Chapter 17

An Investigation of Postgraduate Theses on Scientific Process Skills in Preschool Education in Turkey

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Abstract

Scientific process skills (SPS), which are the thought and behavior processes used for science, are skills that facilitate learning in science education. To raise scientifically literate individuals, gaining scientific thinking skills in early childhood is important. This research paper examined scientific process skills in postgraduate theses covering preschool education in Turkish literature. According to the convenience sampling method, 53 graduate theses, the full text of which was accessed from the national thesis center, were evaluated according to the thesis review form. According to the results of the analysis, more than half of the graduate theses related to scientific process skills are master's theses. More than half of the theses are of quantitative research type. When analyzed in terms of the research methods preferred in the theses, the majority of them included experimental research method. According to the sampling method used in the theses, about half used random sampling. Looking at the sample group in the theses, the sample group of most theses consisted of preschool students. It was seen that more than half of the theses included a scale of science process skills.

1. Introduction

Science and technology are changing rapidly in our age. These changes affect individuals and societies. Changes lead individuals to be able to produce knowledge, use it functionally in life, solve problems, think critically, be entrepreneurial, and determined, have communication skills, empathize, contribute to society and culture, etc. At the same time, it forces societies to catch up with changes in science and technology to take their place in

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international competition (MEB, 2018). Science education is an important area to access to current science and technology (Akman et al., 2017). In other words, science education is a tool for understanding and exploring the world. In other words, science education is the education of the food eaten, the water drunk, the car driven, and the electricity used (Gürdal, 1988). Science education contributes to the individual's creative thinking skills, effective communication with teachers, family, and friends, language development, reasoning skills, and the ability to easily solve daily problems (Hancer et al., 2003). The aim of teaching science in schools, which is the process of thinking about the nature of knowledge, understanding existing knowledge, and producing new knowledge, contributes to raising scientifically literate individuals (Çepni et al., 1997; Korkmaz, 2002; MEB, 2018). A scientifically literate individual can comprehend the relationship between science, technology, and society, and can use his/her knowledge in the field of science in solving problems encountered in daily life (Ayvacı & Özbek, 2017). Science literacy plays an important role in developing an individual's ability to maintain meaningful and productive jobs in the future and in enabling societies to keep up with the times (NRC, 1996). Science literacy includes understanding basic science concepts, the nature of science, and the interrelationship between science-technology-society-individual (Liu, 2009). The American Science Association states that a scientifically literate individual uses scientific thought processes to understand scientific concepts and principles and the natural world (AAAS, 1989). Scientific process skills, which facilitate learning to raise scientifically literate individuals, have an important role in science education (Akman et al., 2003).

Scientific process skills are the processes of thought and behavior used for science (MEB, 2018). Scientific process skills are to enable students to gain research methods, be active, and develop a sense of responsibility in learning (Çepni et al., 1997). In the education process, it is important to answer the question of when and at what level these skills should be acquired. Children begin to access information at an early age with a sense of curiosity and research (Tan & Temiz, 2003). From this point of view, scientific process skills should be taught to children from an early age to provide them with a scientific perspective (Kandemir, 2012). The early childhood period, when development and learning are the fastest, is the period when learning takes place actively in interaction with the child's environment. Experiences and gains acquired at an early age contribute to the development of cognitive-affective-social skills and later life skills (Kesicioğlu, 2019). One of the early childhood education is the pre-school education period (Babaroğlu, 2017). Educational activities in the preschool term have short and longterm benefits for the child's cognitive, affective and social development (Barnett, 1992). Today, the changes and developments of information and technological advances are based on a child-centered approach to education and offer a learning experience that takes into account the learner's interests and abilities. This new approach states that the learner is responsible for his/her learning and that learning takes place as a whole. Thus, early childhood education should be supported with child-centered activities (Ekici, 2015). Science education, which includes child-centered activities in this period, is the basic step in the development of creative thinking skills. Preschool science education provides the opportunity to see how children can use information from daily life (MEB, 2013). Scientific process skills, one of the important steps of science education, enable children to raise as scientifically literate individuals (Saraçoğlu, 2012). Therefore, it is important to train children in scientific process skills in preschool education.

