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Classroom teachers' perceptions of science and inquiry-based teaching[1,2]

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ABSTRACT

Inquiry-based teaching is an approach that carries the same steps as producing scientific knowledge, where the student is at the center of learning and where teachers must develop the inquiry skills of both them and their students. It can be said that in the first years of childhood, the person students spend the most time with, after their families, is their classroom teacher. The basic knowledge taught in primary school forms the basis of the following school levels. An innovative strategy method is essential in developing and implementing educational activities with a research-based teaching approach. However, teachers need time, resources, training, and support to effectively implement inquiry-based teaching in their classrooms and develop inquiry skills. TÜBİTAK 4004 "MAT-SOR Inquiry-Based Activity Development Camp" project was carried out to support classroom teachers within the Science and Community Support Programs Mathematics Year Special Call scope. The project aims to increase the competencies of classroom teachers in developing activity plans and to ensure that they acquire the skills required by the 21st century. Within this project's scope, "mystery boxes" training was organized to help classroom teachers recognize and improve their skills in understanding science and inquiry-based teaching practices. For this purpose, teachers' opinions were taken with open-ended questions before and after the training. The research data was obtained from 25 teachers who participated in the project. The data obtained was analyzed using the content analysis method, one of the qualitative analysis methods. Three researchers conducted analyses independently, and then themes and categories were determined. As a result of the study, it was determined that teachers' ideas about science improved, and their ideas about the steps of inquiry-based teaching in general emerged. It can be stated that providing new methods and approaches and applied training contributes to developing educational activities for individuals.

KEYWORDS

Inquiry-based science, classroom teachers, science education, research and inquiry

Sınıf öğretmenlerinin bilim ve sorgulama temelli öğretim algıları

ÖZET

Sorgulamaya dayalı öğretim, bilimsel bilgi üretmeyle aynı adımları taşıyan, öğrencinin öğrenmenin merkezinde olduğu, öğretmenlerin hem kendisinin hem de öğrencilerinin sorgulama becerilerini geliştirmesi gereken bir yaklaşımdır. Çocukluk çağının ilk yıllarında öğrencilerin ailelerinden sonra en çok vakit geçirdikleri kişinin sınıf öğretmenleri olduğu söylenebilir. İlkokulda öğretilen temel bilgiler ilerleyen kademelerdeki bilgilerin temelini oluşturur. Araştırmaya dayalı öğretim yaklaşımıyla eğitim etkinliklerinin geliştirilmesi ve uygulanmasında yenilikçi bir strateji yöntemi esastır. Ancak öğretmenlerin araştırma-inceleme temelli öğretimi sınıflarında etkili bir şekilde

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uygulamak ve sorgulama becerilerini geliştirmek için zamana, kaynaklara, eğitime ve desteğe ihtiyaçları vardır. TÜBİTAK 4004 "MAT-SOR Araştırmaya Dayalı Etkinlik Geliştirme Kampı" projesi, Fen ve Toplum Destek Programları Matematik Yılı Özel Çağrısı kapsamında sınıf öğretmenlerine destek amacıyla gerçekleştirildi. Projeyle sınıf öğretmenlerinin etkinlik planı geliştirme konusundaki yeterliliklerinin artırılması ve 21. yüzyılın gerektirdiği becerileri kazanmalarının sağlanması amaçlanmıştır. Bu proje kapsamında sınıf öğretmenlerinin bilimi anlama ve sorgulamaya dayalı öğretim uygulamalarını tanıma ve geliştirme becerilerini geliştirmek amacıyla "gizemli kutular" eğitimi düzenlendi. Bu amaçla eğitim öncesinde ve sonrasında açık uçlu sorularla öğretmenlerin görüşleri alınmıştır. Araştırma verileri projeye katılan 25 öğretmenden elde edilmiştir. Elde edilen veriler nitel analiz yöntemlerinden biri olan içerik analizi yöntemi kullanılarak analiz edilmiştir. Üç araştırmacı birbirinden bağımsız olarak analizler gerçekleştirmiş, ardından temalar ve kategoriler belirlenmiştir. Araştırma sonucunda öğretmenlerin fen bilimleri ile ilgili fikirlerinin geliştiği, genel olarak araştırma-inceleme yoluyla öğretimin adımlarına ilişkin fikirlerinin ortaya çıktığı tespit edilmiştir. Yeni yöntem ve yaklaşımların sağlanması ve uygulamalı eğitimin bireylere yönelik eğitim faaliyetlerinin geliştirilmesine katkı sağladığı ifade edilebilir.

ANAHTAR KELİMELER

Sorgulama temelli öğretim, sınıf öğretmenleri, bilim eğitimi, araştırma ve sorgulama

Introduction

Inquiry-based teaching encourages students to learn actively and is based on constructivism (Harlen, 2013; National Research Council [NRC], 1996). This approach ensures the active participation of students in the learning process. Keeping their curiosity alive helps them develop many skills, such as asking questions, conducting research, and analyzing the results (Inter Academy Partnership, 2010; NRC, 1996). Considering the concepts that students are curious about and interested in is crucial to making students active (Yerlikaya, 2019). In this context, it is seen that inquiry-based teaching is nourished from different perspectives of the constructivist approach. In inquiry-based teaching, sociocultural constructivism is achieved through discussion and compromise, communication, language use, and collaboration skills. The cognitive constructivism perspective is used with the dimension of obtaining knowledge by using scientific process skills and thus learning a way about how knowledge is structured (Alexopoulou & Driver, 1996; Kelly & Crawford, 1997; Keys & Bryan, 2001; Khishfe & Abd-El-Khalick, 2002). To carry out inquiry-based teaching practices conveniently, students and teachers must acquire and develop these skills if they still need them (Yerlikaya, 2019). Having these skills also means mastering the nature of inquiry-based teaching. For this reason, teaching students the skills involved in inquiry-based teaching processes is essential to raise inquiring and questioning individuals, which is one of our national education goals (Bal İncebacak & Ersoy, 2019).

