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Comparison of Pre-service Teachers' Metaphors Regarding the Concept of "Scientific Knowledge"

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Abstract The aim of this research was to analyze pre-service teachers' perceptions of the concept 'scientific knowledge' through metaphors. Phenomenology, one of qualitative research designs, was used in the study. A total of 189 pre-service teachers, including 158 females and 31 males, studying at different departments in the education faculty of Kocaeli University, Turkey in spring semester of 2013-2014 academic year, participated in the study. Data of the study was obtained by asking pre-service teachers to complete the sentence "Scientific Knowledge is like ..... because ....." and analyzed by content analysis method. Chi-square test, a non-parametric test, was employed to examine the relationship between the department and pre-service teachers' perceptions of the concept of scientific knowledge. According to the study findings, pre-service teachers produced a total of 129 valid metaphors regarding the concept of scientific knowledge. These metaphors were divided into 13 different conceptual categories after they were examined in terms of their common features. A statistically significant relationship was identified between the department of study and pre-service teachers' perceptions of the concept of scientific knowledge.

Keywords Science, Scientific Knowledge, Metaphor, Teacher Education, Learning and Teaching, Phenomenology

1. Introduction

Knowledge is a general conceptualization, therefore it can be defined as "understanding something as something". Since the definition includes the words "something" and "understanding", there's a "person who understands" and "something which is understood" or a "person who knows" and "something which is known". Therefore, knowledge can be described in many ways, including scientific, philosophical, religious or artistic ways, etc. [33]. Scientific knowledge is the result of the scientific method that will lead us to accurate information [6]. Scientific knowledge can also be defined as a set of systematic propositions generated with activities and transactions, including observations, experiments, implementation of mathematics, reasoning in the light of theoretical approaches [5]. It can be said that the criterion for a piece of knowledge to be scientific is that it is obtained by scientific methods.

According to Aflalo [2] , in programs where teachers are raised, faculty mostly focus on scientific knowledge and methods to teach scientific information, whereas they consider how scientific knowledge evolves, what is the criterion that determines scientific knowledge and the influences on scientific knowledge to a lesser extent. There are several solutions on how to improve scientific knowledge, which is emphasized by Aflalo[2], in the literature. Studies which argue that scientific knowledge can be improved through historical experiments include the discovery of thermometer [9], the secret of the boiling point [10], boiling water and electrochemistry [11], the structure of atom [14], which allow scientific knowledge to be obtained again by complementary tests and such obtained knowledge to be enhanced. Some studies argue that opinions about the nature of science and the concept of scientific knowledge can be improved through in-service training programs [15]. Other studies maintain that opinions on the concept of scientific knowledge can be improved by scientific consultancy training [24]. Improvement of opinions on the concept of scientific knowledge primarily requires identification of the existing views of students, teachers and pre-service teachers.

In the literature, The Views of Nature of Science (VNOS) questionnaire is usually used to identify students' and teachers' perceptions of the concept of scientific knowledge [1,26, 36]. In addition to VNOS questionnaire, Turgut [35] interpreted pre-service teachers' perceptions of scientific knowledge and methods using their responses to open-ended questions and interviews. Köksal and Köksal [22] identified medical school students' perceptions of the nature of scientific knowledge, scientific method, definition of science and characteristics of a scientist by giving them concepts such as biology, science, scientist, experiment, laboratory, hypothesis, theory and law, asking them to make sentences that relate these concepts, and analyzing the results. In order to determine to what extent the nature of scientific knowledge is understood, Kılıç et al. [21] applied a 48-item-Likert-type scale to high school students, and Liang

et al. [27] applied a scale consisting of Likert-type and open-ended questions to a total of 640 pre-service teachers from three different countries. İmer-Çetin and Macaroğlu-Akgül [20] evaluated pre-service teachers' views on scientific information through media reports. Descriptive characteristics of metaphors, which is one of qualitative data collection techniques, are widely used in order to identify individuals' perceptions; however, there's no metaphor study on scientific knowledge in the literature.