2. Scientific Process Skills

Scientific process skills (scientific thinking skills) are the skills of thinking about the scientific problem and presenting the results. Scientific process skills, which are the most powerful tool in producing knowledge about the world, contribute to the student's knowledge structuring, being active, taking responsibility, gaining research methods, and permanence in learning (Arslan & Tertemiz, 2004). Scientific process skills, which include actions such as making scientific predictions by observing the physical and social world, explaining, questioning, and hypothesizing, are thinking skills used in the production of scientific knowledge. Scientific process skills facilitate science learning, allow students to be active and responsible in their learning, and contribute to retention in learning (Çepni et al., 1997). It is known that scientific process skills have a significant effect on attitude towards scientific research (Bahtiyar & Can, 2016), scientific creativity (Aktamış & Ergin, 2007), academic achievement (Mutlu, 2012), and attitude towards science (Yamak et al., 2014). There are some classifications of science process skills in the literature (e.g. Arslan, 1998). In the classification of scientific process skills, it is seen that a step is followed from simple skills to complex skills (Ergin et al, 2005). It is important that teaching from basic to integrated skills is well organized according to the grade level. Some of the skills categorized in the literature are described below (e.g. Akman et al., 2017; Barman, 1992; Çepni et al., 1997; Padilla, 1990; Rezba et al., 2003):

2.1. Basic Skills

2.1.1. Observation

The most basic skill is the ability to observe. However, observation is the most complex skill. The skill of observation, which forms the basis for other skills, is to examine objects directly with the sense organs or indirectly with tools such as telescopes, microscopes, etc. that increase the sensitivity of the sense organs. One or more of the sense organs can be put to work. In other words, the ability to observe is to look, smell or feel carefully and systematically. In science activities, color, size, shape, etc. properties of objects can be observed.

2.1.2. Classification

Classification is the ability to group objects according to certain characteristics. The ability to classify involves grouping objects according to similarities or differences. The ability to classify is related to the ability to observe. By making a good observation, information about objects can be collected and the information collected can be organized with classification skills. Concepts can also be organized with classification skills. In science activities, binary or multiple classifications can be made according to any feature of objects such as color, size, etc.

2.1.3. Inference

Inference skills are possible opinions about an observed situation. It is the evaluation of the information emerging from observations together with experiences. Here, an idea is made about the causes of the situation. On the way to the correct inference, it is important to collect data with good observation and to interpret the observed event well with the collected data. In science activities, children's observations can be questioned.

2.1.4. Prediction

The ability to predict is the ability to anticipate the outcome of an event and/or a situation or to make judgments about the outcome based on experience. In other words, it predicts what the outcome of the event will be. Prediction is achieved through good observation and sensitive measurement. It is achieved by collecting and analyzing appropriate data to support and refute the prediction. The reliability of prediction is related to the accuracy of past observations. In science activities, children can be supported to make predictions about the outcome before the activity.

2.1.5. Measuring

Measure skill is to evaluate the properties of objects numerically. Measurement can take place through direct comparison or with a standard unit. In measure skill, which is the process of comparing an unknown quantity with a known quantity, the object is evaluated quantitatively, its properties are determined or expressed in numbers. In science activities, children can measure changes in the properties of objects such as weight and lightness by observing them and use simple measuring tools.

2.1.6. Communication

The communication is to communicate data obtained through observation in a way that others can understand. In the ability to communicate, it is important to record data to control and present the organization of information. Recording data can be done verbally as well as with representative visuals such as pictures, graphs, etc. In science activities, children can share their work by drawing and using body language.

2.2. Integrated Skills

2.2.1. Interpreting Data

The ability to interpret data is a communication skill to answer the question asked in the problem. Data interpretation involves presenting the results of the analysis. Using representative visual tools such as tables and graphs and statistical skills used in data analysis facilitates interpretation. In science activities, children can interpret the data obtained by comparing it with previously thought data.

