschool contexts [22].

Over the last two decades, mentoring has emerged as an effective process for developing early-career teachers' practices [23, 24]. Early-career teachers include preservice teachers and beginning teachers in the first years of practice. In an attempt to evaluate the effectiveness of mentoring for early-career teachers based on related international related research. In Turkey, some studies have evaluated the effectiveness of mentoring from the perspectives of both preservice teachers and mentors [23, 24].

The research conducted by Inan [17] shows that early childhood teacher candidates are having some difficulties in teaching science. Inan focuses more specifically on teachers' difficulties in content knowledge and pedagogical content knowledge in teaching science process skills. Although about 95% of the teacher candidates involved in the study claimed that they do activities to equip their students with the following science process skills: observation, prediction, measuring/computing, comparison, communicating, data gathering/recording, and categorizing / grouping, they had only 40% overall success in picturing activities of science process skills. More specifically, it is stated, "The Scientific Process Skills can be listed from the most used to the least by the most number of teacher candidates as follows: observation skill 90%, measuring/computing skill 52%, communicating skill 45%, comparison skill 42%, prediction skill 24%, categorizing/grouping skill 21% and data gathering/recording skill 9%" (p. 2315). As seen, teacher candidates showed success in picturing usage of some science process skills in an early childhood classroom while they did now success in picturing some of the science process skills.

Another study conducted by Inan [25] on early childhood teachers working at different early childhood centers in Kutahya, Turkey, showed similar- even worse- results. Inan stated, "the teachers' definitions, examples, and answers to further questions suggested that they had not truly internalized the meaning of the science process skills. Also, it became clear that they had not made use of activities that would help children really acquire and use science process skills." (p.58). The most interesting result from this study is that even though the teachers believed in the importance of developing children's science process skills, they still maintained tight control of science experiences, determining what questions will be asked and what answers children will give. It is interesting that the teachers believed in the idea of children doing experiments, while in practice the children ended up sitting in the corner and watching the teacher do the experiment.

Consistent with the trend in the world, Turkish researchers also stress the fact that there is a strong relationship between quality science education and quality teachers. Teachers should be able to provide children opportunities in which they can engage with science activities; they should be cognizant of different approaches in teaching science; and they should be able to guide children in making explorations and discussing what they know and what they found

in their explorations [17, 25-28]. In order to have effective experiences, teachers should create an atmosphere in which children can make reasonable explanations and make a connection between the cause and the effect. For example, a teacher can help children understand *why we need to put salt on icy roads* by creating a related experiment [41].

Quality early childhood teachers are needed to provide quality science education in early childhood centers. To accomplish this, teachers need strong pedagogical content knowledge as well as content knowledge [17]. Moreover, the science education courses ECE teachers take throughout their education at university also influence their own attitudes toward science. In other words, teacher candidates also need quality science education during their education in order to provide quality science education in their future early childhood classrooms. Accordingly, it is important to understand teacher candidates' perspectives on their own science education [1, 3, 17, 26]. The current research aims to examine the qualifications of teacher candidates who already took science education during their undergraduate years and to understand their perspectives related to science activities. The personal information form used to collect data helps us understand if some personal variables influence science teaching qualifications. The questionnaire provides additional qualitative data for the factors appearing in the survey. The survey section of data collection process focuses more specifically on the following factors:

1. Teacher candidates' perspectives on
    a. their own science education,
    b. importance of science education in early years,
    c. methods used in early childhood science education;
2. Teacher candidates' science material making skills;
3. Teacher candidates' qualifications on science activities planning and application;
4. Teacher candidates' thoughts on their future science applications.

The current study investigates whether teacher candidates are qualified enough to teach science. The study is interested in understanding ECE teacher candidates' qualifications for helping young children learn science content and gain science process skills. This mss study seeks to determine the shortcomings of science activities led by early childhood teachers and then provide necessary recommendations. The results of the study can guide universities in preparation of ECE teacher candidates and guide professors to create quality science education to future early childhood teachers.

3. Methodology of research

3. 1. Participants

This study is consists of ECE teacher candidates attending a 4 year-long early childhood education program at three different universities in Turkey, namely Gazi University, Gazi Faculty of Education and Technical Education Faculties, Dumlupinar University Education Faculty and Afyon Kocatepe University Education Faculty. The research was conducted during 2009-2010 education year and involved 197 out of 200 senior teacher candidates studying early childhood education at the mentioned universities. The teacher candidates participated in the study about one week before their graduation from the university, so that they had taken all the courses, completed all the field experience in early childhood centers, and were ready to teach young children science as well as other disciplines.