Metaphors has been frequently utilized in recent years as an important data collection technique in scientific research [4, 3, 17, 32]. Metaphor means describing a concept by using more familiar and known concepts outside its true meaning as a result of associating the concept with and comparing it to such familiar and known concepts [23]. If we want to conduct a study on concepts such as performance, decision-making, responsibility, which are based on observation but cannot be directly or indirectly visualized, we need metaphors [8, 41]. The concept of scientific knowledge is included in the category of concepts defined by Young [41], so the data of the study was collected through metaphors.

Today, with the courtesy of ongoing rapid technological progress, it is possible to have immediate access to any information. However, this requires people, as creative, inquisitive and thoughtful individuals, to distinguish knowledge from scientific knowledge. This study is important because the results are expected to contribute to teacher training programs and provide resources for further research by determining pre-service teachers' metaphorical perceptions on scientific knowledge as the ones who will raise the individuals of today and tomorrow.

This research is the first study in which metaphorical perceptions related to scientific knowledge were identified.

2. Objectives

The aim of this study was to reveal the metaphors regarding the concept of 'scientific knowledge' developed by pre-service teachers, studying at various departments. For this purpose, answers were sought for the following questions:

1 Which metaphors regarding concept of 'scientific knowledge' do pre-service teachers from the departments of Science Teaching, Mathematics Teaching and Primary School Teaching develop?
2 Under which conceptual categories can the metaphors developed by pre-service teachers from the departments of Science Teaching, Mathematics Teaching and Primary School Teaching be grouped?
3 Do the metaphors developed by pre-service teachers from the departments of Science Teaching, Mathematics Teaching and Primary School Teaching differ by the departments?

3. Materials and Method

3.1. Research Design

Phenomenology was used in this study, which aimed to identify pre-service teachers' perceptions of the concept of 'scientific knowledge' through metaphors. Phenomenology focuses on the phenomena which we are aware of but about which we have no in-depth and detailed understanding [40].

3.2. Study Group

A total of 255 pre-service teachers studying at three different departments (Department of Science Teaching, Department of Mathematics Teaching and Department of Primary School Teaching) in Education Faculty, Primary School Teaching section of Kocaeli University during 2013-2014 academic year participated in this study. Of these participants, 10 pre-service teachers returned the form blank and 56 pre-service teachers didn't provide satisfactory reasons for their metaphors in their forms, or their written metaphors didn't match their indicated reasons so they were excluded from the study, and the metaphors of 189 pre-service teachers were included in the assessment. Demographic characteristics of pre-service teachers are given in Table 1 below.

Table 1. Percentage distribution of genders of the study group by department.

Department	Female		Male		Total
	n	%	n	%	
Science Teaching, daytime education	24	55%	2	5%	26
Science Teaching, evening education	34	77%	2	5%	36
Mathematics Teaching, daytime education	30	58%	11	21%	41
Mathematics Teaching, evening education	17	47%	7	19%	24
Primary School Teaching, daytime education	27	66%	6	15%	33
Primary School Teaching, evening education	26	68%	3	8%	29
Total	158	84%	31	16%	189

3.3. Data Collection

Form for Data Collection through Metaphors: A data collection form incorporating metaphors previously used by several researchers [13, 28-30, 37, 39] was employed to identify metaphors regarding the meanings attributed by pre-service teachers to scientific knowledge. Before pre-service teachers wrote their metaphors, they were given explanations about metaphor and asked to concentrate on a single metaphor while completing the sentence "Scientific knowledge is like .....because ....." In this research, the respondents were asked to generate a logical reason for their metaphors by including the word "because". Moreover, a personal information form was used to collect information about gender and the department of study. They were given approximately 20 minutes to write their metaphors and the reasons for their metaphors.