In inquiry-based teaching, students are expected to be physically and mentally active (Harlen, 2013). This activity is achieved by students' participation and communication with their friends and teachers. Because students learn the scientific inquiries they make in an inquiry-based teaching environment, both individually and through social interactions with each other (Johnson, 2004; Vosniadou, 2003), in this teaching environment, students' communication with each other in their scientific inquiries can be in the form of exchanging information or asking questions. It is essential to ask questions and establish healthy communication in an inquiry-based teaching environment (Yerlikaya, 2019). To create a conducive inquiry-based teaching environment, teachers should improve their students' understanding of inquiry-based teaching, create a safe and fair discussion environment, give their students the opportunity and time to explain, be good listeners, and engage their students with topics they are interested in or curious about. should encourage them to ask relevant questions and conduct research (Hogan & Berkowitz, 2000; van Uum et al., 2016; Yerlikaya, 2019). In such an inquiry-based teaching environment, students are free to ask questions about their interests and try to find answers by researching them (Worth et al., 2009). Thus, students learn to obtain information from their teachers and various sources during the learning process. Inquiry-based teaching is an approach that has the same steps as the production steps of scientific knowledge, where the

student is at the center of learning and where the teacher must develop both his own and his students' inquiry skills (Bal İncebacak, 2019). When viewed from the perspective of the continuity of this development, questioning is a complex skill that is considered within the scope of lifelong learning and requires continuous expansion. Questioning skills are practical in the individual's self-improvement and society's development. Inquiry-based teaching is an approach that positively affects the development of scientific process skills and life skills (Yerlikaya, 2019).

Inquiry-based teaching enables students to develop their skills in conducting research and accessing information. Inquiry-based teaching enables students to understand data in depth rather than just memorizing it and helps them develop critical thinking skills and increase their problem-solving abilities (Bal İncebacak, 2019). In this approach, the inquiry cycle is organized in stages, starting from the student's previous knowledge and experiences, and proceeding through a research process in which this knowledge is expanded and deepened (Sarışan Tungaç, 2023). Students can produce solutions to real-world problems by using their skills in collecting data, analyzing, and interpreting the results (Shih et al., 2010). In addition to the many abilities it provides, this approach makes students' learning more meaningful and equips them to be successful in their future lives. According to Dewey (1933), questioning develops many skills related to experience and practicality. Studies show that developing questioning skills, especially young ones, yields more effective results (Karademir & Oğuz-Ünver, 2018; Nenadal & Mistry, 2018). It can be said that in the first years of childhood, the people with whom students spend the most time, after their families, are their classroom teachers. Classroom teachers are also crucial in developing students' inquiry skills (Collins, 1998). The basic information taught in primary school forms the basis of the following levels. A student with a good foundation will inevitably be successful in the future. In this respect, teachers must learn and transfer this skill to their students and the classroom environment. Transferring the inquiry process to the classroom environment can also be thought of as conducting scientific inquiry in the classroom (Cobern et al., 2010). It seems that inquiry-based teaching is an approach to a whole range of skills that need to be learned by teachers as well as students to be able to do them in the classroom environment. However, teachers need time, resources, training, and support to effectively implement inquiry-based teaching in their classrooms and develop inquiry skills. The TÜBİTAK 4004 “MAT-SOR Inquiry-Based Activity Development Camp” project was carried out within the Science and Society Support Programs Mathematics Year Special Call scope to support classroom teachers. Within the project's scope, teachers were provided with information and practical activities regarding inquiry-based teaching. In this way, it was aimed to ensure that teachers, in addition to learning theoretical knowledge about inquiry-based teaching, can carry out practical activities, gain experience, and carry out inquiry-based activities in their classes with more self-confidence. In this context, in addition to teachers' knowledge, it is also essential to see how their views have changed. Because teachers prefer to apply the methods they have learned in their schools, both in and outside the classroom, in areas where they have positive views and improve their motivation (Burden, 1981). Therefore, this study aimed to determine teachers’ perceptions of science and inquiry-based teaching before and after the training.

Method

This qualitative study aims to determine the perceptions of classroom teachers participating in the project towards science and inquiry-based teaching.

Research Design

In this study, a pretest-posttest single-group weak experimental design was used. The dependent variable of this study is the post-test results given by the study group teachers to the interview form. The independent variable is the inquiry-based teaching method used in the research. An experimental design was adopted in this research, which investigated the effects

of inquiry-based teaching practices on science and inquiry skills in teacher education, where an inquiry-based teaching approach was adopted. The reason for choosing an experimental design is to try to determine cause-effect relationships, and it is a research model in which the data to be observed is produced by the researcher under the researcher's direct control (Karasar, 2008).