Of the teacher candidates who participated in the research, 93,4% are females (N=184); 5,4 % are males. Concerning the types of high schools from which they graduated, 39.1% (N=77) are high school graduates, 25.9% (N=51) are child development graduates from girls' vocational school, and 24.9% (N=49) are graduates of Anatolian high school/ teacher's training high school and super high school. Of the candidates, 40.1 & (N=79) study at Gazi

University, Faculty of Technical Education,; 25.9% (N=51) study at Gazi University, Faculty of Education; 20.8% (N=41) study at Afyon Kocatepe University, Faculty of Education., and 13.2% (N=26) study at Dumlupinar University, Faculty of Education.

The inventory used in this study includes three sections, namely a form, a survey and a questionnaire. While 197 senior teacher candidates completed the form and the survey, only 112 of them answered the questionnaire, which includes 8 open-ended questions.

3. 2. Data gathering tools

The study utilizes a form called *The Personal Information Form* a survey with 5 point Likert type of scale, called *The Early Childhood Teachers' Qualifications in Science Activities Scale*, and a questionnaire with 8 open-ended questions, called *The Questionnaire Form for the Identification of the Opinions, Attitudes, and Expectations of the Early Childhood Teachers about Science Activities.* The questionnaire seeks out teacher candidates' opinions, attitudes and expectations in science activities in early childhood centers.

The survey, the Early Childhood Teachers' Qualifications in Science Activities Scale, which was developed and found to be both valid and reliable by by Ozbey and Alisinanoglu[7], includes 29 items and measures early childhood teachers` qualifications in early childhood science education. The survey includes the following answers: "Totally agree (5)," "Agree (4)," "Not sure (3)," "Disagree (2)," "Totally disagree (1)." The survey has 17 positive and 12 negative items. Negative items (10-20, 27) get reverse scores. The highest possible score is 145, and the lowest possible score is 29. The highest score corresponds to the greatest level of science education competence.

The Early Childhood Teachers' Qualifications in Science Activities Scale consists of four factors, namely, *1-Materials and Methods used by the Teacher, 2-Knowledge Level of the Teacher Concerning Application, 3- General Knowledge Level of the Teacher concerning Science Activities and 4- Teacher Behaviors during Applications.* 232 teachers participated in the testing of the validity and reliability of the survey. The survey has .82 Cronbach Alpha Internal Consistency. More specifically, Factor 1 has .82; Factor 2 has .76; Factor 3 has .63; Factor 4 has .36; and the survey has total .82 Cronbach Alpha Internal Consistency [7]. Table1 presents an interpretation of qualification scores concerning the Early Childhood Teachers' Qualifications in Science Activities Scale and the related 4 factors.

3. 3. Data collection and analysis

The study is mixed-method research, including both qualitative and quantitative methods. After generating some descriptive statistics (e.g., mean), we will perform inferential statistics analysis. The study aims to examine early childhood teacher candidates` qualifications for teaching science. It also aims to examine their scores in relation to some variables, namely, the university they attended, the grade they got from science classes at the university, and the type of high school from which they graduated. Since ANOVA helps calculate the relationship between two or more variables, one-way ANOVA as well as Kuruskal Wallis H Test analyses will be conducted [29]. The proposed alpha level is .05 in this study.

Moreover, this research utilizes a qualitative research method in the form of a questionnaire with open-ended questions to seek out teacher candidates' opinions, attitudes and expectations related to science activities. Analysis of the data is done by content analysis and simple descriptive statistics, namely frequency and percentage. The answers of the teacher candidates to those open-ended questions are analyzed and sub-themes are created for each question. Moreover, frequency and percentage is calculated for those sub-themes. Example excerpts from the teacher candidates' answers are stated.

Table 1. The interpretation table of qualification scores

	Description	Score
Factor 1. Materials and methods used by the teacher	Highly qualified	42-50
	Qualified	34-41
	Average	26-33
	Unqualified	18-25
	Highly unqualified	10-17
Factor 2. Knowledge level of the teacher concerning application	Highly qualified	42-50
	Qualified	34-41
	Average	26-33
	Unqualified	18-25
	Highly unqualified	10-17
Factor 3. General knowledge level of the teacher concerning science activities	Highly qualified	26-30
	Qualified	21-25
	Average	16-20
	Unqualified	11-15
	Highly unqualified	6-10
Factor 4. Teacher behaviors during application	Highly qualified	13.4-15
	Qualified	10.8-12.4
	Average	8.2-9.8
	Unqualified	5.6-7.2
	Highly unqualified	3-4.6
Total	Highly qualified	121.8-145
	Qualified	98.6–120.8
	Average	75.4–97.6
	Unqualified	52.2-74.4
	Highly unqualified	29-51.2

4. Result and discussion

4. 1. Findings about Early Childhood Teachers' Qualifications in Science Activities Scale

a) Mean of the scores

Table 2. Mean of the scores (Early Childhood Teachers' Qualifications in Science Activities Scale)