3.4. Data Analysis

Analysis of data obtained from metaphors developed by pre-service teachers included listing of metaphors, listing of metaphors by departments and their comparison by variables (department and gender) in the given order. Coding was performed to determine to which pre-service teacher the respective metaphor belongs in order to facilitate data analysis. Accordingly, the following coding was performed: Science Teaching (ST), Mathematics Teaching (MT), and Primary School Teaching (PST); daytime education (1), evening education (2); male (M), female (F). For instance, if a metaphor was developed by a male pre-service teacher from the department of science teaching, daytime education, the metaphor was coded (ST/1/M). Frequency and percentage values of metaphors were calculated. Then, x^2 test was applied to test whether 13 conceptual categories differ by department before the results were analyzed and interpreted.

4. Findings

4.1. Metaphors Related to the Concept of 'Scientific Knowledge' Developed by Pre-Service Teachers from the Departments of Science Teaching, Mathematics Teaching and Primary School Teaching

Pre-service teachers developed a total of 129 valid metaphors regarding the concept of 'scientific knowledge'. Of these metaphors, 95 [such as photosynthesis (1), key (1) and rings of a chain (1)] were developed by only one pre-service teacher, 21 [such as book (2), candle (2) and jewel (2)] by two pre-service teachers, and the metaphors, including water (11), light (5), chameleon (5), truth (4), space (4), the sun (3), star (3), gold (3), mountain(3), compass (3), the sky (3), food (3), by three or more pre-service teachers. Pre-service teachers' metaphors regarding the concept of 'scientific knowledge' and their frequency values are shown in Table 2.

Table 2. Pre-service teachers' metaphor categories for the concept of 'scientific knowledge', the number of metaphors (NM), the total number of metaphors (TNM) and percentage (%) values

Category	Metaphor	Number of Metaphors	Total Number of Metaphors	Percentage Value
Category 1: Scientific Knowledge "shaped by purpose"	car (1), dynamite (1), photosynthesis (1), man (1), pencil (1), knife (1), mushroom (1), gun (1), glass half full (1), writing (1), ying yong (1)	11	11	5.8
Category 2: Scientific Knowledge as "food"	tree (1)	1	1	0.5
Category 3: Scientific Knowledge as "a phenomenon that makes the unknown known"	light bulb (1), key (1), daylight (1), mirror (1), iceberg (1), iceberg (1), torch (1), the sun (3), light (5), book (2), microscope(1), candle (2), technology (1), star (3)	14	24	12.7
Category 4: Scientific Knowledge as "a holistic phenomenon"	puzzle (1), domino (2)	2	3	1.6
Category 5: Scientific Knowledge as "a valuable thing"	gold (3), a valuable mineral (1), ice cream (1), diamond (1), saving lives (1), treasure (1), a favor (1), jewel (2), money (1), diamond (1), creativity (1), star (1)	12	15	7.9
Category 6: Scientific Knowledge as "a universal phenomenon"	Chaplin (1), wave (1), sand (1), color (1)	4	4	2.1
Category 7: Scientific Knowledge as "a progressive phenomenon"	river (2), baby (1), Benjamin Button (1), day (2), chameleon (5), mountain (3), drop (1), education system (1), universe (1), dough (1), air (1), pool (1), snowball (1), fashion (1), molecule (1), forest (1), money (1), cake (1), color (1), waterfall (1), writing (1), cooking (1), rings of a chain (1)	23	31	16.4
Category 8: Scientific Knowledge as "a potential phenomenon"	love (1), iceberg (1), mountain (1), Stones at the depths of an ocean (1), the earth (2), universe (2), book (2), sand (1), bus (1), chest (2), infinity (1), soil (1), space (1)	13	17	9.0
Category 9: Scientific Knowledge as "a comprehensive phenomenon"	octopus (1), atom (1), solution (1), sea (1), rainbow (1), life (1), treasure (1), bookcase (1), embroidery (1), pomegranate (2), ocean (1), road (1)	12	13	6.9
Category 10: Scientific Knowledge as "an absolute phenomenon"	encyclopedia, (1), moon (1), the color white (1), President (1), nature (1), the earth (1), truth (4), law (1), water (2).	9	13	6.9
Category 11: Scientific Knowledge as "a guiding phenomenon"	car (2), walking stick(1), brain (1), teacher (1), compass (3), help (1), road (1)	7	10	5.3
Category 12: Scientific Knowledge as "an infinite phenomenon"	Sand in a desert (1), sea (1), bottomless well (2), plane (1), universe (2), sky (3), sand (2), number line (2), number (2), infinity (1), space (4)	11	21	11.1
Category 13: Scientific Knowledge as "source of life"	tree (2), atmosphere (1), vitamin C (1), doctor (2), air (1), medicine (2), heart (2), oxygen (1), water (11), food (3)	10	26	13.8
TOTAL		129	189	100.0

