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THE EFFECT OF PROJECT SUPERVISION TRAINING ON TEACHERS' VIEWS OF NATURE OF SCIENTIFIC INQUIRY

(Research article)

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Abstract

The study aimed to investigate the effect of project supervision training offered to Biology teachers on their views of the nature of scientific inquiry. We employed an action research design, as one of the qualitative research methods in this study. The participants were composed of 39 Biology teachers who had attended training on project supervision. The data were collected using Views of Scienetific Inquiry (VOSI) instrument developed by Schwarts, Lederman, and Lederman (2008). Following that, and a semi-structured interview form developed by the researchers was conducted. The data were analyzed using content analysis methods through creating codes and themes. The results revealed that the project supervision training supported development of teachers on five dimensions; scientific research is directed by questions, use of different methods in scientific investigations, research has many purposes, justification of scientific knowledge, and differences between scientific data and evidence. It was also found out that the training had positive effects on their professional practices.

Keywords: Nature of science, project supervision training, in-service teacher training, views of scientific inquiry

1. Introduction

Science can be defined as all efforts of people to understand themselves, their environment and the universe by using their existing knowledge and discovering new ones (Küçük, 2006). Many important scientists have tried to define science, from Aristotle to Einstein. Basically, science is the process of producing scientific knowledge in various ways such as interpretating, observing, and conducting experiments in order to make sense of an event or entity (Kaptan & Korkmaz, 1999; Keklik, 2019). All these entities of scientific invesitigations support individuals to be scientifically literate. Indivuduals, who are adequately equipped with knowledge about science and scientific invesitigations, will hold scientific orientitioan towards problems encountered in daily life, in global or regional situations (Aslan, Yalçın, & Taşar, 2009:2).

The history of the nature of science has been the subject of investigation and research for nearly sixty years (Metin, 2009). In particular, the concept of the nature of scientific inquiry, which is a newly added aspect to nature of science today, is concerned with the production processes of scientific knowledge and studies in this field are gaining momentum. Considering the importance of scientific literacy, it is thought that it is significant to know how nature of science and scientific inqiry is comprehended by teachers, who are the transmitters of these concepts. Therefore, it becomes valuable to invesitigate the extent to which the project consultancy trainings organized to contribute to the teachers' views about nature of scientific inquiry.

According to Lederman, Abd-El-Khalick, Bell, and Schwartz (2002), in order to be able to provide a meaningful learning about the nature of science and scientific inquiry, teachers must first understand the main concepts and its sub-components and integrate them actively in their lessons. Considering the literature on the topic, the competence of teachers has a very important place in conveying the nature of science and scientific research. The literature usually focuses on understanding the nature of science, and determining the views on its sub-components (Doğan, 2005; Gürses, Doğan, & Yalçın, 2005; Zeidler, Walker, Acett, & Simmons, 2002). Then, some studies focus on teaching and development of the nature and sub-dimensions of scientific inquiry concepts (see: Abd-El-Khalick, 2012; Akerson & Abd-El-Khalick, 2005; Aydemir, 2016; Çavuş, 2010; Çil & Çepni, 2012; Eren-Şişman, Çiğdemoğlu, Kanlı, & Köseoğlu, 2020; Karaman & Apaydın, 2014; Küçük, 2006; Khisfe, 2008; Tuncel, 2012).

Few work has been published about the nature of scientific inquiry in the study context, (see: Abik, 2017; Aydemir, 2016; Cigdemoglu & Köseoğlu, 2019; Çelik, 2019; Karaman & Apaydın, 2014; Leblebicioğlu, Çapkınoğlu, Peten, & Schwartz, 2020), specifically on the impact of project consultancy. Project consultancy training is one of the methods that is frequently used in teaching nature of science and nature of scientific inquiry. The role teachers in improving students' understanding of nature of science and nature of scientific inquiry is already elaborated. Within the scope of this research, we devle into the effect of the project consultancy training on biology teachers' understanding of scientific inquiry as well as their scientific practices.

2. Literature Review

The concept of the nature of science, which emerged after the concept of science, has been accepted as an important learning outcome of science education since the beginning of the 20th century and has been systematically studied in the field since the 1950s (İrez & Turgut, 2008; Lederman, 2006). The first study in the field of science was made by Merrit Kimball in 1968, and the concept was included in the literature by mentioning the nature of sciences (The Nature of Science). The first written work published in the field is the book "Philosophy of science: Implications for teacher education" written by an educator, James Robinson, in 1969 (Türkmen & Yalçın, 2001). Since these dates, on a global scale, it has been realized that individuals' views on the nature of science and scientific inquiry should be developed for the development of scientific literacy (Erdoğan, 2011).

2.1. Nature of Scientific Inquiry

While the nature of science and the nature of scientific research mostly involve common concepts, the nature of science is result-oriented and deals with the outcome of the scientific inquiry process, while the nature of scientific inquiry deals with the process of scientific investigations. What science is, what scientific knowledge is, and how science is affected by social cultural values are among the mostly investigated research area in nature of science literature. The issues of how scientific knowledge is produced and accepted are generally the field of study of the nature of scientific inquiry (Karaman & Apaydın, 2014).

In order to understand scientific processes, it is important to understand the nature of scientific inquiry along with its characteristics (Minner, Levy, & Century, 2010; Schwartz, Lederman, & Lederman, 2008). The characteristics of the nature of scientific inquiry that students should know were first introduced by Schwab in 1962. Later, Schwartz et al. (2008) stated the six characteristics of scientific inquiry. These are; 1) scientific investigations are guided by questions, 2) scientific investigations can be conducted by various methods, 3) scientific research has many purposes, 4) scientific knowledge is justified with evidence and data, 5) sources of data and evidence, 6) there is a community of practice impacting scientific inquiry.

2.2. The Role of Teachers in Teaching Nature of Science and Scientific Inquiry

Teachers are the most responsible guide for helping students to develop positive attitudes towards nature of science. In order for students to develop positive attitudes about the nature of science, teachers' attitudes should be in this direction (as cited in Doruk, 2018). In his research, Lederman (2007) revealed that students' views on the nature of science were not at the expected level and attributed that to teachers' misconceptions (myth) about nature of science.