Study Group

The study group of the research is classroom teachers, including at least one person from all districts of a major city in the Black Sea region, in the 2022-2023 academic year. All the teachers have trained students from first grade to fourth grade. The study group was determined by a purposeful sampling method. Among the 320 people who applied to the project for which the working group's online application was opened, they must not have been involved in a similar project before within the scope of the relevant call, have conducted a class at least once at each grade level from first grade to fourth grade, and already have a classroom (support or education class). 24 classroom teachers who work in different districts of the province where data were collected and who declare that they use other education and training methods in their lessons are open and willing to learn. While selecting teachers from the districts, care was taken to include teachers from every district with five socio-economic statuses, considering the 2022 socio-economic ranking of the communities by the Socio-Economic Development Ranking Research (SEGE) by the General Directorate of Development Agencies under the Ministry of Industry and Technology. This method, used within the scope of purposeful sampling by Patton (2014), is preferred for research to find and define basic themes that include the desired differences. The maximum variation sampling method makes the findings and results obtained in the examination richer than those obtained by other sampling methods. The study was conducted in 17 other districts in the big city. Teachers working as classroom teachers in these districts were reached through the Provincial Directorate of National Education. Among the 320 teachers who applied with voluntary participation, 24 people were the target group, including district distribution, grade level, state of declaring that they used different methods, having conducted a class at least once at each grade level from first grade to fourth grade, and among those who agreed to continue the entire project compulsorily. Has been selected. There are 16 female and eight male classroom teachers in the study group. Yıldırım and Şimşek (2012) stated that this sampling method is preferred in research because it provides a wealthy evaluation in terms of both its widespread effect and maximum diversity.

Training Process

It is seen in the literature that there is more than one application method for the application of inquiry-based teaching approach. There are four ways of applying the inquiry-based teaching approach in the classroom: Open, Guided, Structured, and Confirmation Exercises (Tafoya et al., 1980; Fradd et al., 2001; Walker, 2007). The researchers planned this study's training, so this training was applied as a guided inquiry approach to classroom teachers because the researchers structured the application. In training within the project's scope, an analogy of inquiry-based teaching was made, and they were enabled to realize and use the skills expected to be used in this approach. In this way, skills such as determining the steps of accessing scientific knowledge (such as establishing a hypothesis, using previous knowledge, making observations), determining the skills used, reaching a common idea, and presenting and defending this idea, refuting a statement by giving an argument, or getting new ideas with new arguments. It consists of stages to ensure an understanding of the nature of science and inquiry-based teaching. These stages were expected to shape teachers' views on science and inquiry-based teaching.

TÜBİTAK 4004 "MAT-SOR Inquiry-Based Activity Development Camp" project was carried out within the Science and Society Support Programs Mathematics Year Special Call scope to provide classroom teachers with the support they need for inquiry-based teaching. The project aims to increase the qualifications of classroom teachers in developing activity plans and enable

them to acquire the skills required by the 21st century. The inquiry-based teaching approach contributes to developing educational activities as an innovative strategy method. Within this project's scope, "mystery boxes" training was held to help classroom teachers realize and develop their skills in understanding science and inquiry-based teaching practices. The mystery box training is about talking about science and the scientific process. The idea of this training is that "science" encompasses far more than merely a collection of knowledge; our comprehension of the mechanisms governing the world around us is in a state of perpetual advancement, indicating that vast territories remain to be explored and unveiled. This training consists of stages such as understanding inquiry-based teaching, determining the steps of accessing scientific knowledge, determining the skills used, defending the common idea, and refuting a statement by presenting an argument. These stages were expected to shape teachers' views on science and inquiry-based teaching. Therefore, this study aims to determine how mystery box training affects teachers' views on science and inquiry-based teaching.

Data Collection Tools

For this purpose, teachers' opinions were taken with open-ended questions before and after the training. The study's data were collected in written form from classroom teachers. Data was obtained by asking the teachers questions in the data collection tool before and at the end of the training. The data collection tool consists of 4 open-ended questions to determine their knowledge and opinions about science and inquiry-based teaching. Open-ended questions that do not offer options for answering are very effective in revealing individuals' thoughts, knowledge, and attitudes in detail (Sevinç, 2009). Data was obtained through open-ended questions to effectively present the opinions and understanding of the study group's teachers regarding science and inquiry-based teaching and discovering the unknowns. The questions included in the data collection tool are as follows:

- "What is science?"
- "What skills do we use when making science?"
- "What is inquiry-based teaching?"
- "What are your views on inquiry-based teaching?"

Data Analysis

The data obtained was analyzed using the content analysis method, one of the qualitative analysis methods. Three researchers made analyses independently, and then agreement percentages were calculated. Code categories and themes were discussed on common and non-common expressions, determined based on the common denominator, and calculated with the Miles and Huberman (1994) percent agreement formula. After the calculation, the percentage of agreement was calculated as 98%.

Validity and Reliability

It was carried out according to the validity and reliability principles Guba and Lincoln (1985) determined. The relevant study examined the credibility, transferability, consistency, and confirmability measures. The credibility criterion states that the study results were reached by explaining how they were reached in detail. In this context, the researchers' analyses of how the study results were achieved are detailed. The transferability criterion expresses the results obtained from the data analysis in a way that allows generalization. In this context, the results obtained from the data are represented by making positive and negative comparisons with the results of other studies in the literature. For consistency, examples from similar studies in the literature should be given. The data were interpreted in this context if we compared it with other existing studies. For confirmability, other researchers must obtain the same results under similar conditions. In this context, the study's data obtained by the researchers with doctoral degrees were analyzed separately and compared.

Findings

The data collected after the training was analyzed, and four themes emerged because of the analysis of the texts. These themes are View of Science, Use of Skills, Inquiry Process, and Use of Inquiry Approach in the Classroom. The codes and categories that emerged when the responses of classroom teachers participating in the project were analyzed are presented in tables under the themes.