4.2. The Categories Comprising Pre-Service Teachers' Metaphors Regarding the Concept of 'Scientific Knowledge'

When the pre-service teachers' metaphors on the concept of scientific knowledge were analyzed by content analysis, they were grouped under 13 categories. Conceptual categories and percentage distribution of the metaphors developed by pre-service teachers are presented in Table 2.

As can be seen in Table 2, the category which was preferred the most by pre-service teachers was the category, scientific knowledge as "a progressive phenomenon" (16.4%). The 2nd, 3rd, 4th, 5th, 6th, 7th, 8th, 9th, 10th, 11th, 12th most used metaphors by pre-service teachers were respectively as follows: scientific knowledge as "source of life" (13.8%), "a phenomenon that makes the unknown known" (12.7%), "an infinite phenomenon" (11.1%), "a potential phenomenon" (9.0%), "a valuable thing" (7.9 %), "a comprehensive phenomenon" and "an absolute phenomenon" (6.9 % for both), "shaped by purpose" (5.8 %), "a guiding phenomenon" (5.3%), "a universal phenomenon" (2.1%), "a holistic phenomenon", and "food" (0.5%).

4.2.1. Conceptual Categories

13 conceptual categories developed by pre-service teachers and their reasons are listed below by making direct quotations from pre-service teachers' completed forms.

Category 1: Scientific Knowledge as "shaped by purpose"

According to Table 2, this category is represented by a total of 11 pre-service teachers (5.8%) and 11 metaphors (8.5%).

Frequencies (1) of the metaphors in this category are equal to each other. Examples of metaphors in this category include knife (1), dynamite (1) and glass half full (1).

"Scientific Knowledge is like a glass half full. Because it is different depending on from which side you look at it. It is used to make atomic bomb or antidote for cancer." (PST/2/F)

"Scientific Knowledge is like a car. Because how you drive it establishes the direction which you go. " (ST/2/F).

Category 2: Scientific Knowledge as "food"

The metaphor in this category was generated by 1 pre-service teacher (0.5%). In this category, a pre-service teacher from the department of primary school teaching generated a metaphor, whereas pre-service teachers from the departments of science teaching and mathematics teaching didn't generate any.

"Scientific Knowledge is like a tree. Because it produces fruits, if it's used in the right way. " (PST/1/F)

Category 3: Scientific Knowledge as "a phenomenon that makes the unknown known"

This category is represented by a total of 24 pre-service teachers (12.7%) and 14 metaphors (10.85%).

Dominant metaphors in this category are light (5), star (3), the sun (3).

"Scientific Knowledge is like an iceberg. Because it allows us to obtain the reality below what is visible." (PST/2/F)

"Scientific Knowledge is like a microscope. Because it allows us to see what we normally cannot see. " (ST/1/F)

Category 4: Scientific Knowledge as "a holistic phenomenon"

This category is represented by a total of 3 pre-service teachers (1.6%) and 2 metaphors (1.5%).

Dominant metaphor in this category is domino (2). In this category, pre-service teachers from the department of science teaching generated metaphors, whereas pre-service teachers from the departments of primary school teaching and mathematics teaching didn't generate any.

"Scientific Knowledge is like a puzzle. Because if a piece is missing, it doesn't mean anything. " (ST/2/F)

"Scientific Knowledge is like a domino. Because if you touch one, you'll see that it affects the others." (ST/1/M)

Category 5: Scientific Knowledge as "a valuable thing"

This category is represented by a total of 15 pre-service teachers (7.9%) and 12 metaphors (9.3%).