In order to have a positive attitude towards nature of science and to understand the concepts, various in-class and extra-curricular activities that will remove these myths should be implemented into classroom practices with appropriate methods by teachers (Lederman, 1999). Individuals who understand science and scientific knowledge can easily and correctly explain the changes and situations in their environment (Aliyazıcıoğlu, 2012, p. 16). Teachers have the role of designing a learning environment that is beyond traditional instruction and enriched with contemporary understanding of science. Teachers, as the implementers of the program, who will develop the understanding of the nature of science in students should not have incomplete knowledge and wrong beliefs about this concept. The fact that teachers are knowledgeable about the nature of science will contribute to students' understanding of science and scientific knowledge (Gül & Erkol, 2016; İflazoğlu Saban & Saban, 2014; Kubilay Tatar & Özenoğlu, 2018).

Students' understanding of the nature of science is related to teachers' pedagocigal content knowledge on the subject. Teachers should increase students' awarness on the concepts of science, scientific knowledge, and nature of scientific inquiry, and they should be an effective guide in encouraging them through the scientific inquiry process by allowing students to use their creativity (Çakıcı, 2009; Demir & Akarsu, 2013). Professional development programs that will guide teachers to improve their understanding of science and the nature of scientific inquiry have become a necessity in terms of supporting teachers in areas where they feel lack of knowledge in science and nature of scientific inquiry (Karaman & Apaydın, 2014).

2.3 Professional Development and In-service Training Activities

The success of an education system is directly related to the qualifications of the teachers who will operate the system. Educational models can produce services in line with the quality of those who implement the model (Abazoğlu, 2014). Teachers are the organizer of learning environments, work directly with the students, and implement the curricula. The fact that information is shared more quickly and easily accessible today has brought about great changes in nature of the teaching profession. Teachers are transformed from being the source of knowledge to guide for adapting to changes, knowing the ways of accessing information, (MEB: Teacher Strategy Document, 2017).

In line with the changing needs in the country, the Ministry of National Education aims to ensure the professional development of teachers. In this context, needs analyzes have been made by the ministry and in-service training activities are planned and carried out in cooperating with partners such as universities, various state institutions, and non-governmental organizations for professional development of teachers (MEB, Teacher Strategy Document, 2017). Based on the need analysis of vocational and technical teachers, in the study of Drage (2010), activities that support teachers' professional development are listed as:

- Developing and improving the use of technology for teaching activities

- Developing critical thinking and problem solving skills of students
- Developing teamwork skills in in-class and out-of-class activities
- Development of meaningful context-based learning
- Development of teaching methods within the scope of pedagocical content knowledge

2.3.1. Project-Based Learning

A project in an educational setting can be described as: an activity that takes place with the participation of a student or a group of students, series of research activities in which students can work freely in the acquisition of a concept or skill, solving a problem, developing high-order thinking skills, increasing reasoning, finding solutions to the problems, as well as an activity that produces a product (Öztürk, 2013; Doğanay, Koç, Korkmaz, Karataş Coşkun, Sarı, Ünver, Tok, & Tok, 2008; Vatansever Bayraktar, 2015; Yıldırım, 2007). In this sense, projects can be described as intense experience based process that attracts students' attention, has an educational value that requires active participation of students (Fleming, 2000). Vatansever Bayraktar (2015) defined the project as a research activity that includes steps such as evaluating a problem in detail, conducting research on the subject or problem using scientific methods, evaluating data obtained and preparing a final report. Using project method, students can decide how to solve a problem by following some certain processes in line with their interests and needs (Kaya, 2020; Yalçın İncik, 2017).

During the project work, students discover the knowledge and they are responsible for their own learning. During a project, students may conduct experiments, organize data, interpret data, discuss with peers, get an outcome, so they develop many science related skills (Bingöl, 2019; Sector, 2018). Teachers are required to hold knowledge of project-based learning in order to implement all related activities. However, it has been reported in various studies that teachers experience many problems at different steps of project-based learning method (Aydın, Bacanak, & Çepni, 2013; Öztuna Kaplan & Diker Coşkun, 2012). For this reason, it is necassary for teachers to follow the current concepts and trainings about professional development activities specifically on project-based learning until they feel that they have learned the method in the best way (Kaya, 2020). This study therefore seek answer to the question: How does a project supervisoin training impact on teachers' views of scientific inquiry?

3. Method

3.1. Research design

This research consists of two parts. In the first part of the study, the action research method from the qualitative research approach was adopted to measure the understanding of teachers who received project supervisoin training about the nature of scientific inquiry. Then, the "Views of Scientific Inquiry" questionnaire which consists of unstructured open-ended questions was applied to the teachers as a pre-test and post-test, using a face-to-face survey.

3.2. Participants

Participants in the study were determined by criterion sampling method among biology teachers working in public and private schools affiliated to the Ministry of National Education between 2013-2014. Criterion sampling is the creation of the sample from people, events, objects or situations with the qualities determined in relation to the problem (Büyüköztürk, Çakmak, Akgün, Karadeniz, & Demirel, 2012).

In this context, volunteer teacher applications were received on the project website to receive project training in the field of biology in 2013 June and 2014 January-February. The teachers were chosen randomly among the teachers who applied for the project, and the selected teachers were announced on the project's website. A total of 39 secondary school biology teachers participated in the study between June 2013 and January-February 2014. The selection criteria were: work in different provinces, having 2-15 years of professional experience, having an equal distribution between those who have prepared a project, having a level of foreign language, and being experienced on use of computer.

