

# Question Tree Technique in Science Education: A Model Implementation

## Fen Eğitiminde Soru Ağacı Tekniği: Örnek Uygulama

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### ABSTRACT

The main purpose of this study is to determine the effect of the question tree technique used in the science lesson and the questions brought independently by the students on academic success. In addition, it is to get the opinions of the students about the use of question tree. Mixed method was used in the study. In the study lasting eight weeks, 61 participants participated with random sampling method. A fully structured interview form was preferred in the collection of qualitative data. Question tree questions and academic achievement test were used to collect quantitative data. In descriptively and content analyzes, assistance was taken from Microsoft Excel and SPSS 17 programs. T-Test, ANCOVA, frequency and percentage and participant citations were used to interpret the data. According to the findings; it was determined that the question tree technique did not make a significant difference on the academic achievement of the experimental and control groups. The test of question tree questions did not affect academic success. It is thought that bringing the questions out of the book, freeing them not under the control of the teacher, and using the low level questions are effective on this result. It has been determined that the questions used in the question tree are useful and entertaining in learning unclear topics and sharing and solving them with the class. It has been determined that the questions placed in the question tree have effects such as giving information to students and learning new and different questions and solutions.

**Keywords:** Academic success, Asking questions, Question tree, Science, Student opinions

### Öz

Bu çalışmanın temel amacı, fen bilimleri dersinde kullanılan soru ağacı tekniğinin ve öğrencilerin bağımsız olarak getirdikleri soruların akademik başarıya etkisini belirlemektir. Ayrıca soru ağacının kullanımına ilişkin öğrenci görüşlerinin alınmasıdır. Çalışmada karma yöntem kullanılmıştır. Sekiz hafta süren araştırmaya tesadüfi örnekleme yöntemiyle 61 katılımcı katılmıştır. Nitel verilerin toplanmasında tam yapılandırılmış görüşme formu tercih edilmiştir. Nicel verilerin toplanmasında soru ağacı soruları ve akademik başarı testi kullanılmıştır. Araştırmada kullanılan ölçme araçlarının verileri Microsoft Excel programı ve SPSS 17 programı yardımıyla analiz edilmiştir. Betimsel ve içerik analizleri ile t-testi, ANCOVA, frekans ve yüzde değerleri gibi teknikler kullanılmıştır. Bulgulara göre; soru ağacı tekniğinin deney ve kontrol gruplarının akademik başarıları üzerinde anlamlı bir farklılık oluşturmadığı belirlenmiştir. Soru ağacında bulunan sorulardan oluşan testin akademik başarıyı etkilemediği tespit edilmiştir. Bu sonuç üzerinde soruların kitaptan çıkarılmasının, düşük seviyeli soruların kullanılmasının serbest bırakılmasının ve öğretmenin kontrolünde yapılmamasının etkili olduğu düşünülmektedir. Soru ağacında kullanılan soruların, anlaşılmayan konuların öğrenilmesinde ve sınıfla paylaşılıp çözülmesinin faydalı ve eğlenceli olduğu belirlenmiştir. Soru ağacına konulan soruların öğrencilere bilgi verme, yeni ve farklı sorular ve çözümler öğrenme gibi etkileri olduğu tespit edilmiştir.

**Anahtar Kelimeler:** Akademik başarı, Soru sorma, Soru ağacı, Bilim, Öğrenci görüşleri

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## Introduction

May I ask you a question? Can learning take place without asking questions? Considering every detail of daily life, it is noticed that the situations that do not ask questions are very rare in the learning that takes place. This is more clearly understood, especially when entering learning with children. The child intends to eliminate curiosity and anxiety with constant tendency to ask questions at home, on the street and at school (Aguiar et al., 2009; Graesser et. al., 2005). Although they assume the role of students in school, they never give up without asking questions with a sense of childhood. Students are tempted to ask more than one question in each lesson at school. Because the lessons at school help students learn. One of these lessons is science. It draws a great deal of attention from students with concrete, abstract, inaccessible, dangerous, and mysterious concepts and topics (Ministry of National Education (MoNE), 2018). Due to this interest, children constantly ask questions in the learning process. In science classes, students use questioning in student activities, group interactions or lessons. The quality of learning in the classroom environment depends on the quality of the questions asked in the classroom (Moriber, 1972). The questions asked by teachers should be the ones that activate the student cognitive level (Eliasson et. al., 2017). Otherwise, students' ability to ask questions may be negatively affected.