2.2.2. Hyphotheses

Questions, predictions and inferences are important in hypothesizing. The ability to form hypotheses are propositions that can test the truth of the problem. A hypothesis is useful when it is tested by observation or experiment. Therefore, a hypothesis based on observations and scientific principles is a good proposition when it is clear, specific, and testable. In hypothesis formulation, there are steps of determining the problem to be investigated well, then collecting and testing data about the problem. The hypothesis should be designed so that its truth or falsity can be proven. In science activities, children can create testable statements based on hypotheses.

2.2.3. Experimentation

The ability to conduct experiments is the ability to design processes of collecting data, testing data, changing variables, controlling variables, and recording data. An experiment can also be based on an observation. Even if it is an observational process, the experiment is based on a plan. Experimentation involves testing hypotheses by collecting empirical evidence. In science activities, children can design experiments to answer the questions they pose.

In addition to these skills from simple to complex, some skills cannot be mentioned such as changing variables and evaluation in this paper. Although the classifications of scientific process skills generally differ according to researchers, it is known that there are more limited skills (such as observation, classification, and measurement) that preschool children should have (AAAS, 1993).

3. Scientific Process Skills in Preschool Education Postgraduate Theses

There are many theses written on scientific process skills in Turkey. Theses are published in the library system of universities and the National Thesis Center of the Council of Higher Education (YOK), where all theses are archived from a common point. The abstract and/or, depending on open access, the full text of the theses produced in Turkish universities can be accessed from the electronic environment of the YOK National Thesis Center (https://tez.yok.gov.tr/UlusalTezMerkezi/). Postgraduate theses related to scientific process skills written within the scope of the preschool period were searched by YOK National Thesis Center. The terms "*preschool education*", "*early childhood education*", and "*scientific process skills* (SPS)" were used for the search on the relevant web. According to the appropriate sampling method, within the framework of these concepts, 53 theses were accessed as open-access full text from the YOK National Thesis Center (Attachment 1). The theses were examined in terms of masthead (year, program) and method (research type, research method, sampling method, sampling group, measurement tool, statistical method) by using the thesis review form developed by Sarı (2011). The SPSS 27 (Statistical Package for the Social Sciences) program was used to analyze the data obtained from theses using the thesis review form. According to the thesis review form, coding compatibility was considered to ensure reliability in theses. In this respect, Miles and Huberman's (2015) formula (Reliability = Consensus/(Consensus + Disagreement)) was used to check the reliability of the researcher's coding and another researcher's coding. The coding agreement rate was calculated as 92%. Analysis results, frequency (N), and percentage (%) values are given. This analysis's result is important in determining the tendency related to scientific process skills in postgraduate theses related to preschool period and guiding future studies.

3.1. Distribution of theses according to years

The distribution of postgraduate theses related to scientific process skills, which can be accessed open access from YOK National Thesis Center, according to years is shown in Table 1.

Table 1. Distribution of theses according to years

Year	N	%
2010	1	1.9
2012	1	1.9
2014	2	3.8
2015	3	5.7
2016	5	9.4
2017	2	3.8
2018	3	5.7
2019	13	24.5
2020	3	5.7
2021	4	7.5
2022	4	7.5
2023	10	18.8
2024	2	3.8
Total	53	100.0

When Table 1 is examined, it is seen that scientific process skills in postgraduate theses written in preschool education were published in 2019 (24.5%), followed by 2023 (18.9%). According to the years, 2 or more theses on scientific process skills were published as of 2014.

3.2. Distribution of theses according to postgraduate program

The distribution of postgraduate theses related to scientific process skills, which can be accessed openly from the National Thesis Center, according to the postgraduate program is shown in Table

Table 2. Distribution of theses according to postgraduate program

Program	N	%
Master	38	71.7
PhD	15	28.3
Total	53	100.0

According to Table 2, 71.7% of the postgraduate theses on science process skills were master's theses, while 28.3% were doctoral theses.