3.3. The Training Workshop

The teachers participated in the "Project Supervision Training Workshop for Biology Teachers", which was prepared with support of The Scientific and Technological Research Council of Turkey (TÜBİTAK) BİDEB 2229 program and lasted for eight days. A budget was created by TÜBİTAK for the workshop and the travel, accommodation and training expenses of the participants were covered. Within the scope of this training program, the direct reflective approach (Khishfe & Abd-El-Khalick, 2002), which aims to teach the characteristics of the nature of scientific inquiry with explicit emphasis is given. In order to develop teachers' views on the nature of scientific inquiry, trainers also provided an indirect approach that adopt the teaching of scientific inquiry and process skills with implicit messages. With the active participation of the teachers, we ensured that the they reflected their views on the themes of the nature of scientific inquiry.

The specific objectives of the workshop includes: identifying a scientific problem, accessing the scientific literature on the relevant subject, having a scientific literacy culture for the literature review, identifying the variables that will affect the related problem, gaining awareness about the scientific approaches to be used in the solution of the determined problem and to develop scientific approaches appropriate to the subject, using basic skills related to project design and planning while investigating the identified problem, building a team for the determined project, developing ability to make observations, developing a measurement tool, classifying findings, interpreting the findings during the solution process, drawing conclusions based on the comments made as a result of the findings, deciding on the appropriate result for the solution of the identified problem, determining the generalizability level of the result, reporting skills for the writing the report, visual and verbal presentation skills, finally, enabling teachers to gain experiences in transforming the qualifications and responsibilities required by the project knowledge into personal skills.

In order to achieve the specific objectives, a series of theoretical and practical activities were organized during the project workshop, in which the sub-dimensions of the nature of scientific inquiry were given with an indirect and direct/reflective approach. The project consultancy training workshop was held in Antalya between 21-29 June 2013 and lasted for eight days. It was under the coordination of a professor working in the biology education, and eight invited speakers consisting of professor, assistant professor, associate professor were invited. A doctor, six consultants, a technician, four assistant personnel, and 39 participating biology teachers were selected for the training.

The sub-dimensions of the nature of scientific inquiry, which are aimed to be conveyed with an indirect and direct/reflective approach with the theoretical and applied training given within the scope of the training program, are as follows: scientific investigations are guided by questions, scientific investigations can be done with more than one method, scientific investigations have many purposes, justification of knowledge in scientific inquiry, differences between data and evidence, science being the application of a scientific community.

3.3. Data Collection Tools

In the study, the views of scientific inquiry were used as a data collection tool to measure teachers' understanding of the nature of scientific inquiry. Schwartz et al. (2008) have developed the original Views of Scientific Inquiry (VOSI) questionnaire which consists of 5 unstructured open-ended questions asked about scientific inquiry. The questionnaire was applied to the teachers participating in the workshop at the beginning and the end of the project implementations as a pre-test and post-test,

Schwartz et al., (2008) stated the nature of scientific inquiry and its dimensions, Table 1 provides details.

Table1. *Items and themes of views of scientific inquiry*

Dimensions of Scientific Inquiry	Items
Theme -1. Scientific inquiry is guided by questions.	1, 2, 4
Theme -2. Scientific inquiry has more than one method.	1, 2, 3
Theme -3. Scientific inquiry has many sources and multiple purposes.	1, 2
Theme -4. Justifying scientific knowledge.	3, 4, 5.
Theme -5. Differences between data and evidence.	5
Theme -6. Science as being the practice of a scientific community.	2, 4

This questionnaire was translated into Turkish by Kaya (2007) and validated by expert opinions. In the pilot study, it was determined that the students had difficulty in understanding some questions, and in order to eliminate this situation, short explanations were added in parentheses next to the statements in some items. The Cronbach Alpha reliability coefficient of the questionnaire was found to be 0.79. In addition, the questionnaire was adapted into Turkish again in the study conducted by Karaman and Apaydın in 2013. After it was translated into Turkish, expert opinions were obtained from two researchers working in the field of science education, especially in the nature of science, and two researchers working in the field of Turkish Language in order to ensure language validity. We used the questionnaire that is adapted to Turkish by Kaya (2007).

3.4. Data Analysis

The data obtained from questionnaire was analzed based on scale, codes created by Schwartz et al. (2008) and Hughes et al. (2012). Based on content analysis method, three researchers coded the data. As a result of the analysis process, the answers of the teachers were classified in three categories as naive, transitional, and informed. Descriptive statisticis were provided for views of the teachers about the nature of scientific inquiry before and after the implementation. For each question, the answers of the encoders were compared and the agreement of 80% and above was determined, and the inter-coder reliability between the encoders was reached.

4. Results

In the first part, the findings obtained from the questionnaire are provided based on pre and post scores as naive, transitional, and informed. The values are given in table 2. In order to reach detailed information, each theme related to the nature of scientific inquiry was handled one by one and the findings were reported in tables.

Table 2. *Views of nature of scientific ınquiry before and after the workshop*

Views of Scientific Inquiry												
	Naive				Transitional				Informed			
	PreTest		Post Test		Pre Test		Post Test		Pre Test		Post Test	
	n	%	n	%	n	%	n	%	n	%	n	%
Theme 1	15,5	%39,74	9	%23,07	12	%30,76	11	%28,20	11,5	%29,48	19,5	%50
Theme 2	19	%48,71	17,3	%44,35	12	%30,76	15,6	%40	7,6	%19,48	6	%15,38
Theme 3	23	%58,97	20,5	%52,56	9,5	%24,35	12,5	%32,05	6,5	%16,66	5,5	%14,10
Theme 4	28,75	%73,71	21,5	%55,12	8,25	%21,15	15,25	%39,10	1,75	%4,48	2,25	%5,76
Theme 5	17,3	%44,35	14,3	%36,66	18,3	%46,92	22,6	%57,94	3,3	%8,46	1,6	%4,10
Theme 6	36	%92,30	34	%87,17	2,5	%6,41	4,5	%11,53	0,5	%1,28	-	-

4.1 Scientific Inquiry is guided by Questions

In line with the codes created in the analysis of the questions, the answers of the teachers who stated that scientists ask questions when starting a scientific research and seek answers to these questions by using different methods were accepted at the level of informed opinion. At the transitional level, there were teachers who stated that scientists apply the steps of the scientific process; they form hypotheses and test them. Finally, the answers that did not mention these and stated that scientists only made experiments and observations were included in the category of naïve views.