Factors	Mean	N
Materials and methods used by the teacher	42,99	197
Knowledge level of the teacher concerning application	18,23	197
General knowledge level of the teacher concerning science activities	27,83	197
Teacher behaviors during application	10,80	197
Total	99.87	197

The findings of the scores stated in Table 2 are interpreted based on the interpretation table (see Table 1) as follows: Table 2 shows that the mean of participants' scores gained on *Factor 1 Materials and methods used by the teacher* is 42.99, which refers to highly qualified. Accordingly, it can be said that teacher candidates are highly qualified based on the materials and methods they used in early childhood science education. More specifically, 'highly qualified' includes creating an environment in which children can make observations; considering children's developmental level and interests when selecting a project topic; helping children ask questions during the activities; supporting children to express their own opinions and discuss issues appearing during activities; asking children questions to help them interpret issues related to science; letting children make drawing pictures after site-visiting; asking open-ended questions to help children find solutions to problems related to science;

enrich environment with materials: books, newspapers, journals, and documentaries; organizing outdoor activities to support children's explorations; and having enough knowledge about early childhood science education.

Table 2 shows that the mean of participants' scores gained on *Factor 2 Knowledge level of the teacher concerning application* is 18.23, which refers to unqualified. The research found out that teacher candidates are unqualified in terms of their knowledge level in relation to applications. More specifically, teacher candidates think that it is the teachers who find different solutions to problems and just let children select one of those solutions; it is teachers' role to tell children what happened during experiments; science includes abstract information and children are not able to grasp abstract information; it is teachers' responsibility to make evaluation of science activities; it is teachers' role to conduct experiments and children only watch it; since group work causes chaos in the class, it is not a good idea to organize group work; concept maps are not proper technique in early childhood science education; problem solving is just related to math, not science; the topics like the world, stars, light, magnetic objects, are not proper topics for early childhood science education and should not be included in the related curricula; since water, sand and mud are dirty work, they should not be included in the curriculum.

Table 2 shows that the mean of participants' scores gained on *Factor 3 General knowledge level of the teacher concerning science activities* is 27.83, which refers to highly qualified. Accordingly, it can be said that teacher candidates are highly competent in terms of their knowledge level in relation to science activities. More specifically, teacher candidates think that early childhood science education helps children develop observation, creative thinking and problem solving skills; there should be science/nature corner in every early childhood classroom; science activities should be planned to promote children's observation, creative thinking and problem solving skills; teacher should learn and search with children; s/he let children use simple tools and materials in science activities; and s/he uses different techniques in science activities, painting and drawing graphics.

Table 2 shows that the mean of participants' scores gained on *Factor 4 Teacher behaviors during application* is 10.80, which refers to qualified. Accordingly, it can be said that teacher candidates are qualified in terms of their behaviors during the application of science activities. More specifically, teacher candidates think that s/he do not tell what children should do at every step of an experiment; s/he let children do their concept map on their own along with the support of the teacher as needed; s/he integrate science education with music, drama, Turkish language activities, literacy and play.

In general, Table 2 shows that the mean of participants' scores gained on the whole scale in total is 99.87, which refers to qualified. Accordingly, it can be said that teacher candidates are qualified in science activities.

b) University

Table 3 shows whether the scores that early childhood teacher candidates got on The Early Childhood Teachers' Qualifications in Science Activities Scale is related to the universities they attended.

In terms of Factor1, Table 3 shows that the mean of DEF' scores is higher than the mean of other universities' scores. In terms of Factor2, Table 3 shows that the mean of AKEF' scores is higher than the mean of other subjects' scores. In terms of Factor3, Table 3 shows that the means of GFE and DEF' scores are higher than the mean of other subjects' scores. In terms of Factor4, Table 3 shows that the means of GTEF and DEF scores are higher than the mean of other university' scores.

Table 3. The results of the Kuruskal Wallis H Test concerning the scores that early childhood teacher candidates got on The Early Childhood Teachers' Qualifications in Science Activities Scale according to the universities they graduated

Factors	University	N	Mean Rank	Sd	X^2	P
1.Materials and methods used by the teacher	GFE	51	95,69	.675	3	.879
	GTEF	79	97,91			
	AKEF	41	100,55			
	DEF	26	106,38			
	Total	197				
2.Knowledge level of the teacher concerning application	GFE	51	91,32	3,441	3	.328
	GTEF	79	95,55			
	AKEF	41	111,32			
	DEF	26	105,12			
	Total	197				
3.General knowledge level of the teacher concerning science activities	GFE	51	103,54	1,072	3	.784
	GTEF	79	96,32			
	AKEF	41	95,09			
	DEF	26	104,40			
	Total	197				
4.Teacher behaviors at the time of application	GFE	51	90,60	3.140	3	.371
	GTEF.	79	104,23			
	AKEF	41	92,91			
	DEF	26	109,19			
	Total	197				
Total	GFE	51	88,22	3.565	3	.312
	GTEF	79	98,24			
	AKEF	40	102,88			
	DEF	26	112,73			
	Total	196				

P>0.05.