3.3. Distribution of theses according to research type

The distribution of postgraduate theses related to scientific process skills, which can be accessed open access from the National Thesis Center, according to the type of research is shown in Table 3.

Table 3. Distribution of theses according to research type

Research Type	N	%
Mixed Model*	9	17.0
Qualitative	5	9.5
Quantative	35	66.0
Quantitative * Qualitative	4	7.5
Total	53	100.0

**** It is quoted as expressed in the theses.***

According to Table 3, 66% of the postgraduate theses on science process skills were quantitative, 9.5% were qualitative and approximately 25% were multiple research types.

3.4. Distribution of theses according to research method

The distribution of postgraduate theses related to scientific process skills, which can be accessed open access from the National Thesis Center, according to the type of research is shown in Table 4.

Table 4. Distribution of theses according to research method

Research Method	**N**	**%**
Action Research	3	5.7
Case Study	1	1.9
Correlational Method	1	1.9
Descriptive Method	9	17.0
Descriptive Method, Case Study	1	1.9
Embedding Mixed	1	1.9
Experimental Method	33	62.3
Experimental Method, Case Study	1	1.9
Mixed Method	3	5.7
Total	53	100.0

According to Table 4, among the research methods in postgraduate theses on science process skills, the experimental method (62.3%) was used the most; the survey method (17.0%) was used the second; the action research method (5.7%) and the mixed method (5.7%) were used the third. In the theses, 1.9% used case study, 1.9% used the relational method, and 1.9% used the grounded theory method. When Table 4 is examined, 1.9% of the theses used the survey method and case study method and 1.9% used the experimental method and case study method together.

3.5. Distribution of theses according to the sampling method

The distribution of postgraduate theses related to scientific process skills, which can be accessed open access from the National Thesis Center, according to the sampling type is shown in Table 5.

Table 5. Distribution of theses according to sampling method

Sampling Method	**N**	**%**
Cluster Sampling	5	9.4
Purposive Sampling	17	32.1
Random Sampling	23	43.4
Random Sampling, Cluster Sampling	1	1.9
Random Sampling, Purposive Sampling	1	1.9
Missing	6	11.3
Total	53	100.0

When Table 5 is examined, random sampling (43.4%), purposive sampling (32.1%), and cluster sampling (9.4%) methods were used in the postgraduate theses on science process skills. While 3.8% of the theses used more than one sampling method, 11.3% did not indicate the sampling method used.

3.6. Distribution of theses according to sample group

The distribution of postgraduate theses related to scientific process skills, which can be accessed open access from the National Thesis Center, according to the sample group is shown in Table 6.

Table 6. Distribution of theses according to sample group

Sampling Group	**N**	**%**
48-60-month-old Children	1	1.9
48-66-month-old Children	1	1.9
48-66 month-old Children, Preschool Teacher	1	1.9
48-66-moth-old Children, 60-66 month-old Children	1	1.9
48-72-month-old Children	2	3.8
5-year-old Children	5	9.4
5-year-old Children, First-grade Children	1	1.9
55-72-month-old Children	1	1.9
6-year-old Children	3	5.7
60-66-month-old Children	1	1.9
60-72-month-old Children	20	37.8
60-72-month-old Children, Parent	1	1.9
60-72-month-old Children, Preschool Teacher	2	3.8
60-72-month-old Children, Preschool Teacher, Academician, Parent	1	1.9
60-72-month-old Children, Preschool Teacher, Science-based Children Book	1	1.9
Preschool Children, Preschool Teacher	1	1.9
Preschool Children	4	7.5
Preschool Teacher	3	5.7
Preschool Teacher Candidate	2	3.8
Missing	1	1.9
Total	53	100.0

According to Table 6, the majority of the sample group in the graduate theses on science process skills consisted of preschool children (90.6%). In the theses, 60-72-month-old children (37.8%), 5-year-old preschool children (9.4%), and preschool children (7.5%) were the most common sample groups. While 9.4% of the theses included more than one sample group, 9.4% included only adults.