Table 3. *Teachers' views of questions guide scientific inquiry*

Theme 1. Scientific Inquiry is Guided by Questions												
	Naive				Transitional				Informed			
	Pre Test		Post Test		Pre Test		Post Test		Pre Test		Post Test	
	n	%	n	%	n	%	n	%	n	%	n	%
Item 1	24	%61,53	11	%28,20	10	%25,64	12	%30,76	5	%12,82	16	%41,02
Item 2	7	%17,39	7	%17,39	14	%35,89	10	%25,64	18	%46,15	21	%53,84
Mean	15,5	%39,74	9	%23,07	12	%30,76	11	%28,20	11,5	%29,48	19,5	%50

In this context, 7 teachers (17.39%) in both the pre-test and the post-test did not explain that scientists asked questions in their studies and sought answers to them, and they remained at naïve level. Additionally, 14 of the teachers (35.89%) in the pre-test and 10 in the post-test (25.64%) expressed a transitional level by explaining that scientists use scientific process. Finally, 18 (46.15%) teachers in the pre-test and 21 (53.84%) teachers in the post-test stated that scientists were curious, asked questions and sought answers to them through scientific process steps, and were at the informed level. One teacher (2.56%) left the question unanswered in the posttest.

The findings of the first item of the questionnaire, which directly measures the theme, are explained in detail. When the data of the first item of the questionnaire before the training (pre-test) were examined, it was determined that 24 (61.53%) of the teachers were at naive level. Teachers holding this view state that scientists do research, observation and/or experiments, review the literature to gain information, attend seminars and congresses, etc. It was determined that there were 10 (25.64%) teachers at the informed level. From the statements, it is understood that some teachers stated that scientists follow the steps of the scientific process, establish hypotheses and use various methods to confirm or reject it. However, their expressions lack in providing evidences. Below are some excerpts provided by the teachers' pre-test responses:

- They do research, conduct experiment, read periodicals. They try to keep their minds open. (BT-1) (naive)
- They follow the steps of scientific proceseses. They use data from observation and experimentation and they utilize from previous studies. (BT-34) (transitional)
- Knowledge is shaped by curiosity. A specific problem is identified. Data related to the problem are collected and the literature is reviewed. Experiments are made in line with the hypothesis. The results are analyzed by statistical methods. Finally, evaluation and interpretation is made. (BT-5) (Informed)

When the post-test data of the 1st item was examined, 11 (28.20%) of the teachers mentioned the existence of experiments or observations in scientific processes and explained them insufficient views. Contrary to the pre scores, it is seen that 16 teachers (41.02%) made explanations at informed level. The remaining 12 teachers (30.76%) did not justify their answers with appropriate evidences and remained at a transitional level. Below are some excerpts provided by the teachers' as post-test responses:

- Scientists follow scientific publications, they benefit from scientific web sites, foreign web sites, university libraries on the Internet. They acquire knowledge through scientific symposiums, congresses and conferences. (BT-18) (Naive)
- Scientists must reach scientific knowledge in order to learn about a phenomenon. In order to reach scientific knowledge, they should do research, make observations, and experiments. For scientific investigations, all steps of scientific inquiry should be applied. (BT-30) (transitional)
- Scientists primarily question the reasons of events with curiosity. They draw conclusions based on collected data, apply different methods of science to answer their questions. If the findings do not answer their questions, they may seek answers to their questions using different scientific methodologies. (BT-33) (informed)

When the data were examined, it was seen that the teachers emphasized the theme that scientific research would start with questions after the project consultancy training.

4.2 Scientific Inquiry has more than one Method

Teachers who emphasized that there is only one method of doing science were viewed as insufficient. Teachers who stated that scientists use more than one method but could not explain them with appropriate examples and justifications are regarded as transitional. Teachers who explained that science works with many methods and that methods are successfully differentiated from each other were described as informed.

Table 4. *Teachers' views on method diversity in scientific inquiry*

Theme 2. Scientific Inquiry has more than one Method												
	Naive				Transitional				Informed			
	Pre Test		Post Test		Pre Test		Post Test		Pre Test		Post Test	
	n	%	n	%	n	%	n	%	n	%	n	%
Item 3(a)	19	%48,71	12	%30,76	15	%38,46	23	%58,97	5	%12,82	4	%10,25
Item 3(b)	23	%58,97	24	%61,63	7	%17,94	5	%12,82	9	%23,07	10	%25,64

Item 3(c)	15	%38,46	16	%41,02	14	%35,89	19	%48,71	9	%23,07	4	%10,25
Mean	19	%48,71	17,3	%44,35	12	%30,76	15,6	%40	7,6	%19,48	6	%15,38

When the (pre-test) data were examined, it was determined that 19 (48.71%) teachers who investigated whether this study was an experiment or not, stated this study as an observation, but did not detail why it was not an experiment. In addition, it was seen that some of the teachers described the study as an experiment and remained at the level of naive view. The other 15 (38.46%) teachers stated that this study was not an experiment but an observation, and by detailing their answer with at least one example, it was determined that the teachers had transitional view. On the other hand, only 5 (12,82%) teachers stated that there is no dependent-independent variable, the accuracy of a hypothesis or idea is not tested, etc. in this inquiry. They stated that the study was not an experiment due to reasons such as:

- Because it's a qualitative observation. (BT-2) (naive)
- It's not an experiment. Because the conditions were not prepared by the researcher. However, there may be observations. (BT-21) (transitional)
- It's not an experiment, it's just an observation. The experiment is carried out using control groups with a mechanism designed to solve the hypotheses put forward as a result of the observations. (BT-17) (informed)

Examining the post-test data in part (a), which investigates whether the event given in item 3 is an experiment, only 4 (10.25%) teachers stated that it was not an experiment but repeated observation with at least two reasons and made statements at informed level. The understanding of the other 12 (30.76%) teachers was naive oriented. Among these teachers, it was determined that there were teachers who stated that this was not an experiment without specifying details, and that there were also teachers who had a false belief that this study was an experiment. The remaining 23 (58.97%) teachers were found to have transitional view stating that this was an observation without detailing their answers. Below are examples of the answers given by the teachers to the post-test of the option (a) of the third item:

- It's not an experiment. It is an observation. Food varieties were observed according to beak types without any intervention. The obtained results were compared and concluded. It would be more reliable if quantitative data were obtained by measuring. (BT-25) (Informed opinion)
- It is an observation. Only qualitative observation was made. There is no quantitative expression. (BT-11) (transitional)
- It is an observational experiment. Because beak shapes were investigated according to the feeding style. (BT-43) (naive)

Examining the pre-test data in part (b), which investigates whether the example given in item 3 is a scientific study; 23 (58.97%) teachers hold naive views, 7 (17.94%) teachers described the study as scientific and did not elaborate their answers with appropriate examples and justifications, and 9 (23.07%) teachers expressed an informed view.

When the post-test data were examined, 24 (61.63%) teachers stated that this investigation was not scientific, there was no experiment in the research, and there was no quantitative data in the part (b), which measured whether the investigation given in the 3rd item was scientific, and they did not agree with the answers of these teachers in the pre responses. It was determined that they were persistent and remained at naive level. Similar to the pre-test, it was determined that 5 (12,82%) teachers stated that this was a scientific study and did not explain their answers with appropriate justifications and examples, so they had transitional view. The other 10 (25.64%) teachers stated that this is a scientific study, that a conclusion was reached with repeated observations, and they detailed their answers with explanations as informed view.

In part (c) of item 3, the teachers were asked to explain their answers with an example by asking whether scientists use a single method or more than one method in accessing scientific knowledge. In the pre-test data, it was determined that 15 (38.46%) teachers were at naive view. Also, there are teachers who stated that there may be more than one method in their answers and did not detail their answers with appropriate examples, there were also teachers who stated that there was only one way to reach scientific knowledge. The other 14 (35.89%) teachers hold transitional view stating partially on different methods of investigations. It was determined that 9 (23.07%) teachers, who stated that scientists could use more than one method in their research and at the same time supported their answers with appropriate examples from the scientific world, were regarded as informed view.

4.3 Scientific Inquiry Has Multiple Purposes

The data obtained from the pre-test and post-tests of teachers with naive, transitional and informed views were obtained from 1st and 2nd items, and values are presented in Table 5.

Table 5. *Teachers' Opinions on Multiple Purposes of Scientific Inquiry*

Theme 3. Scientific Inquiry Has Multiple Purposes												
	Naive				Transitional				Informed			
	Pre Test		Post Test		Pre Test		Post Test		Pre Test		Post Test	
	n	%	n	%	n	%	n	%	n	%	n	%
Item 1	31	%79,48	28	%71,79	8	%20,51	11	%28,20	-	-	-	-
Item 2	15	%38,46	13	%33,33	11	%28,20	14	%35,89	13	%33,33	11	%28,20
Mean	23	%58,97	20,5	%52,56	9,5	%24,35	12,5	%32,05	6,5	%16,66	5,5	%14,10

Most of the answers (n=31, 79.48%) in the pre-test focused only on the steps of the scientific process and did not explain that there would be more than one purpose in the inquiry. Only 8 (20.51%) teachers mentioned scientific processes as well as the impact of scientists' curiosity, interests and needs. Similarly, in the post-test data, 28 (71.79%) teachers were naive by explaining only the scientific process steps, while the remaining 11 (28.20%) teachers stated that scientists were curious and applied the scientific process steps with their interests and needs holding transitional view. In both the pre-test and post-test, there was no explanation that gave an informed view. The findings of the second question of the questionnaire, which directly measures the theme, are explained in detail.

In the second item, the opinions of the teachers were taken about how the scientists decided on the research topics and the process as well as factors affecting their work. When the pre-test data were examined, it was determined that 15 (38.46%) teachers explained that scientists carried out the process with curiosity and interest, did not detail their answers and made statements with naive views. However, 11 (28.20%) teachers were at transitional view. These teachers stated that scientists decided on the process and carried out their studies in line with the curiosity, interests, and needs, and they gave answers partially explaining the factors affecting the process. The other 13 (33.33%) teachers were at the informed level. In their answers, emphasizing the importance of curiosity, interest and needs of scientists, personal, cultural, social, economic, political issues. Below are examples of the answers given by the teachers:

- They're observing. They don't miss the details where they live. Kids always give good ideas. (BT-28) (naive)
- They can research anything they are curious about. First they have to decide what the problem is. Daily changes can affect their work; such as climate, bad weather conditions. (BT-34) (transitional)
- The determination of the research subject can be shaped by the questions, results or reviewing that occur during the studies. I think personal interests also have an effect. How the research is conducted depends on the content of the subject. The method is determined in the process. Studies can be affected by many factors, starting from financial opportunities, economic, political, and cultural structure in the country. (BT-5) (informed)

When the post-test data of the second item is examined, 13 (33.33%) teachers did not elaborate on their answers by mentioning scientists' curiosity and interest in scientific investigations. They had naive views. The other 14 (35.89%) teachers explained transitional view. The remaining 11 (28.20%) teachers expressed curiosity, interest, scientific processes, social, economic, cultural, political, etc. It was determined that they hold informed view. Below are examples of the answers given by the teachers to the post-test of the second item:

- His work is prejudiced, the culture he grew up in, etc. affected by the effects. In addition, he decides by choosing the appropriate materials and methods for the subject he will study. Takes a look at previous studies on this subject. (BT-33) (informed)
- It all starts with curiosity. He makes observations. Hypotheses are created. Experiments are made. (BT-17) (transitional)
- First identify the problem. For the problem, he starts from questions that cannot be answered with his previous knowledge. (BT-48) (naive)

In the first question of the questionnaire, teachers were indirectly measured about how scientists start their research and what factors affect their work. When the data are examined, it is remarkable that there was a positive improvement in the perception that scientists can have many different purposes in scientific research in the post-test and there were positive changes in teachers' beliefs at transitional level.