Dominant metaphors in this category are gold (3) and jewel (2).

"Scientific knowledge is like a valuable mineral. Because as it is processed, its value increases even more. (MT/1/M)

"Scientific Knowledge is like a treasure. Because a person who has it becomes rich. " (PST/2/F)

Category 6: Scientific Knowledge as "a universal phenomenon"

This category is represented by a total of 4 pre-service teachers (2.1%) and 4 metaphors (3.1%).

Frequencies of the metaphors (1) in this category are equal to each other. Examples of metaphors in this category include Chaplin (1), sand (1) and color (1) .

"Scientific Knowledge is like sand. Because it covers the whole world with its tiny grains. (ST/2/F)

"Scientific Knowledge is like a color. Because we always come across with one in everywhere. " (MT/2/F)

Category 7: Scientific Knowledge as "a progressive phenomenon"

This category is represented by a total of 31 pre-ervice teachers (16.4%) and 23 metaphors (17.8%).

Dominant metaphors in this category are chameleon (5), mountain (3), river (2) and day (2).

"Scientific Knowledge is like the universe. Because it constantly continues to expand and grow." (ST/1/F)

"Scientific Knowledge is like rings of a chain. Because all of them complete one another and keep getting longer." (PST/1/M)

Category 8: Scientific Knowledge as "a potential phenomenon"

This category is represented by a total of 17 pre-service

teachers (9.0%) and 13 metaphors (10.0%).

Dominant metaphors in this category are the earth (2), the universe (2), book (2) and chest (2).

"Scientific Knowledge is like a bus. Because when you get on it, you see different people." (ST/2/M)

"Scientific Knowledge is like a chest. Because it is mysterious and arouses curiosity." (PST/2/F)

Category 9: Scientific Knowledge as "a comprehensive phenomenon"

This category is represented by a total of 13 pre-service teachers (6.9%) and 12 metaphors (9.3%).

Dominant metaphor in this category is pomegranate (2).

"Scientific Knowledge is like a pomegranate. Because when you look inside, it's possible to utilize its many seeds." (ST/2/M)

"Scientific Knowledge is like embroidery. Because each detail is finely sewn." (PST/1/F)

Category 10: Scientific Knowledge as "an absolute phenomenon"

This category is represented by a total of 13 pre-service teachers (6.9%) and 9 metaphors (6.9%).

Dominant metaphors in this category are truth (4) and water (2).

"Scientific Knowledge is like water. Because it's clear and precise like water. (MT/1/F)

"Scientific Knowledge is like law. Because it's undisputed and has no holes." (MT/1/F)

Category 11: Scientific knowledge as "a guiding phenomenon"

This category is represented by a total of 10 pre-service teachers (5.3%) and 7 metaphors (5.4%).

Dominant metaphors in this category are compass (3) and car (2).

"Scientific Knowledge is like a compass. Because it shows the right way. " (ST/2/F)

"Scientific Knowledge is like a road. Because it facilitates going distances." (MT/1/M)

Category 12: Scientific Knowledge as "an infinite phenomenon"

This category is represented by a total of 21 pre-service teachers (11.1%) and 11 metaphors (8.5%).

Dominant metaphors in this category are space (4) and sky (3).

"Scientific Knowledge is like a number line. Because it has no end." (MT/2/F)

"Scientific Knowledge is like space. Because it's the door to infinity. " (PST/2/F)

Category 13: Scientific Knowledge as "source of life"

This category is represented by a total of 26 pre-service teachers (13.8%) and 10 metaphors (7.7%).

Dominant metaphors in this category are water (11) and food (3).