However, when all the factors are examined separately or together it can be seen that the difference between the means is very small. As seen in Table 3, it can concluded that there is no significant university difference in scores on The Early Childhood Teachers' Qualifications in Science Activities Scale for each university's teacher candidates ($X^2_{(3)}$= 3.565, p>0.05).

Unal and Akman [39] have found out in their research on the attitudes of early childhood teachers towards science activities that, in terms of teachers' attitudes about feeling comfort or discomfort in science, teachers holding an undergraduate and master degree adopt more positive attitudes than the ones with an associate degree (i.e. 2 year education after high school). Similarly, teacher candidates with master degrees have a more positive attitude than high school graduates. In the research, it has been argued that since teachers holding a graduate degree take science and mathematics courses as separate courses, they feel more comfortable carrying out science activities. When these findings are evaluated together with the results of the research, it can be argued that science courses given at the undergraduate level support teacher candidates' qualifications to lead science activities.

c) Grades of undergraduate science courses

Scores that early childhood teacher candidates got at The Early Childhood Teachers' Qualifications in Science Activities Scale according to their science course grades at the undergraduate level are given in Table 4.

According to the Table 4, there is not a significant difference among the scores of teacher candidates on they got from The Early Childhood Teachers' Qualifications in Science Activities Scale *(F (7-188) =1,009; p>.05)* according to their science course grades at the undergraduate level.

Table 4. Results of One-Way ANOVA of scores on Early Childhood Teachers' Qualifications in Science Activities Scale according to their science course grades

	The source of the variance	Total sum of the square numbers	Sd	Average of the square numbers	F	p
Materials and methods used by the teacher	Among groups	193,465	7	27,638	,873	,529
	Within groups	5985,530	189	31,669		
	Total	6178,995	196			
Knowledge level of the teacher concerning application	Among groups	213,301	7	30,472	,487	,843
	Within groups	11831,958	189	62,603		
	Total	12045,259	196			
General knowledge level of the teacher concerning science activities	Among groups	174,594	7	24,942	1,710	,109
	Within groups	2756,208	189	14,583		
	Total	2930,802	196			
Teacher behaviors during application	Among groups	30,783	7	4,398	,781	,604
	Within groups	1063,887	189	5,629		
	Total	1094,670	196			
Total	Among groups	787,126	7	112,447	1,009	,426
	Within groups	20950,792	188	111,440		
	Total	21737,918	195			

p>0.05.

d) Type of high school being attended

Results concerning the scores that early childhood teacher candidates got from The Early Childhood Teachers' Qualifications in Science Activities Scale according to the type of high school attended are given in Table 5.

Table 5. Results of One-Way ANOVA of scores on Early Childhood Teachers' Qualifications in Science Activities Scale according to the type of high school they graduated

	The source of the variance	Total sum of the square numbers	Sd	Average of the square numbers	F	p
Materials and methods used by the teacher	Among groups	61,265	3	20,422	0,644	0,587
	Within groups	6117,730	193	31,698		
	Total	6178,995	196			
Knowledge level of the teacher concerning application	Among groups	16,589	3	5,530	0,089	0,966
	Within groups	12028,670	193	62,325		
	Total	12045,259	196			
General knowledge level of the teacher concerning science activities	Among groups	5,958	3	1,986	0,131	0,942
	Within groups	2924,844	193	15,155		
	Total	2930,802	196			
Teacher behaviors during application	Among groups	15,720	3	5,240	0,937	0,424
	Within groups	1078,950	193	5,590		
	Total	1094,670	196			
Total	Among groups	322,797	3	107,599	0,965	0,411
	Within groups	21415,122	192	111,537		
	Total	21737,918	195			

P>0.05.

Table 5 shows that there is no significant difference in teacher candidates' qualifications to conduct science activities in connection with the type of high school they graduated (F (3-192)=0.965 p>0.05).

Parallel to the findings of the current study, Aykut [30] has found in his research that there is not a significant difference in teachers' opinions in science education according to the type of high school they attended.

The current research has shown that teacher candidates' level of qualification to conduct science activities does not vary according to the type of high school they graduate. When evaluated together with the results of the other research, the type of the high school can be argued to have little influence on the science education provided at the undergraduate level.

4. 2. Findings of the open-ended questions asked teacher candidates about science activities

The answers of the teacher candidates to these open-ended questions are analyzed and sub-themes are identified for each question. Frequency and percentage is calculated for those sub-themes. Example excerpts from the teacher candidates' answers are given.