4.4. Justifying the Scientific Knowledge

When the 3rd and 5th questions of the questionnaire were examined with the codes created, it was determined that the teachers did not give answers containing any of the codes created for the theme of justifying scientific knowledge in both the pre-test and post-tests.

Table 6. *Teachers' Opinions on the "justification of scientific knowledge"*

Theme 4. Justifying the Scientific Knowledge												
	Naive				Transitional				Informed			
	Pre Test		Post Test		Pre Test		Post Test		Pre Test		Post Test	
	n	%	n	%	n	%	n	%	n	%	n	%
Item 4(a)	28	%71,79	16	%41,02	10	%25,64	20	%51,28	1	%2,56	3	%7,69
Item 4(b)	28	%71,79	23	%58,97	9	%23,04	15	%38,46	2	%5,12	1	%2,56
Item 4(c)	31	%79,48	22	%56,41	6	%15,38	14	%35,89	2	%5,12	3	%7,69
Item 4(d)	28	%71,79	25	%64,10	8	%20,51	12	%30,76	2	%5,12	2	%5,12
Mean	28,75	%73,71	21,5	%55,12	8,25	%21,15	15,25	%39,10	1,75	%4,48	2,25	%5,76

In the pre-test data, only 1 (2.52%) teacher stated that scientists may work independently, they may use the same data and apply the same procedures, their prior knowledge and experience, their personalities, and the socio-cultural structure of the society they grew up in all have impact on their invesitgations and results. This an example to informed view. It was determined that 28 (71.79%) teachers remained at naïve view. When the answers of the teachers were examined, it is seen that they made statements stating that scientists could reach different results, but this would usually be due to personal or experimental errors. It was observed that 10 (25.64%) teachers hold transitional view, and in their answers, they stated that scientists could reach different conclusions, but could not justify this with appropriate examples. In part (b) of the same question, the teachers were asked "Independent scientists who did the same research; Do they necessarily reach the same result when they follow different processes to collect data? Explain why." question was posed. Only 2 (5.12%) teachers stated that the personalities of scientists can differentiate the results they reach. It was an informed view. However, 9 (23.04%) teachers were at transitional view, 28 (71.79%) teachers attributed the same or different results to material errors and stated that they hold naïve views.

In part (c) of the question, the teachers said, "Scientists who do the same research and work together; Do they necessarily reach the same result when they follow the same process to collect data? Explain why." It was seen that 31 (79.48%) teachers hold naive views and some of these teachers stated that scientists working together would influence each other's thoughts and go for persuasion.

In the last part (d) of the same item, teachers were asked for their opinions on the conclusions of scientists who worked together on the same study and followed different processes to collect data. It was determined that 28 (71.79%) teachers who answered the item gave similar to (c) and they had the wrong belief that scientists have general goals and that developing a common point of view (consensus) will affect the results they will reach, and so they had naïve view. The remaining 8 (20.51%) teachers were found to make scientifically transitional explanations, and they could not detail why scientists would reach different conclusions with adequate and appropriate examples in their answers. Only 2 (5.12%) teachers stated that scientists' personalities, the society they live in, or their thoughts have impact on their result. These teachers hold informed views. There is 1 (2.56%) teacher who left the question unanswered. Below are examples to the pre-test of the 4th item

- They may not reach the same result. Even though they follow the same process, they can interpret it in different ways and reach different results. The interpretation skills of scientists are very important. The results may not be the same unless they have enough knowledge and experience. At the same time, it is very important for the person to comply with the ethical rules. (BT-30) (4-a, b, informed)
- They may not get the same results. They can show different perspectives on events. They can make different interpretations by observing the event. But science was supposed to be objective, I guess. I am confused. (BT-17) (4-a, b, c, d, transitional)
- Every research can not find the same result because everything changes over time. If there are no statistically significant differences, the experimental results can be accepted as the same. Reliability is essential. (BT-1) (4-a, naive)

4.5. Difference between Data and Evidence

If the teacher clearly stated the distinction between data and evidence and gave answers explaining that the evidence was obtained by processing the data, this opinion was considered as informed. The findings obtained from the 5th item, which directly measures the theme are explained in detail. The pre-test and post-test scores of the teachers are presented in Table 7.

Table 7. *Teachers' views on the difference between data and evidence*

Theme 5. Difference Between Data and Evidence												
	Naive				Transitional				Informed			
	Pre Test		Post Test		Pre Test		Post Test		Pre Test		Post Test	
	n	%	n	%	n	%	n	%	n	%	n	%
Item 5(a)	22	%56,41	27	%69,23	14	%35,89	11	%28,20	3	%7,69	1	%2,56
Item 5(b)	10	%25,64	2	%5,12	28	%71,79	35	%89,74	1	%2,56	1	%2,56
Item 5(c)	20	%51,28	14	%35,89	13	%33,33	22	%56,41	6	%15,38	3	%7,69
Mean	17,3	%44,35	14,3	%36,66	18,3	%46,92	22,6	%57,94	3,3	%8,46	1,6	%4,10

In the 5th item investigating the relationship between scientific data and evidence, the first the teachers were asked in part (a) “What does data mean in science? Please explain. It was determined that 22 (56.41%) teachers gave insufficient explanations for the question that the data was information or findings gathered through experiments or observations. However, only 3 (7.69%) teachers stated that the data is a collection of information obtained in various ways for research, and the existing information/study results before the research, literature, previous studies. It was determined that they had a scientifically informed view. The other 14 (35.89%) teachers remained at transional view since they could not support their answers with justifications.