"Scientific Knowledge is like water. Because it's nor possible to be without it; anyone takes it or leaves it but the need for water is endless." (ST/2/F)

"Scientific Knowledge is like oxygen. Because what concerns everyone are truths." (PST/1/F)

4.3. The Relationship between the Perceptions of Pre-Service Teachers from the Departments of Science Teaching, Mathematics Teaching and Primary School Teaching Regarding the Concept of "Scientific Knowledge" and the Type of Departments

The results of chi-square test on whether the categories of metaphors regarding the concept of 'scientific knowledge' developed by pre-service teachers differ by the type of department are given in Table3.

Table 3. Comparison of the metaphors regarding the concept of 'scientific knowledge' developed by pre-service teachers by the type of department

Conceptual Category	Science Teaching		Mathematics Teaching		Primary School Teaching		Total	
	f	%	f	%	f	%	f	%
Shaped by purpose	5	45,5	4	36,4	2	18,2	11	5,8
Food	0	0	0	0	1	1,6	1	0,5
Makes the unknown known	6	25	6	25	12	50	24	12,7
A holistic phenomenon	3	100	0	0	0	0	3	1,6
A valuable thing	6	40	5	33,3	4	26,7	15	7,9
Universal	1	25	1	25	2	50	4	2,1
A progressive phenomenon	10	32,3	5	16,1	16	51,6	31	16,4
A potential phenomenon	5	29,4	9	52,9	3	17,6	17	9
A comprehensive phenomenon	4	30,8	5	38,5	4	30,8	13	6,9
Absolute	2	15,4	9	69,2	2	15,4	13	6,9
Guiding	4	40	2	20	4	40	10	5,3
Infinite	3	14,3	12	57,1	6	28,6	21	11,1
Source of life	13	50	7	26,9	6	23,1	26	13,8
$X^2 = 39.93$ sd=24 p= .022								

In view of Table 3, in the case of conceptual categories on the concept of *scientific knowledge*, it is clear that re-service teachers studying at the department of science teaching perceive t*he concept of scientific knowledge* as holistic (100%), source of life (50%), shaped by purpose (45.5%) and a valuable thing (40%) to a larger extent. It is seen that pre-service teachers studying at the department of mathematics teaching perceive the concept of *scientific knowledge* as absolute (69.2%), infinite (57.1%), potential (52.9%) and a comprehensive phenomenon (38.5%), while pre-service teachers studying at the department of primary school teaching perceive the concept of *scientific knowledge* as progressive (51.6%), that makes the unknown known (50%), universal (50%) and food (1.6%). Furthermore, pre-service teachers from the departments of science teaching and primary school teaching perceive scientific knowledge as a guiding phenomenon by 40%. When the frequencies of the pre-service teachers'(studying at various departments) conceptual categories regarding the concept of 'scientific knowledge' were analyzed using chi-square test, a significant difference was found between the departments and pre-service teachers' perceptions regarding the concept of scientific knowledge ($X^2 = 39.93$, $p < .05$).

5. Discussion, Conclusions and Suggestions

The aim of this study was to identify the perceptions of pre-service teachers from various departments regarding the concept of scientific knowledge, and pre-service teachers were found to generate 129 different metaphors regarding the concept of "*scientific knowledge*". As a result of the analysis of these metaphors, it was established that the perceptions of pre-service teachers regarding the concept of scientific knowledge are grouped under 13 conceptual categories, including *"shaped by purpose", "food", "a phenomenon that makes the unknown known", "a holistic phenomenon", "a valuable thing", "a universal phenomenon", "a progressive phenomenon", "a potential phenomenon", "a comprehensive phenomenon", "an absolute phenomenon", "a guiding phenomenon", "an infinite phenomenon"* and *"source of life"*. In addition, pre-service teachers emphasized the category of scientific knowledge as "a progressive phenomenon" the most and the category of scientific knowledge as "food" the least. Using the data obtained by interviews, Tsai [34] established that students defined scientific knowledge as "facts which may change-provisional facts", while Yeşilyurt [38] established that students' belief levels regarding "variance" of scientific knowledge were above average. These previous results in the literature support a finding of this study that scientific knowledge was defined as "a progressive phenomenon".