3.7. Distribution of theses according to data collection tool

The distribution of postgraduate theses related to scientific process skills (SPS), which can be accessed open access from the National Thesis Center, according to the data collection tool is shown in Table 7.

Table 7. Distribution of theses according to data collection tool

Tools	N	%	Tools	N	%
SPS Scale	5	9.4	SPS Test	3	5.7
SPS form / Observation Form	1	1.9	SPS Scale /* Game-Based Activity	1	1.9
SPS Scale / Science Activity	2	3.8	SPS Test / STEM Activity	1	1.9
SPS Scale / STEM Activity Interview Form	1	1.9	SPS Test / STEM Activity Interview Form	1	1.9
SPS Scale Basic Skills of Preschool Children Scale	1	1.9	SPS Scale Environment Scale For Children	1	1.9
SPS Scale Critical Thinking Skill Rubric	1	1.9	SPS Scale Frostig Visual Perception Scale	1	1.9
SPS Scale / Learning Styles Scale	1	1.9	SPS Scale / Nature Education Program	1	1.9
SPS Scale / Montessori's Activity	1	1.9	SPS Scale / STEM Activity	1	1.9
SPS Scale / Observation Form	1	1.9	SPS Scale / Interview Form	2	3.8
SPS Scale / Science Literacy Scale	1	1.9	SPS Scale / Science Efficacy Form	1	1.9
SPS Scale / Block Code Program	1	1.9	SPS Scale / Primary Program	1	1.9
SPS Scale / Drama-Based STEM Program Torrance creative thinking	1	1.9	Bracken Basic Concept Scale Observation Form	1	1.9
SPS Scale / Diary / Video Science Concepts	1	1.9	SPS Scale / STEM Teaching Scale Awareness Scale of STEM	1	1.9
SPS Scale / Observation Form Scale of Preschool Teachers' Competency	1	1.9	SPS Test / Interview Form Stem Activity	1	1.9
SPS Test Observation Form / Interview Form	1	1.9	SPS Interview Form Course Plan / Observation Form	1	1.9

SPS Test Decision-Making Test Problem Solving Skill Test	1	1.9	SPS Scale Evaluation of Critical Thinking Through The Philosophical Inquiry Scale	1	1.9
SPS Scale STEM Program	1	1.9	SPS Scale / Stem Activity Cognitive Field Development Form	1	1.9
SPS Scale / Science Attitude Scale Science Self-Efficacy Scale Mathematics Attitude Scale	1	1.9	SPS Form / Interview Form Problem-Solving Scale Science Self-Efficacy Belief Scale	1	1.9
SPS Scale Bracken Basic Concept Scale Inquiry-Based Science Education Program	1	1.9	SPS Scale Scale for The Tendency to Play Games Game Skills Assessment Scale	1	1.9
SPS Test / Interview Form Boehm Test of Basic Concepts Science Activity Based on Reggio Emilia	1	1.9	SPS Scale / Risk Factors List Early Childhood Resilience Scale Mathematic Content Standards Scale	1	1.9
SPS Scale Observation Form Interview Form / Document	1	1.9	SPS Scale / Observation Form Early Learning Skills Scale Interview Form / Document	1	1.9
SPS Test / Diary Early Schildhood Creativity Scale Problem-Solving Skills Scale Observation Form	1	1.9	SPS Scale Torrance Creative Thinking Photos / Observation Form 5w Form / Interview Form	1	1.9
Total	N= 53	%100			

** "/" sign is used for comma purposes.*

When Table 7 is examined, it is seen that the science process skills scale was used in the majority of the theses. The SPS (Scientific Process Skills) scale (60.8%) was used frequently in the theses, SPS test (13.2%) was used second frequently, and the SPS form (5.7%) was used third frequently. While 15.2% of the theses used a single measurement tool, the others frequently used more than one measurement tool

3.8. Distribution of theses according to statistical methods used in the research

The distribution of postgraduate theses related to scientific process skills, which can be accessed open access from the National Thesis Center, according to the data collection tool is shown in Table 8.