In part (b) of the 5th question of the questionnaire, the opinions of the teachers about what the analysis of the data includes were questioned. Regarding this, it was determined that 28 (71.69%) teachers remained at transitional view by partially explaining the methods used in data analysis. It was seen that 11 (25.64%) teachers who answered the question did not have sufficient scientific view about what data analysis includes. Only 1 (2.56%) teacher expressed the qualitative or quantitative values of the data analysis as a process of making sense using various statistical methods and explained informed view. In part (c) of the question focusing on the relationship between scientific data and evidence, it was determined that the majority of teachers had misconceptions. When the answers given to the question are examined, it is seen that the information and evidence of the data are proven, unchanging, proven facts, etc. It was determined that 20 (51.28%) teachers who had misconceptions. However, 6 (15.38%) teachers stated that data is knowledge and evidence is products that emerge with the interpretation of this information, etc. They hold informed view. The other 13 (33.33%) teachers stated that there was a difference between the data and the evidence, and it was determined that they had transitional view as they could not justify this with appropriate examples.

When the post-test data of the 5th question measuring the distinction between scientific data and evidence were examined, in part (a), the teachers were asked to explain what the data was. It was determined that 27 (69.23%) of the teachers gave answers with naive view, which included that the data was information but did not mention its contribution to scientific research. It is noteworthy that the number of teachers who hold more informed views increased after the workshop compared to the pre-test. While the other 11 (28.20%) teachers had transitional view. It was determined that only 1 (2.56%) teacher made an explanation that was accepted as informed. In part (b) of the question, the opinions of the teachers about what the data analysis includes were taken. According to the post-test data, only 2 (5.12%) teachers did not show informed view about the methods including data analysis and remained at naive view.

It was determined that 35 (89.74%) teachers hold transitional view, showing an increase according to the pre-test data, while only 1 (2.56%) teacher gave informed view by exemplifying methods and techniques involving data analysis. Only 1 (2.56%) teacher left the question unanswered.

Part (c) of the question difference between scientific data and evidence. When the post-test data were examined, it was found that 14 (35.89%) teachers stated that data and evidence are different things, but they did not explain it in detail, so they hold naive view. It was noted that this number decreased compared to the pre-test findings. The other 22 (56.41%) teachers gave answers explaining that data and evidence are different and related to each other, but not detailing it, and they were holding transitional view. Only 3 (7.69%) teachers explained the question at an informed level, and it was determined that these teachers expressed the difference between data and evidence in their answers and explained the connection between them with appropriate examples. Below are examples of the answers given by the teachers to the post-test of the 5th question:

- Data is the accepted information that can help solve a problem or the information that the researcher collects during the research. (BT-21) (5-a, informed)
- Data is the knowledge level of a scientific study. It is formed by experimentation and observation. (BT-12) (5-a, transitional)
- Information obtained as a result of observation. (BT-41) (5-a, naive)
- Evaluation, comparison, and interpretation of the obtained data. (BT-43) (5-b, Informed)
- Data analysis is the interpretation of data on whether they are true or false. (BT-2) (5-b, transitional)
- Data analysis includes weeding out unnecassary information. (BT-27) (5-b, naive)
- Data is any information that helps to solve a problem. Evidence is the truth obtained as a result of this information. In other words, evidence is obtained from the data. (BT-9) (5-c, informed)
- Data is raw information about the problem. Evidence is processed data. (BT-41) (5-c, transitional)
- Evidence is the proof of data. (BT-9) (5-c, naive)

When the data were examined, it was noted that there was no obvious change in defining the difference and relationship between scientific data and evidence in the pre and post-tests.

4.6. Science as Being the Practice of Scientific Community.

"Scientists review the research results of others and ask questions about them. Science advances through logical skepticism." (NRC, 1998, p.20). Scientific work is influenced by a large community of scientists. They carry out their work with the practices and standards set by the communities. They are influenced by each other's work; they are in communication with each other. Scientists are aware that others have read, studied, been influenced by their research, etc. A holistic view is used fot this dimension since there was no direct item in the insturment. In the options (a), (b), and (c) of item 4 were taken. There were no teachers who emphasized the theme. The pre-test and post-test data are presented in Table 8.

Table 8. Views on s*cience* as *being the practice of scientific community*

Theme 6. Science as Being the Practice of Scientific Community												
	Naive				Transitional				Informed			
	Pre Test		Post Test		Pre Test		Post Test		Pre Test		Post Test	
	n	%	n	%	n	%	n	%	n	%	n	%
Item 2	36	%92,30	35	%89,74	2	%5,12	3	%7,69	1	%2,56	-	-
Item 4(c)	36	%92,30	33	%84,61	3	%7,69	6	%15,38	-	-	-	-
Mean	36	%92,30	34	%87,17	2,5	%6,41	4,5	%11,53	0,5	%1,28	-	-

In this context, when the pre-test responses of the teachers are examined, in the second question, 2 (5.12%) teachers stated that they would look at the work of other scientists, and provided transitional view. Only one teacher expressed an informed view by mentioning that scientists are affacted from thier works. According to the pre-test data, there are teachers who emphasized that scientists can influence each other when they work together only in option (c) of item 4. In their answers, 3 (7.69%) of the teachers expressed trasnitional view by briefly stating that when scientists work together, they will be affected by each other's comments and thoughts, and that they can exchange ideas and get consensus. There was no teacher who gave informed view on this item.

In line with the codes created, it was determined that 3 (7.69%) teachers in the 2nd item and 6 (15.38%) teachers in only option (c) of the 4th item expressed a transitional view, emphasizing that scientists can be affected by the work and opinions of other scientists. None of the other teachers expressed the opinion that science is the practice of a scientific community. Sample excerpts for items 2 and 4 from in the post-test responses are as follows:

- Examines the old methods. Sometimes they use it in the same way, sometimes by modifying it. (BT-1) (2, transitional)
- They decide by examining the methods used in previous studies. (BT-3) (2, transitional)
- They may not reach the same result. But the probability of reaching close results is high. At the same time, following the same processes increases unity and integrity. (BO-39) (4-c, transitional)

When the data were examined, it was noticed that the items in the questionnaire were not sufficient to get the opinions of the teachers.

4.7. Views about Project SupervisonTraining

After analyzing the views of the teachers who received project training on the nature of scientific research, 4 of the teachers who showed informed view, and 4 of the teachers who showed transitional view and 5 of the teachers who expressed naive view were interviwed. Teachers' thoughts about project supervision training and their views on the nature of scientific inquiry were examined.