Gondwe and Longnecker's [18] study conducted to identify the perceptions of students from various cultural backgrounds regarding the meanings of scientific knowledge and traditional knowledge, and the relationship between them concluded that the students perceived scientific knowledge as *'intelligence'* and *'advanced knowledge'*. This conclusion also substantiates another finding of the current study that pre-service teachers defined scientific knowledge as a phenomenon "that makes the unknown known" and "a progressive phenomenon". However, in Gondwe and Longnecker's [18] study, the 'food' category was in the category about the definition of traditional knowledge, whereas in this study, the 'food' category, even though it was preferred the least, was defined as scientific knowledge; so this finding is not supported. A study by Lederman and O'Malley [25] conducted on 69 students aged 9–12 using open-ended questions, concluded that students perceived scientific knowledge as "provisional", which was the case for science teachers according to the data obtained by Holliday and Lederman [19] by surveying science teachers. These previous results also substantiate another finding of this study that scientific knowledge was perceived as "a progressive phenomenon". Although many metaphor categories were obtained in this study, metaphor categories which satisfy the characteristics of scientific knowledge by content, also defined by Abd-El-Khalick and Lederman [1], were not obtained, which is in line with the results of previous studies in the literature indicating that pre-service teachers' knowledge on the concept of scientific knowledge is limited [7, 20]. This result indicates that pre-service teachers should be supported on the nature of scientific knowledge during their undergraduate study.

It is clear that pre-service teachers studying at the department of science teaching perceive the concept of scientific knowledge as "*holistic", "source of life", "shaped by purpose"* and *"a valuable thing"* to a larger extent. It is seen that pre-service teachers studying at the department of mathematics teaching perceive the concept of scientific knowledge as "*absolute", "infinite", "potential" and "a comprehensive phenomenon"*. Pre-service teachers studying at the department of primary school teaching perceive the concept of scientific knowledge as "*progressive", "that makes the unknown known", "universal"* and *"food"*. Percentages of pre-service teachers from the departments of science teaching and primary school teaching who perceive scientific knowledge as "a guiding phenomenon" were equal. The difference observed between the departments of pre-service teachers and perceptions of pre-service teachers regarding scientific knowledge was found to be significant. Turgut [35] concluded that perceptions of pre-service science teachers regarding scientific knowledge usually focus on the concepts of *'objectivity', 'experimentality', 'certainty'* and *'provableness'*. That result does not lend support to the results of the present study, however, Cofré et al. [12] found that the primary school teachers perceived scientific knowledge as "provisional", which supports a finding of this study.

According to the results of this study, the difference observed between the departments of the pre-service teachers and the perceptions of the pre-service teachers' regarding scientific knowledge can be attributed to the

difference between the contents of courses taken by pre-service teachers in each department or the experiences gained by them depending on the contents of courses. For instance, pre-service teachers from the department of science teaching are involved in inquiry activities, during which they define events and objects in a science laboratory, ask questions, make explanations, test their explanations against available scientific knowledge and share their ideas, due to the contents of the courses in the field [16]. However, since mathematics is a branch of science which examines abstract concepts and the relationships between them, it is likely that pre-service teachers from the department of mathematics teaching cannot gain experience in acquisition of scientific knowledge and inquiry to the extent gained by pre-service teachers from the department of science teaching. In addition, the reasons why the pre-service teachers from the department of primary school teaching do not have adequate knowledge and views about scientific knowledge may include the lack of a course that directly emphasizes the nature of science in the undergraduate primary school teaching program and that an effort has been made to indirectly emphasize the nature of science only using other courses, although the undergraduate science teaching program includes the nature of science and history of science courses and the undergraduate mathematics teaching program includes history of science course.

Nature of science course can be included as a compulsory course in the curricula of all programs.

The content of the courses on pedagogy in the curricula of undergraduate teaching programs can be enriched with socio-scientific subjects such as nuclear power plants, stem cell, genetic cloning, nanotechnology and pre-service teachers can be asked to question scientific aspects of knowledge.

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