Question 1: What do you think about the argument that science education at the early childhood level is inessential and that it should start only at the primary school level?

Based on the sub-themes appeared from the answers, Table 6 presents teacher candidates' opinions about whether science education should start at early ages.

Table 6. The teacher candidates' opinions about whether science education should start at early ages

Sub-themes	N	%
It should definitely start at the early childhood level	112	100
Total	112	100

When Table 6 is analyzed, it can be concluded that all of the teacher candidates argue for science education at the early childhood level. The following excerpts from the teacher candidates' answers emphasize this point:

- It is possible to teach science in concrete ways.
- Early childhood science education can be given at the basic level.
- Science education can be given through activities in accordance with the development level of children.

Many researchers [26, 30-34] have concluded in their research that all of teachers who participated in their research hold the idea that science education is essential at the early childhood level. In the research conducted by Aykut [30] it has been found out that 93.9 % of the teachers agree with the idea that early childhood education should include science activities.

At this point, rather than question whether science education should be given or not at the early ages, further research should explore how a qualified science education can be provided.

Question 2: Can you develop the materials needed for science activities on your own? Do you need any support to do this?

The sub-themes appeared from teacher candidates' opinions about developing materials for science activities are given in Table 7.

Table 7. Distribution of teacher candidates' opinions about developing materials for science activities

Sub-themes	N	%
No Answer	1	0,9
Yes, I can develop materials on my own. I need no support.	58	51,8
I feel unable to develop my own materials. I need support.	23	20,5
I need partial support.	30	26,8
Total	112	100

When Table 7 is analyzed, it is seen that 51.8% (N=58) feel competent enough to developing materials for science activities and need no support. The percentage of teacher candidates who feel unable to develop my own materials for science activities is 20.5 (N=23). The percentage of teacher candidates who feel competent in part and state their need for

support is 26.8 (N=30). It is seen that the percentage of teacher candidates who feel competent in developing materials for science activities and need no support and the percentage of those who feel incompetent in total or part and need some support are close to each other.

Some excerpts from teacher candidates' answers on the issue are given below:

Participant 1: I don't think I can develop materials for science activities.

Participant 2: I made a house model for a light and shadow experiment and put opaque, translucent and transparent items on the windows of the house.

Participant 3: I cannot develop enough materials. Rather I use readymade materials. I need support.

Participant 4: I try to develop materials on my own even though I sometimes find it quite difficult. However, I think I need support.

Participant 5: I can develop some materials on my own. But I think there should be special courses for material development in science.

Participant 6: I can develop materials on my own thanks to the courses I have taken. I feel competent to do this.

After analyzing the answers given, it is observed that the teacher candidates have developed science materials such as experiment mechanisms, wind roses, graphics, concept maps, size and weather graphics, materials about planets and body organs, magnifying glasses, materials for friction, scales, telephones, noisy pipes, tissue samples with clothes, mechanisms on balloons that show the development phases of the caterpillar, and air sacs of the fish.

In his research, Ayvaci et al. [35] has found out that early childhood teachers cannot develop original materials for science activities. Karaer and Kosterellioglu [36] have come to the conclusion in their research that early childhood teachers do not feel confident to develop materials for science activities. Ozbey and Alisinaoglu [31] have found in their research the percentage of early childhood teacher candidates who feel competent to develop materials for science activities at 14%. The rest have stated that they need support because they do not feel confident or feel partially competent. In the research of Goktas et al [34], early childhood teachers are asked in what ways they do not feel confident and 44.6 % of them say they do not feel confident in material development.

Considering the results of the given research, it can be argued that since 51.8 % of the teacher candidates in the current research feel competent in science materials development, the current science courses offered at the undergraduate level throughout Turkish universities provide the teachers candidates useful information and support their skills in terms of material development.

Question 3: Do you think that science education courses given at the undergraduate level are sufficient? What are your expectations about science education courses?

Table 8. Distribution of teacher candidates according to their opinions about whether the science education courses given at the undergraduate level are sufficient

Sub-themes	N	%
I think it is perfectly sufficient	31	27,7
I don't think it is sufficient. It should be offered in two semesters and the course hours are not enough.	24	21,4
It is sufficient in terms of theoretical information, but not in terms of practice.	57	50,9
Total	112	100,0

When Table 8 is analyzed, it can be seen that the percentage of teacher candidates who think that the science courses are perfectly sufficient is 27.7 % (N=31), the percentage of those who think science course is sufficient in theoretical terms but not in practice is 50.9 (N=57), and the percentage of those who say that number of course hours is inadequate 21.4 % (N=24). Some of the excerpts from the answers of teacher candidates about the issue are given below:

Participant 1: I don't feel myself competent because the courses' contents lack enough practice.