View of Science

Table 1 View of science themes, codes, and categories of the themes emerged from the responses of the classroom teachers before and after the training

			Pre-test		Post-test	
Theme	Category	Code	Teachers	Frequency	Teachers	Frequency
View of Science	Scientific process skills	Use of experimental methods	T1, T4, T6, T9, T23	5	T2, T3, T5, T6, T7, T9, T10, T11, T12, T13, T16, T20, T21, T23, T24	15
		Testing the accuracy of knowledge	T9	1	T6, T8, T10, T11, T12, T13, T14, T15, T17	9
		Making a statement	T1	1	T2	1
		Arouse curiosity	T8	1	T24	1
		Hypothesis development	T3	1	T24	1
	Knowledge	Verifiable information	T4, T9, T12, T14, T18, T19, T21	7	T1, T10, T11, T12	4
		Information	T5, T9, T12, T19, T21, T22, T23	7	T6, T9	2
	Process of accessing knowledge	Being research-based	T3, T8, T11, T20, T22	5	T2, T5, T10, T12, T14, T16, T17, T18, T19, T20, T23, T24	12
		Based on review	T1, T2, T12, T19, T20	5	T2, T5, T6 T14, T17, T23	6
		Having a way to access knowledge	T4	1	T5, T7, T13, T24	4
		Configuration in process	T3, T10, T11	3	T14, T16, T24	3
		Revealing new knowledge	T2, T16	2	T1, T3, T18	3
		Having knowledge	T20	1	T8	1
		Being the product of effort	T14, T15, T24	3	T18	1
		Being a whole system	T6	1	-	-
		Having a field	T18	1	-	-

Creating a Product	Production of information	T15	1	T3, T6, T7, T9, T11, T12, T14, T19, T22, T23	10
	Bringing original innovations	T10	1	T19	1
	Contributing to the production of technological tools and equipment	T7, T13	2	T19	1
Total			49		75

"What is science?" was asked to the teachers before and after the training. The findings obtained from analyzing their answers to the question are given below. When the teachers' responses to this question were examined before the training, they expressed science as identifying events and phenomena in the universe, reaching information through trial and error, researching intriguing information, and proving knowledge. T1 stated that science is more experimental: "*Discussing and explaining the events and phenomena in the universe with experimental methods*." T16 expressed it as follows: "*As a result of the analysis and evaluation of information as a result of experiences, new research topics are created, and researching these is science.*" T13: "*It refers to all technological developments that meet the needs of the age*." Teacher 13 stated that science, which he referred to as a pioneer in the development of technology. Some teachers noted that science has a cumulative structure. T20: "*It is a body of knowledge based on being examined, researched, and proven.*" T21: "*It is a body of knowledge that can be proven and whose accuracy has been confirmed.*" After the training, it was determined that the teachers expressed science as a way of reaching valid and reliable information that leads people to research and as a process of creating knowledge that adapts to the developments of the age. T15 was expressed as "*Acquiring knowledge by using generally accepted research methods and processes on a subject that we want to know and feel the need for.*" The idea of the immutability of scientific knowledge has been eliminated. However, after the training, it was determined that while teachers explained what science is, they added the process of discovering existing and new knowledge to their statements of explaining the understanding before the training. T4: "*Discovering new information in line with needs.*". It is understood that the definitions of science expressed by the teachers after the training talk about knowledge that can change, update, and be structured with new evidence after the research and questioning process rather than certainty and immutability.

Use of Skills

Table 2 Use of skills themes, codes, and categories of the themes emerged from the responses of the classroom teachers before and after the training

			Pre-test		Post-test	
Theme	Category	Code	Teachers	Frequency	Teachers	Frequency
Skills used while doing science	Basic skills	Observation	T3, T4, T5, T7, T8, T11, T12, T13, T17, T21, T22, T23	12	T3, T4, T5, T6, T7, T8, T9, T11, T14, T15, T20, T22	12
		Measurement	T11, T17	2	T6, T11, T13, T15, T20, T21, T24	7
		Using space/time relationships	T2, T4, T8, T16	4	T3, T6, T11, T13, T19, T23	6
		Classification	T12	1	T11, T13, T15	3
		Inference	T3, T14, T11, T15, T19	5	T13, T14, T21	3
		Communication	-	-	T6, T11	2

	Integrated skills	Experimentation	T1, T2, T4, T5, T7, T8, T9, T12, T13, T14, T16, T17, T18, T19, T20, T21, T22, T23	18	T1, T2, T4, T5, T6, T7, T8, T9, T!0, T11, T12, T13, T14, T17, T18, T19, T20, T23, T24	19
		Hypothesizing and testing	T3, T9, T17	3	T11	1
		Saving and interpreting data	T4, T9	2	T7, T11, T24	3
		Identifying and controlling variables	-	-	T11	1
		Creating a model	T7, T20, T22	3	-	-
	Attitudinal skills	Curiosity	T1, T11, T24	3	T13	1
		Patience	T1	1	T22	1
		Collaborate	-	-	T13	1
Total				54		60