The term asking questions is used to refer to the resolution of mental problems and the production of new ones (Silver, 1994). Asking questions is a natural part of the learning process set out with curiosity. It is a term used to generate new questions and to organize the given questions (Huang et. al., 2017). Basically, the individual tends to ask questions in the face of curiosity, desire, motivation (Allison & Shrigley, 1986; Aguiar et al., 2009) or in the face of obstacles, abnormalities, restlessness, and imbalances (Graesser et. al., 2005). The students' questions indicate their mental thoughts, as well as the state of emptiness, inconsistency and the desire to expand knowledge. Especially in new learning after the question, the questioning continues and varies according to the status of the concepts or inconsistencies (Chin & Osborne, 2008). In addition, it can be used for many reasons such as asking questions, determining preliminary information, recognizing, choosing the right ones, finding the mistakes, identifying the deficiencies (Cumhur, 2019). The student's questioning also shows the mismatch between the textbook information and its cognitive structure. The student begins to ask questions with the tendency of the inconsistent mental structure to both learn the thoughts of other individuals and persuade

them (Graesser et. al., 1996; Huang et. al., 2017; Wilson, 1969). The questions asked form the basis of learning.

The questions generated by the student help the student to learn and evaluate the subject (Billingsley et. al., 2020; Huang et. al., 2017). Generally, it is thought that students do not tend to think higher (Kocaöz, 2019). However, it is also known that high level thinking skills develop when they receive sufficient attention and education (Bahtiyar, 2019). Asking questions in the classroom environment, the quality and quality of the questions should be under the control of the teacher (Russell, 1983). It is important that the teacher is a guide or an active questioner in the classroom (Oliveira, 2009). Science teachers should use the technique of asking questions to get the answers of concepts such as why and how (Huang et. al., 2017). Indeed, students tend to ask questions with the effect of these concepts and the contribution of their individual curiosity. Factors such as teachers' dialogues in the classroom, interactive activities, authentic questioning and using scientific techniques encourage the student's mental structure and tend to ask questions. (Bielik & Yarden, 2016). Although some teachers are not aware of their own effects on activating students' mental structures, it is a situation that can be overcome in time. It was determined that some of the teachers did not know how their questions in the classroom might affect the emotional and cognitive domain of the student (Eshach et. al., 2014). However, in general, it is known that the teacher has an effect on the development of student cognitive and emotional aspects. In particular, it was determined that the questions asked by the teacher were both modeling and activating the student (Dönmez et. al., 2018; Grace & Langhout, 2014).

Teachers generally tend to ask low level questions (Baysen, 2006; Mercan, 2019; Yeşilyurt, 2012). As a result, it gives lower answers to the student as well as low levels in the questions they produce (Aslan, 2011; Çakici et. al., 2012). But when asked high-level questions, the student's mental activities increase. Teachers are required to ask questions at all levels in the lesson. Especially, asking high-level questions that cause thought and lead to cognitive confusion is effective in generating the student's own questions (Günel et. al., 2012). In addition, the teacher should wait for the students to think and reproduce the questions they ask the students. It should give them opportunities (Baysen et. al., 2003). Encouraging questions asked by the teacher should be waited until they are answered. Sometimes clue can be given. When students have enough time to answer, they can provide more creative answers with their own sentences, as well as ask questions from confusion or curiosity in their

mental structure. In addition, the student is more flexible both himself and others. Questions increase in the classroom environment (Büyükalın Filiz, 2009).

### **Theoretical background**

Vygotsky's (1980) socio-cultural learning theory shows that knowledge develops at a certain level among people and then passes into the mind of the student (Benedict-Chambers et. al., 2017). Although teachers are accepted as the primary source of information in schools, books, the internet, friends and family are sources of information (Chin & Osborne, 2008). When the student interacts with the information sources, he learns new information. Most importantly, he finds the answers to his questions, which are the source of curiosity and restlessness. It also improves the student's higher-order thinking skills and allows them to evaluate themselves and the lesson. (Huang et. al., 2017). Especially in science lessons, this interaction is quite high. According to this theory, school is an environment where socio-cultural interaction is experienced intensely. Teacher-student, student-student interaction accelerates the structuring of knowledge. It is also known that answering questions from a collaborative environment, generating new questions, and learning are more permanent (Cano et. al., 2014; Kawalkar & Vijapurkar, 2011; Hoppenbrouwers, 2012). Students' group-generated or individual questions affect collaborative work and knowledge (Chin & Brown, 2010).