Participant 2: The professor can present example activities in class for the application of science activities.
Participant 3: We presented our activities imagining our class as a preschool class, but that does not match the reality. I think that it would be more useful if we could have the chance to apply our activities with children at real preschools.
Participant 4: Science courses should be offered for two semesters at least.
Participant 5: I don't think they are perfectly sufficient. There should be more course hours.
Participant 6: The theoretical contents of the courses are sufficient, but there should be more practical examples.
Participant 7: In general, undergraduate study mostly includes theoretical information. Since we are not experienced enough in practice, we might have difficulties when we start working.
Participant 8: Science education courses focus mostly on experiment practices, therefore I think they are not rich enough in content.
Participant 9: Science education courses are not sufficient. The scope of the courses should be broadened and they should include more practice.

Similar to the findings of the current research, Ozbey and Alisinanoglu [31] have found in their research that 60% of the teacher candidates involved in their research think that their science courses were not sufficient. In the research, the teachers argue for the enrichment of course content in science courses and for more practice.

Moreover, in the research conducted by Ozbek [33], early childhood teachers are asked whether the science courses they took at the undergraduate level were sufficient for them, and 14.1 % of the teachers say science courses were sufficient while 46.9 % say they were not. Those who think that their science courses were partially sufficient are 39.1% of all.

Kildan and Pektas [42] have proposed in their research that the knowledge of early childhood teachers about science and nature obtained during their undergraduate education should include in-service training.

In the research that Goktas et al [34] carried out, while 39.6% of early childhood teachers say that they don't think the science courses they took during their undergraduate studies were sufficient, 21.8 % say that the science courses were sufficient, and 35.1% say that they are partially sufficient.

When the results of the current research are compared to the previous research, it can be said that similar findings have been reached. Most of the teacher candidates think that science courses given at the undergraduate level are considered insufficient in terms of practice or both practice and theory and want more hours on those.

Question 4: Do you think that course books guiding early childhood teachers about science activities are sufficient? Do you have any suggestions about this issue?

Table 9. Distribution of teacher candidate opinions about whether books on science activities are sufficient

Sub-themes	N	%
No Answer	5	4,5
I think they are sufficient	31	27,7
I don't think they are sufficient	37	33,0
I think they are partially sufficient. They should be developed and they should be enriched in terms of application.	39	34,8
Total	112	100,0

According to the Table 9, 27.7% (N=31) of the teacher candidates think that books on science activities are sufficient; 33% (N=37) of the teacher candidates think that they are insufficient and 34.8% of the teacher candidates think that they are partially sufficient. When findings in the table are analyzed, it is seen that nearly 70% of the teacher candidates think that books for science practice are not sufficient enough for various reasons.

Some of the excerpts from the answers of teacher candidates about the issue are given below:

Participant 1: I think CD-ROM support is necessary to show how experiments in books are carried out.

Participant 2: There are enough books available, but activities in the books are generally limited, with much repetition of the same type of activities.
Participant 3: There are mostly the same few activities in books. I think academicians and teachers need to produce original activities and new source books for teachers.
Participant 4: I don't know much about books.
Participant 5: Books should include more practical examples than theoretical information.
Participant 6: There are fewer books on science activities than on other topics. More creative books could be prepared.
Participant 7: There are enough books on science activities. But I think that academicians should work on this issue and write those books or encourage related experts to write them.

Parallel to the findings of the current research, Ozbey and Alisinanoglu [31] have found in their research that 56% of the teachers think that books for science activities are not sufficient. It can be concluded that more books including both theoretical information and examples, should be published.

Question 5: Do you feel competent enough in planning and applying science activities? What kind of support do you need?

Table 10. Distribution of teacher candidates according to their feelings about their qualifications in planning and applying science activities

	N	%
No answer	5	4,5
I feel competent	47	42
I don't feel competent	15	13,4
I sometimes do not confident	45	40,2
Total	112	100

It is seen in Table 10 that in terms of planning and applying science activities, 42% (N=47) of the teacher candidates feel competent, 13.4% (N=15) of them feel incompetent and 40.2% (N=45) of them feel partly competent. Based on the table, it can be argued that 53.7 % of the teacher candidates always or sometimes unconfident in planning and applying science activities for various reasons.

Some of the excerpts from the answers of teacher candidates about the issue are given below:

Participant 1: I don't feel competent at all. I would like to observe how early childhood teachers apply science activities in class.
Participant 2: I need support in the planning and application of science activities other than experiments.
Participant 3: I feel quite competent about this issue, because I did not confine myself to courses only. I improved myself with further research. I need support especially in planning.
Participant 4: I feel competent in planning and practice, but I need to learn more activity examples.
Participant 5: I have difficulties in planning, but I feel competent in practice.