What skills do we use when doing science? In response to the question, teachers stated that before the training, experimental methods, developing hypotheses, observing, and experimenting, and after the training, they mentioned research, questioning, observing, generating ideas, reaching a conclusion by trying, determining concepts, analyzing and synthesizing, without applying, evaluating, and verifying. However, they stated that skills such as asking questions, curiosity, patience, observation, mental skills, problem-solving, thinking, and philosophizing were used. T6 expressed the skills used in science as "*Using process skills based on knowing, comprehending, applying, analysis, synthesis, and evaluation*." T12 added writing report to the skills used while doing science: "*Observations are made. Problem-solving. Classification. Don't test. Experimentation. Analyzing. Writing a report.*". In addition, T4: "*We use mathematical skills to reach a percentage by making observations through trial and error, asking questions, generalizing, using numbers to reach precise and provable information*." They stated before the training that scientific knowledge is definitive information. Some teachers expressed skills as talents before the training. T3: "*Mental skills are used together with observation ability. Questioning and reasoning skills are used.*" After the training, it was determined that the teachers did not use precise knowledge and ability expressions regarding the skills used while doing science. In addition to the skills they stated before the training, it was determined that they added skills such as thinking, data collection, decision-making, inference, curiosity, and generating new ideas to other skills.

Inquiry Process

Table 3 Inquiry-based teaching themes, codes, and categories of the themes emerged from the responses of the classroom teachers before and after the training

			Pre-test		Post-test	
Theme	Category	Code	Teachers	Frequency	Teachers	Frequency
Inquiry-based teaching	Scientific process skills	Questioning	T1, T2, T5, T8, T9, T!0, T11, T12, T13, T16, T17, T18, T20, T22	14	T2, T11, T14, T16, T19, T20, T21	7
		Asking questions	T3, T4, T5, T7, T9, T14, T19, T20	8	T1, T4, T6, T11, T14	5
		Research	T1, T4, T9, T11, T16, T19, T22, T24	8	T3, T6, T7, T11, T12	5
		Curiosity	T1, T8, T9, T14, T16	5	T1, T2, T4, T13, T24	5

	Discovery	T2, T24	2	T3, T22, T24	3
	Creativity	-	-	T2, T15, T19	3
	Using prior information	T10	1	T13, T19	2
	Problem-solving	T2, T4, T5, T9	4	T14, T21	2
	Evaluation	-	-	T13, T20	2
	Analyzing	T11	1	T2	1
	Modelling	-	-	T13	1
	Explaining the reasons	T11, T22	2	T13	1
	Experimenting	T4	1	T6	1
	Examination	-	-	T7	1
	Data collecting	T10	1	-	-
	Interpretation	T9	1	-	-
	Observing	T4	1	-	-
	Using 21st-century skills	T17	1	-	-
Constructivism	Using as a learning method	-	-	T1, T2, T3, T7, T9, T!0, T12, T13, T14, T17, T19, T21	12
	Putting the student at the center	T2, T20	2	T6, T9, T!0, T11, T13, T14, T15, T21	8
	Supporting self-learning	T2, T6, T9, T12, T15	5	T2, T4, T5, T7, T11, T14, T15, T21	8
	Guiding	-	-	T2, T3, T4, T5, T7, T13	6
	Achieving permanent learning	T7, T8, T16, T17, T22	5	T11, T20, T21, T22	4
	Staying away from memorization	T7, T21, T24	3	T8	1
	Using communication skills	T17	1	T15	1
Determining common aspects from a scientific perspective	Accessing information	T3, T4, T5, T7	4	T6, T11, T12, T16, T17, T18, T24	7
	Systematic	T5	1	T4	1
	Creating new methods and techniques	T23	1	T8	1
	Based on science	-	-	T4	1
	Reaching accurate information	T4	1	-	-

	Changing/updating knowledge with new evidence	T4, T23	2	-	-
	Getting a problem resolved	T5	1	-	-
Total			77		91

"What is inquiry-based teaching?" to the question of teachers before the activity while expressing it as the situations of questioning the reason, asking questions, curiosity, discovering and having research competence, after the training, learning to learn on one's own, being responsible for one's learning, getting to the heart of the subject, revealing the reasons of the issue, solving complex problems, learning to ask the right questions, They expressed it as the process of questioning information. T1: "*It is an education model in which information is not presented directly to students, but is researched, questioned and structured.*" emphasized the student-centered structure of inquiry-based teaching; another teacher, T2, said: "*It is an educational process that puts the student at the center in the educational content and enables the student to learn the content by using their curiosity, discovery, and research skills.*" It has been determined that it emphasizes the skills that students in the inquiry-based teaching process should have. T5 described the perspective of inquiry-based teaching as philosophy. T5: "*I think it is a philosophy.*". T7, on the other hand, has the idea that inquiry-based teaching will start with questions and break away from rote patterns, thus enabling complete and permanent learning. T7: "*It is a system that avoids memorization, where learning will be complete and permanent. The child is already ready to learn when he asks. Learning has occurred when he finds answers to the questions in his mind.*" T8: "*It is education that leads the person to curiosity and questioning.*" It has been determined that inquiry-based teaching emphasizes curiosity, perhaps the most essential skill of inquiry-based teaching. After the activity, teachers added expressions regarding accompanying the student in the learning process and the evaluation phase, in addition to the answers they gave before the training. T1 explains, "*Research and inquiry-based education keeps students' curiosity and interest alive. It improves their learning. Since knowledge is learned by structuring, it becomes permanent. It develops students' critical thinking, reflective-creative thinking, and problem-solving skills.*" T13: "*The student is directly involved in the process and reaches the wise by establishing cause and effect relationships. It is a learning method in which we plan what the student expects to learn, push the student to think about the process with modeling questions from daily life, increase curiosity and motivation in the student by using methods such as effective reading, identify the student's prior knowledge, offer them environments for observation, experimentation, and research, and accompany the student and become a learning companion. It provides opportunities for student, teacher, and group evaluations during the evaluation process.*" stated. However, it has been observed that inquiry-based teaching is a skill teaching and that it is a teaching approach that is researched and presented by the student himself, is permanent, increases interest, and opens different horizons and experiences for both the student and the teacher. T11: "*Information revealed by researching and questioning the reasons, rather than placing it directly in the schema of the information learned, becomes permanent, and it is easier to shape the information. Since the learning individual works actively in the process, the resulting product will also be open to development.*" T16: "*Permanent learning takes place. It increases interest in learning.*" T17: "*It provides the researcher with different experiences in the process of accessing information.*" T23: "*I think it is a system that will open horizons in the education process and renew teachers and students.*" T24: "*It should be made widespread. The student should be guided away from memorization and discover the most ideal for himself.*"