It was observed that all of the teachers interviewed stated that the project supervison training made positive contributions to their professional and/or personal development. Except for one of the teachers interviewed (BT-1), they stated that project supervison training was very beneficial for them and they would very much like to participate in such trainings. The teacher coded as BT-17 stated that he currently works in the team that organizes teacher training at the Ministry of National Education. The teacher, who was coded as BÖ-40, expressed his views on the importance of being in that environment that all teachers should attend such trainings. Some responses given by the teachers who participated in the interview are listed below:

- I did not attend a similar training, but I would be very happy to attend if there is a training about 4005 projects. I would particularly like to attend trainings on Biotechnology or molecular biology. Previously, Izmir Yuksel Technology Institute had done a 4005 project in the field of biotechnology, but only teachers working in the Izmir region participated. If he had been accepted from other provinces, I would definitely have applied to it. Hopefully, such trainings will be held and we will also participate, so we can learn something. (BT-2)
- I did not attend such a training later, but I would love to participate in such training if it is avaliable. (BT- 8)

As a summary the workshop was perceived to be beneficial for teachjers. They would be happy is project team offers similar trainings.

5. Discussion and Conclusions

As a result of the training, the findings of this research introduce the nature of scientific inquiry to teachers; the theoretical and practical activities carried out with the indirect and direct-reflective approach were applied throughout the project supervision training. Teachers developed better views compared to their initial views. According to the analysis and the codes created, it was determined that teachers showed improvement in the level of transitioanl views in five of the six themes related to the nature of scientific inquiry, and in the level of informed views.

Scientific research is guided by questions. Scientific processes do not always start with a hypothesis, contrary to popular belief. Scientists ask questions and work to find answers to these questions (Schwartz et al., 2008). This theme, which measures the importance of questions in scientific inquiry, was the theme in which teachers showed the most positive change. It was found that there was an increase in the number of teachers (from 29.48% to 50%) who hold informed view after the project supervision training. During the project supervision training teachers prepared a practical project and wrote the research questions themselves in their projects. While progressing on their scientific inestigations, they experienced that the research questions guided the whole process. This situation was also reflected in the post-test results of the teachers, and the teachers gave more informed answers to the importance of the questions in the scientific research processes. This result also resembles the findings of Karaman and Apaydın's (2014) which states the positive outcomes obtained form astronomy summer science camp on teachers' views on the nature of scientific inquiry through a direct reflective approach.

Scientific research has multiple methods. Until the beginning of the 21st century, it was adopted that there was only one method in science, and textbooks were prepared in this direction. In that idea, research begins by establishing a hypothesis, then data is collected, data is analyzed and results are reached (İrez, 2006). With the changing understanding of science today, it is accepted that there is more than one scientific method followed in scientific investigations, and it is seen that scientists seek answers to these questions by using different methods according to their research questions (NRC, 1998). Although the teachers who showed naive views on this theme, this number decreased at the end of the training (from 48.71% to 44.71%). It was seen that the teachers had the wrong view that scientific investigations follow one method, in order to be scientific. The data obtained from the 1st and 2nd questions of items support this situation. Although some teachers state that different methods are used in scientific research as a concept, they do not internalize it. The findings show that teachers improved positively (from 30.76% to 40%) in the answers they hold transitional views. It is thought that the theoretical courses given in the project supervison training and the different methods used in the applied projects support this development but is insufficient to reach an informed view. Similar results were found in the studies conducted with teachers and students in different branches in the theme of "Method Diversity in Scientific Research" (Doğan & Ozcan, 2010; Aydemir, 2016; Lederman et al, 2014; Karaman & Apaydın, 2014; Dursun & Ozmen, 2018).

It was observed that the teachers emphasized that scientists' curiosity and interests significaltly affacet their studies, but they gave insufficient views by not mentioning other factors. Although this rate decreased in the post-test (from 58.97% to 52.56%), it was determined that most of the teachers showed similar thoughts at the end of the training.

However, there has been an increase in teachers showed transitional views (from 24.35% to 32.05%), and teachers have emphasized the existence of different social or personal factors in scientific processes. The decrease in the number of teachers who showed informed views demonstrated that the impact of the project supervison training on this feature was moderate in developing views.

Another theme of the nature of scientific inquiry in which teachers developed their views was the justification of scientific knowledge. Emphasizing that scientific data is not sufficient on its own and that it can be interpreted together with other variables (Tuncel, 2012 as cited in Osborne), this theme also emphasizes the subjective aspect of science. Even if scientists work together or differently, they may perceive data differently and concentrate on different parts of it. Therefore, it is not always possible to reach the same result.

All of the interviewed teachers stated that the training was beneficial, contributed to their professional development, and stated that they used the knowledge they gained in preparing projects. The fact that teachers expressed their needs for this and similar trainings revealed that practical training such as project supervision should be included in in-service training. After receiving the project supervision training, it has been seen that some teachers have prepared their students for Science Olympics and science fairs. Some of these teachers apllied to The Scientific and Technological Research Council of Turkey for funding support to their projects.

As a result, project consultancy training especially developed teachers on the issues:

- Scientific research guides scientific inquiry, project supervision training positively improves views of teachers on this dimension.
- It provided an acceptable level of development about using different methods in scientific investigations; scientific inquiry has many purposes, justification of scientific knowledge and differences between scientific data and evidence. However, we don't have enough evidences to support that the training was as effect as developing informed views.
- The sixth theme, that states science is the product of a scientific community, has least amont of data, and we attributed it to the survey itmes measuring it.
- However, it has been determined that teachers' misconceptions about various themes still continue
- In addition, the effectiveness of this training was demonstrated by the fact that the teachers provided project supersivion to their students and other teachers in various projects and competitions.

The scope of this study is limited to in-service teachers' understanding of nature of scientific inquiry exposed to project supervision training. We observed notable positive changes in teachers' views. In this way, teachers are more likely to encourage their students and peers quide on supervising scientific projects as well as developing more informed views.

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