In the study of Ozbey and Alisinanoglu [31], 74% of early childhood teachers have said that they feel incompetent in planning and applying science activities for various reasons.

On the other hand, in the research conducted by Ozbek [33], 45.3% of teachers have stated that they feel competent in planning science activities, 15.6% say they feel incompetent and 39.1% say they sometimes feel incompetent. Of the teachers, 54.7% feel either completely or partially incompetent for various reasons. Moreover, in the study of Goktas et al [34] , it has been found out that in terms of planning of science activities, 43.6% of the teachers feel competent, 23.3% feel incompetent and 32.7% feel incompetent from time to time. According to the study, 56% of the teachers feel completely or partially incompetent.

Question 6: What are the methods and techniques you employ in science activities?

The distribution of the methods and techniques employed by teacher candidates are given in Table 11.

Table 11. The distribution of the methods and techniques employed by teacher candidates

Methods and techniques used in science activities	F	%
Painting	87	77,7
Group work	75	67,0
Project	72	64,3
Question and Answer- Discussion	58	51,8
Art work	56	50,0
Play	55	49,1
Concept map	52	46,4
Drama	51	45,5
Literacy (Turkish language)	49	43,8
Experiment	37	33,0

According to the Table 11, it can be seen that teachers use painting the most, the percentage being 77.7%; and then successively group work (67%), question and answer discussion (51.8%), art works (50%), play (49.1%), concept map (46.4%), drama (45.5%), literacy (Turkish language) (43.8%) and experiments (33%). In the light of these findings, it can be argued that teachers employ methods such as painting, group work and projects more while they conduct experiments less often.

When the literature is examined, parallel results from different research appear. For example, Ayvaci et al [35] has found that early childhood teachers do not make use methods such as play, drama, discussion and problem solving. On the other hand, in the research of Ozbey and Alisinanoglu [31], it has been found that teachers mostly use field trips, question/answer discussions, group work, integrated work (drama, language, art and play), experiments and concept maps respectively. Ozbek [33] has found that teachers use experiments more than other science activities. In Aykut's [30] research, early childhood teachers have stated that they feel most competent when they use experiment and observation methods.

In their research, Karamustafaoglu and Kandaz [37] have found that in science and nature activities, early childhood teachers use direct instruction method most while they use project work least. In their research, direct instruction (100%), dramatization (62%), using hand-made models (56%), conducting experiments (44%), using concept maps (32%), playing games (30%), using analogies (12%) and employing project work (2%) respectively are said to be used by teachers.

Question 7: What are the points you pay the most attention to in the assessment of children`s science activities?

Criteria taken into account by teacher candidates in the assessment of science activities are given in Table 12.

Table 12. Opinions of teacher candidates about the assessment of science activities

Sub-themes	F	%
I pay attention to children's comprehension level, comments, answers, their ability to establish cause and effect relationships, their problem solving skills, science process skills, and their ability to use knowledge.	64	57,1
I pay attention to the level of their participation.	15	13,4
I pay attention to whether children are interested and having fun.	24	21,4
I pay attention to whether goals and benefits are achieved.	20	17,9
I pay attention to my own success.	6	5,4
I pay attention to the development level of children.	10	8,9

When Table 12 is analyzed, it is seen that of the teacher candidates, 57.1% (N=64) take into consideration children's comprehension level, comments, answers, their ability to establish cause and effect relationship, their problem solving skills, science process skills and their ability to use knowledge, 13.4 % (N=15) pay attention to the level of their participation, 21.4 % (N=24) pay attention to whether children are interested and having fun, 17.9 %

(N=20) pay attention to whether goals and benefits are achieved, 5.4 % (N=6) pay attention to their own success and 8.9% (N=10) pay attention to the child's development level while doing the assessment.

In the research of Ozbey and Alisinanoglu [31], teachers stated that while doing the assessment, they generally pay attention to the interest of children and whether goals and benefits are achieved or not. Researchers [17, 25-28] underline that the importance of assessing the science process skills of children and closely following the criteria to be used in the assessment of scientific processes such as observation, classifying, communication, measurement, prediction and conclusion.

The assessment process of science activities should be done in detail. It should involve the pre-activity period as well as the interests of children, questions they ask, discussions they have in class with friends and teachers throughout this process, their comprehension level of this process, and their induction skills when establishing cause and effect relationships [31].

The fact that teacher candidates pay attention to children's science process skills with a percentage of 57.1, and that they also pay attention to their ability to establish cause and effect relationships, their problem solving skills, their application of knowledge, and so on, can be interpreted as an indicator that teachers who have recently graduated from the university do not have traditional assessment attitudes in the planning and implication of science activities.

Question 8: Do you think you can apply science activities every day in a regular fashion when you start teaching?