Use of Inquiry Approach in the Classroom

Table 4 Inquiry-based teaching themes, codes, and categories of the themes emerged from the responses of the classroom teachers before and after the training

Theme	Category	Code	Pre-test		Post-test	
			Teachers	Frequency	Teachers	Frequency
Views on inquiry-based education	Opinions about students (positive)	Facilitating learning	T1, T15	2	T3, T7, T9, T11, T13, T21, T22, T23	8
		Providing permanent learning	T1, T2, T8, T11, T16, T19, T22	7	T3, T9, T11, T19, T21, T22	6
		Being useful	-	-	T1, T!0, T18, T19, T20, T22	6
		Ensuring student development	T23	1	T2, T7, T8, T15, T19	5
		Ensuring active participation of the student	T2, T6, T9 T11, T17	5	T7, T11, T21	3
		Ensuring learning the source of information	T5	1	T11, T12, T21	3
		Ensuring skill development	T1, T3, T4, T17, T20	5	T2, T15	2
		Providing learning opportunities by constructing	T1	1	T21	1
		Giving opportunity to develop creativity	-	-	T19	1
		Keeping interest alive	T1, T8, T16	3	T24	1
		Being fun	-	-	T3	1
		To be necessary	-	-	T22	1
		Ensuring complete learning	-	-	T23	1
		Keeping wondering	T1, T8, T9, T14, T19	5	-	-
		Providing motivation	T9	1	-	-
	Opinions towards the teacher (positive)	Contributing to teacher development	T21, T23	2	T4, T7	2
		Willingness to use	T12	1	T13, T20	2
		Guiding discovery	T24	1	T3	1

	Enabling outdoor education	T6	1	-	-
	Providing practice at every grade level	-	-	T6, T11	2
	Ensuring interdisciplinary relationships	T17	1	-	-
	Ensuring time management by gaining experience	-	-	T24	1
Opinions towards the teacher (negative)	Difficulty while applying	T10	1	T5, T23	2
	We have not included in our curriculum.	T17		T16	1
	Not using the method before	T12, T18	2	-	-
	Not common	T24	1	-	-
	Ensuring basic level learning	T10	1	-	-
	Taking much time	-	-	T18, T24	2
Total			43		52

When asked their opinions about inquiry-based teaching, teachers stated they were unsure whether they used it in their classroom before the activity because they needed to understand this approach entirely. T12 and T18 indicated they needed to practice or learn about inquiry-based teaching. T12: "*I have never used it in a classroom environment. I will use it at the end of the process when I learn how to use and apply it.*" The teachers declared that they would practice afterward. T18: "*It's an area I feel like I'm not fully in yet.*" It was determined that they viewed inquiry-based teaching as an area they did not understand. After the activity, teachers stated that they found it challenging to implement inquiry-based teaching besides the pre-activity, as it is fun and valuable but time-consuming, with the following sentences: T1: "*I think it is beneficial*." T3: "*Learning by having fun and discovering because children discover and think independently. It becomes permanent*.". However, T5: "*It is quite difficult to apply to the current education system.*" The teacher stated that it is challenging to implement it in the current education system. T14: "*It can be applied if the appropriate environment and curriculum intensity are reduced.*" He stated that he is willing to apply it in his lessons but may have problems in terms of time. T18 also expressed the same idea: "*It is a beneficial method for students, but there may be difficulties in developing the course curriculum.*". T22 regarding time constraints: "*It can be used in all parts of the education process. Its limitation will be in time management, but this time will be shorter as we will gain experience in this after implementing a few designs and applications.*" The teacher draws attention to the point of time management and states that applications can be more applicable with experience and skill development. From another perspective, T23, who drew attention to the class size while preparing lessons by the inquiry-based teaching approach, stated, "It will ensure full learning in uncrowded classes." The teacher emphasizes that the class size should be sufficient. From the perspective of the reflection of technological developments, another factor in addition to class size to educational environments, T24 stated: "*The attention of children in the technology age can be captured with such current approaches. May God bless*

the finder." The teacher emphasizes the attractiveness of this approach. When the findings are evaluated in general, it can be said that teachers have positive views and will apply the methods they have learned in the areas where they improve their motivation, both in and outside the classroom, in their schools.

Discussion, Conclusion, and Suggestions

It was determined that teachers had not used vocal instruction during questioning in their lessons before the training. To implement inquiry-based teaching practices, there are perspectives and some basic skills that both students and teachers need to acquire. Because Patterson (2016) stated that teachers should guide their students in inquiry-based activities, for teachers to guide their students, they must first have this perspective and skills. One of the important factors for the success of inquiry-based learning is understanding and experiencing the nature of this approach (Harlen, 2013). Recognizing and possessing these skills is an element that will help understand the nature of inquiry-based teaching (NRC, 1996). For this reason, acquiring skills to carry out the inquiry-based teaching approach in a qualified manner is essential.