Table 8. Distribution of theses according to statistical method

Statical Method	**N**	**%**
Content analysis	2	3.8
Descriptive analysis	1	1.9
DFA, one-way ANOVA	1	1.9
Mann Whitney U test	2	3.8
Mann Whitney U test, Kruskal Wallis H Test	2	3.8
Mann Whitney U test, Kruskal Wallis H Test, Wilcoxon Signed Rank test	2	3.8
Mann Whitney U test, Wilcoxon Signed Rank test	10	18.9
Mann Whitney U test, Wilcoxon Signed Rank test, ANCOVA	2	3.8
Mann Whitney U test, Wilcoxon Signed Rank test, Content Analysis	2	3.8
Mann Whitney U test, Wilcoxon Signed Rank test, Spearman Correlation	1	1.9
One-way ANOVA, Two-way ANOVA, Hierarchical Multiple Regression	1	1.9
Rasch Model, Content Analysis	1	1.9
Reliability, Validity	1	1.9
T-test	4	7.5
T-test, Content Analysis	2	3.8
T-test, Mann Whitney U test, Wilcoxon Signed Rank test, Kruskal Wallis H test, one-way ANOVA	1	1.9
T-test, Mann Whitney U test, Kruskal Wallis H test, one-way ANOVA	1	1.9
T-test, Mann Whitney U test, Content Analysis	1	1.9
T-test, Mann Whitney U test	1	1.9
T-test, one-way ANCOVA, two-way ANOVA	1	1.9
T-test, one-way ANOVA	6	11.3
T test, one-way ANOVA, Kruskal Wallis H test	1	1.9
T-test, Wilcoxon Signed Rank test	2	3.8
Wilcoxon Signed Rank test	1	1.9
Wilcoxon Signed Rank test, Content Analysis	2	3.8
Wilcoxon Signed Rank test, Kruskal Wallis H test	2	3.8
Total	53	100.0

According to Table 8, the Mann Whitney U test and the Wilcoxon Signed Rank test (18.9%), the T-test, the one-way ANOVA (11.3%), and the T-test (7.5%) were the most common statistical methods used in theses on science process skills. When Table 8 is examined, 3.8% of the theses used content analysis; 3.8% used the Mann Whitney U test; 1.9% used descriptive analysis; and 1.9% used the Wilcoxon Signed Rank test. 81.1% of the theses stated that they used more than one statistical method.

4. Conclusion

Preschool children's experiences with the environment they observe are among the subjects of science teaching. The goal of science teaching is to raise science literate individuals (MEB, 2018). To achieve this goal, scientific process skills have an important place in science teaching (Akman et al., 2017). For science literacy, preschool children need to acquire scientific process skills through activities. To improve the quality of preschool science education for children aged 36-72 months in Turkey, the preschool curriculum is organized in light of scientific developments (e.g. MEB Preschool Teaching Curriculum, 2013, 2018). These programs are based on teaching scientific process skills to preschool students to teach them scientific thinking and research methods. Accordingly, in this article, "Scientific process skills in preschool graduate theses in Turkey were examined. We accessed 53 open-access theses from the database of the YOK National Thesis Center. While more than half of the theses written within the scope of scientific process skills are master's theses; less than half of them are doctoral theses. Postgraduate theses on scientific process skills were most frequently produced in 2019, followed by 2023. In theses, quantitative research was the most common research type, followed by multiple research types. As a research method, more than half of the theses used experimental research methods. In postgraduate theses, the random sampling method was most frequently used as the sampling method, and the purposive sampling method was preferred secondly. The sample group of almost all of the theses consisted of children aged 48 months and above, while very few of them consisted of only adults or children with adults. Although differences were observed in terms of the variety of data collection tools in the theses, it was observed that more than half of them used the science process skills scale. It was observed that most of the theses used parametric and nonparametric tests based on comparison analysis as statistical methods. Since it is important to support and improve the scientific process skills of preschool children in line with the goal of science literacy, it is recommended that research methods, sampling methods, and diversity of sampling groups should be included in future studies.

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