Table 13. Opinions of teacher candidates about the application of science activities every day in a regular fashion

Sub-themes	N	%
No answer	5	4,5
Yes, I think I can.	47	42
No, I don't think I can.	22	19,6
Maybe not every day, but I could apply science activities 2-3 times a week	38	33,9
Total	112	100

According to Table 13, of the teacher candidates 42% (N=47) think that they can apply science activities regularly, while 19.6% think they cannot apply science activities regularly, and 33.9% think that they can apply science activities twice or three times a week. When these rates are analyzed, it can be argued that 75.9 % (N=85) of the teacher candidates think that they can apply science activities at least 2-3 times a week in a regular fashion.

Uysal [32] argues that the daily course plans of early childhood teachers do not include a sufficient number of science activities. According to teachers, inadequate physical conditions and lack of materials are the cause of this. In Aykut's [30] research, 7.8% of early childhood teachers surveyed say that they can apply science activities every day, 21.7% every 2-3 days, 35.3 % once a week, 15.3% every two weeks, 20% once or twice a month. Ozbek [33] has searched how much early childhood teachers deal with science activities in their daily plans and has found that teachers generally carry out our science activities twice or three times a week. In their research, Ozbey and Alisinanoglu [31] have found that more than half of the teachers involved in the research cannot regularly carry out science activities.

5. Conclusion

Quality early childhood teachers should be able to provide children with quality science education. For example, a teacher should be able to organize the environment to include science materials and then provide time for children to work with the materials. In addition, teachers should help children work in both small and large group environments, encourage children to discuss events during science activities, and guide them in using resources in their

research, such as journals, newspapers, and encyclopedias. Teachers should encourage children to discuss what they found in different resources and what they observed, create activities to help children test their hypotheses, look for answers to their own questions, and use science process skills in science activities [40-43]. To accomplish quality science education, it is also essential to know the strengths and weakness of teachers and whether some factors make an important impact on quality.

In the current research, it has been found that the qualification level of early childhood teacher candidates in regard to planning and carrying out science activities does not significantly depend upon teachers' former high schools, the universities they currently study at or their science course grades. Moreover, the research shows that the qualification level of teacher candidates concerning science activities is high in general.

However, the research discovered that teacher candidates are unqualified in terms of one factor out of four, namely their knowledge level in relation to applications. More specifically, teacher candidates have some misbelieves: It should be the teacher who finds solutions to problems and not the children; it is the teacher's role to say what happened during experiments and not the children's; children do not have the capacity to comprehend science; it is the teacher's responsibility to evaluate science activities and not the children's; it is the teacher's role to conduct experiments and children only watch it; since group work causes chaos in the class, it is not a good idea to organize group work; concept maps are not a proper technique in early childhood science education; problem solving is just related to math and not science; the world, stars, light, and magnetic objects are not proper topics for early childhood science education and should not be included in the related curricula; since water, sand and mud are dirty work, they should not be included in the curriculum. It is essential for university professors to take action to correct these misbelieves of early childhood teacher candidates.

When teacher candidates' answers to the open-ended questions are evaluated, it becomes clear that some issues need to be taken into consideration:

- Half of the teacher candidates do not feel confident in developing materials for science activities.
- Likewise, a large part of teacher candidates think that the science courses they took during their undergraduate studies were sufficient in theoretical terms, but as for offering new practical examples, they were insufficient.
- Books involving science activities are considered insufficient by teacher candidates in terms of practical examples and originality.
- More than half the teacher candidates ask for support because they state that they don't feel competent enough to plan and carry out science activities.
- About half of the teachers say that they will not be able to apply science activities regularly.

Although the positive results of the research are encouraging, the educators need to take into consideration the negative results of the study. Considering there is a possibility that teacher candidates' beliefs about early childhood science activities will persist after graduation from the university, it is essential to take some actions based on the findings of the research. Taking into consideration all of the results of this study, the authors make the following suggestions:

Teacher candidates think that they will not be able to regularly carry out science activities in class when they start working. This could stem from the fact that they regard science activities as comprehensive and as activities difficult to carry out. In order to change this assumption, instructors of science education courses should teach simple ways to include science activities in class and present examples to students. Many teacher candidates do not feel confident in planning and applying science activities. According to them, this is caused by the fact that the science courses offered at the undergraduate level mostly include theoretical knowledge and lack enough practice. In this respect, it can be suggested that

instructors of science courses arrange their schedules to enable students to present the science activities that they have carried out in early childhood classrooms, rather than performing those activities solely in university classrooms. Besides, the content of science courses needs to be enriched in terms of material development for science activities.

It has been stated by teacher candidates that existing books on science activities are insufficient. Therefore, it is quite obvious that instructors specializing in this field need to work on producing new books on science activities.

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