John Dewey (1933) stated that education begins with curiosity. The inquiry-based learning approach is related to curiosity and starts with the process of curiosity. Garrison, Cleveland-Innes, and Fung (2004) stated that questioning contributes to cognitive progress. An activity was held in which the sense of curiosity, one of the most basic emotions, was not lost during the event. When the findings were examined, teachers also stated that they thought curiosity was essential in learning, asking questions, and questioning. In addition, developing hypotheses, observing, experimenting, researching, examining, generating ideas, communicating, collaborating, reaching a conclusion by trying, analyzing, and synthesizing, applying, evaluating, creativity, etc., are used in the inquiry-based learning environment and the scientific process steps in the activity. They stated that skills such as critical thinking, observation, asking questions, curiosity, patience, and using sensory organs were used. At this point, it is known that acquiring these skills supports the acquisition of 21st-century skills (Yerlikaya, 2019). Considering those skills such as critical thinking, problem-solving, communication, collaboration, and creativity, which are used and noticed to be used during the activity process, point to learning and innovation skills, which are 21st-century skills, it is seen that inquiry-based teaching environments provide 21st-century skills.

Schramm, Jin, Keeling, Johnson, and Shin (2017) stated in their studies in which they developed inquiry-based teaching activities that these lesson plans contributed to students' learning. In a survey conducted by Qureshi, Vishnumolakala, Southam, and Treagust (2016), they stated that inquiry-based activities attracted students' attention. Similarly, the teachers in the relevant project indicated they were interested in learning the inquiry-based teaching approach and actively participated in the process. Şahin, Atasoy, and Somyürek (2010) stated that event plans should use case studies. In their research, Bal İncebacak and Ersoy (2019) said that case studies were used in questioning plans. Similarly, in the relevant activity, various case studies were given to the teachers, and their perspectives on inquiry and science were tried to be learned. Zeichner and Liu (2010) stated that the more equipped teachers are, the more effective they are in helping students succeed in the educational process. For this purpose, it can be said that the more teachers are in the inquiry environment, the more equipped they will be. It can be noted that the activity carried out for this purpose contributed to the teachers' equipment.

As a result of the findings obtained after the activity, it was determined that teachers were willing to adapt it to their classes for various courses; in other words, they developed a positive attitude towards the inquiry-based teaching approach. Briede (2013) stated that learning by doing and experiencing rather than memorizing is essential in the learning process. In the inquiry-based teaching approach, teachers teach lessons by sharing with their students and carrying out

various activities. This ensures success. When Varlı and Sağır (2019) examined the curricula of multiple countries defined as successful, they stated that countries with inquiry-based activities at the forefront were more successful. In this context, it can be said that the teachers who laid the foundations of education in primary school, receiving this training, will provide a positive change in their students' perspectives on science and inquiry. Attitudes can be acquired through learning (Açıkgöz, 2019). Learning also occurs by integrating and structuring previous experiences (Demirci, 2009). Similarly, it was determined that there were changes in teachers' perspectives on science after the activity. As a result of the analysis of the data obtained from classroom teachers who touched the lives of students in early childhood, it was determined that in this activity, where the nature of inquiry-based teaching was explained, classroom teachers were aware of the skills they needed to acquire to carry out inquiry-based teaching, their ideas about science developed. Their thoughts about the steps of inquiry-based teaching, in general, emerged. From this perspective, it can be said that with the activity, teachers both developed positive attitudes towards inquiry-based teaching, which they stated they had not used before, and understood the nature of inquiry-based teaching.

The activity in this study was carried out with classroom teachers. It is recommended to conduct studies in which the inquiry-based teaching approach is taught to prospective and current teachers who appeal to different age levels through similar or other activities. Learning and using the inquiry-based teaching approach will likely increase students' success in the long term. It has been stated that success increases in mathematics courses where the inquiry-based teaching approach is applied (Bal İncebacak, 2019). For this purpose, it is recommended that teachers be given this training. This training was provided to teachers and was found to be effective. The activity carried out in the study can also be applied to teacher candidates, and the inquiry-based teaching approach can contribute to the more equipped training of teacher candidates who have met before practicing their profession.

Author Contribution Rates

The 1st Author: 34%, the 2nd Author: 33%, and the 3rd Author contributed 33% to the study.

Conflict of Interest Declaration

Our article titled “Classroom Teachers' Perceptions of Science and inquiry-based teaching” has no financial conflict of interest with any institution, organization, or person. There is no conflict of interest between the authors.

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Extended Abstract

Sorgulama temelli öğretim, öğrencilerin aktif bir şekilde öğrenmelerini teşvik eden ve yapılandırmacılığı temel alan bir öğretim yaklaşımıdır. Bu yaklaşım, öğrencilerin öğrenme sürecine aktif olarak katılımlarını sağlamak ile birlikte; merak duygularını canlı tutarak, sorular sorma, araştırma yapma ve sonuçları analiz etme gibi birçok becerilerini geliştirmelerine yardımcı olur. Öğrencilerin merak ve ilgi duydukları konu-kavram-olguları dikkate almak öğrencileri aktif kılmanın en önemli unsurudur. Bu bağlamda sorgulama temelli öğretimin yapılandırmacı yaklaşımın farklı bakış açılarından beslendiği görülmektedir. Sorgulama temelli öğretimde; iletişim, dil kullanma, iş birliği gibi becerileri kullanılarak bilgiye tartışma ve uzlaşma yoluyla varılmasıyla sosyo-kültürel yapılandırmacılık; bilimsel süreç becerilerini kullanarak bilgiye varma ve böylece bilginin nasıl yapılandığıyla ilgili bir yol öğrenme boyutu ile de bilişsel yapılandırmacılık bakış açısı kullanılmaktadır.

Sorgulama temelli öğretim, bilimsel bilginin üretim basamakları ile aynı basamaklara sahip olan, öğrencinin öğrenmenin merkezinde olduğu, öğretmenin hem kendi hem de öğrencilerinin sorgulama becerilerini geliştirmesi gereken bir yaklaşımdır. Sorgulama, hayat boyu öğrenme kapsamında ele alınan ve sürekli gelişim ihtiyacı gösteren kompleks bir beceridir. Sorgulama becerisi hem bireyin kendini geliştirmesinde hem de toplumun gelişiminde etkilidir. Özellikle küçük yaşlarda bu becerilerin geliştirilmesinin daha etkili sonuçlar verdiğine yönelik birçok araştırma bulunmaktadır. Çocukluğun ilk yıllarında öğrencilerin ailelerinden sonra en çok vakit geçirdikleri kişilerin sınıf öğretmenleri olduğu söylenebilir. Sınıf öğretmenleri de öğrencilerin sorgulama becerilerini geliştirmede önemli kişiler arasındadır. İlkokulda öğretilen temel bilgiler ilerleyen kademelerdeki bilgilerin temelini oluşturmaktadır. İyi bir temele sahip olan öğrencinin de ilerde başarılı olması kaçınılmazdır. Yenilikçi strateji yöntem olan sorgulama temelli öğretim yaklaşımı ile eğitsel etkinliklerin geliştirilmesi ve uygulanması önemlidir. Fakat öğretmenler sorgulama temelli öğretimi sınıflarında etkili bir şekilde uygulamaları ve sorgulama becerilerinin gelişimi için zaman, kaynak, eğitim ve desteğe ihtiyaç duymaktadırlar.

Bu desteği sınıf öğretmenlerine sağlamak amacıyla Bilim ve Toplum Destekleme Programları Matematik Yılı Özel Çağrısı kapsamında TÜBİTAK 4004 "MAT-SOR Sorgulama Temelli Etkinlik Geliştirme Kampı" projesi yapılmıştır. Projenin amacı sınıf öğretmenlerinin etkinlik planı geliştirme niteliklerinin artırılması, 21. yüzyılın gerektirdiği becerileri kazanmaları; yenilikçi strateji yöntem olan sorgulama temelli öğretim yaklaşımı ile eğitsel etkinliklerin geliştirilmesine katkı sağlanmasıdır. Bu proje kapsamında sınıf öğretmenlerinin bilimin anlaşılmasına ve sorgulama temelli öğretim uygulamalarına yönelik becerilerini fark etmelerine ve geliştirmelerine yönelik "gizemli kutular" etkinliği yapılmıştır. Gizemli kutular etkinliği, sorgulama temelli öğretimin anlaşılması, bilimsel bilgiye erişim basamaklarını belirleme, kullanılan becerilerin belirlenmesi, ortak fikri savunma ve bir fikri argüman sunarak çürütme gibi aşamalardan oluşmaktadır. Bu aşamaların öğretmenlerin bilim ve sorgulama temelli öğrenmeye yönelik görüşlerini şekillendirmesi beklenmiştir. Bu nedenle yapılan bu çalışmanın amacı gizemli kutular etkinliğinin, öğretmenlerin bilime ve sorgulama temelli öğretime yönelik görüşlerini nasıl etkilediğini belirlemektir. Bu amaçla etkinlik öncesinde ve sonrasında açık uçlu sorular ile öğretmenlerin görüşleri alınmıştır. Çalışmanın verileri projeye katılım gösteren, Samsun ilinin 17 ilçesinde mesleğini icra eden 25 öğretmenden elde edilmiştir. Elde edilen veriler, nitel analiz yöntemlerinden içerik analizi yöntemi kullanılarak çözümlenmiştir. Analizler üç araştırmacı tarafından bağımsız şekilde yapılıp daha sonra uyuşum yüzdeleri hesaplanarak tema ve kategorileri belirlenmiştir.

Yapılan analiz sonucunda öğretmenlerin bilime yönelik fikirlerinin geliştiği ve genel olarak sorgulama temelli öğretime ilişkin basamaklar hakkında fikirlerinin ortaya çıktığı belirlenmiştir. Bu sonuç göz önüne alındığında sorgulama temelli öğretim ortamında öğretmenlerin etkinlik geliştirmek için farklı bakış açılarını elde edecek deneyimler elde ettiklerim belirlenmiştir. Öğretmenlerin yaşadıkları deneyimler sonucunda etkinlik geliştirdikleri ve bunun yanı sıra kendi sınıflarında sorgulama temelli öğretim etkinliklerini çeşitli derslerde de proje sonrası uygulamaya ve kendi sınıflarına

uyarlamaya istekli oldukları tespit edilmiştir. Yeni yöntem ve yaklaşımların uygulamalı eğitimler ile verilmesinin bireylerin eğitsel etkinliklerin geliştirilmesine katkı sağladığı ifade edilebilir.