Many studies focus on the analysis of questions that teachers ask in class (Eliasson et. al., 2017; Oliveira, 2009; Huang et. al., 2017). Also, there are studies for the analysis of students' questions in the classroom (Benedict-Chambers et. al., 2017; Cano et. al., 2014; Chin & Brown, 2010; Maskill & Jesus, 1997). The basis of these studies is to make the learning process more active and to activate the student's mental structure. Similarly, in this study, it was aimed to stimulate student mental structure and to continue science education with an active performance in the classroom environment. Unlike the field writing, a visual tool was used in the study. This vehicle is hung in a suitable part of the class. The students were asked to write their questions on this tool or to write on other notes and hang them here. Since this tool is designed as a tree, it is symbolized by the fact that the trees bear fruit, and the students produce questions, and it is named as the "question tree". There are studies in which the question tree is used as a mathematical method (Duan et. al., 2008; Yao et. al., 2013). However, it has been determined that these studies are not used as a visual theme. In addition, it was found that the question tree technique was used in mathematics lesson on a website, although it is not academic (URL1, 2020).

This technique writes the questions that the student comes to mind at home, at school or in another environment, writes them on the notes paper and hang on the question tree for solves them together with the teacher and other students in the science class. The teacher does not make any comments about the quality of the questions. Before starting the lesson, the teacher will browse the questions on the question tree and read it out loud. It gives the right to speak to those who want to answer from the class. When there is no one who wants to answer, he answers. In this way, the question owner gets his answer. These questions remain in the question tree until the subject is over. If a student in the class forgets something about the topic or comes up with a question, he first compares it with the questions on the tree. Sometimes he gets answers based on existing questions. Because the answers to each question hanging on the tree and solving together are noted on it. This work continues at the beginning of each subject. At the end of the subject, the teacher takes all the questions one more time and reads them one by one. It repeats points that are not understood. The same process continues in the next topic.

### **Purpose of the research**

The main purpose of this study is to determine the effect of the question tree technique used in the science course on academic success. In addition, it is to get the opinions of the students about the use of question tree. Apart from this, without the involvement of the teacher, it is the examination of the questions brought or produced by the participants in the experimental group according to their quality or type. In addition, it is to determine the effect of question tree questions on academic success. In this context, the following hypotheses and questions have been questioned.

### **Research hypotheses**

Hypothesis 1: Question tree technique increases students' academic success.

To test this hypothesis, the question tree technique was used in the experimental group. In the control group, this technique was not used. All remaining features are assumed identical. The condition of the hypothesis was applied as a pre-posttest, reliability and validity study was conducted, and it was determined by academic success test.

Hypothesis 2: Questions that are not under the control of teachers have no effect on academic success.

In order to test this hypothesis, students were asked to bring questions about the subject and hang them to the question tree without teacher guidance in the experimental group. Here, the teacher does not make any comments on the

questions such as quality and level of the questions. The students in the control group were not asked to bring questions. All remaining features are assumed identical. The state of the hypothesis was determined by the question tree questions test applied as a post-test. This test consists only of questions brought by students.

### Research questions

1. According to the academic achievement test findings, is there a significant relationship between the experimental and control groups before and after the application in terms of academic success?
2. According to the findings of the question tree questions test, is there any significant relationship between the experimental and control groups after the application in terms of academic success?
3. What are the general characteristics of the questions hanging on the question tree?
4. What are the participants' views on the question tree?
  - 4.1. Why did the participants use the question tree?
  - 4.2. What are the positive and negative effects of the question tree?

### Methods

A mixed method was used to complement the qualitative and quantitative data of the study (Creswell, 2017). The quantitative dimension of the research was completed by using the experimental design. As a matter of fact, experimental designs provide an understanding of how effective the solution will be by intervening in a certain

problem within the framework of controlled conditions. The groups in the experimental process were randomly determined (Büyüköztürk, 2009; Çepni, 2010; Metin, 2014). The application lasted 8 weeks. In this study, systems in our body on the 6th grade subjects of science were discussed. In the qualitative aspect of the study, fully structured interview form was used. This form was used to determine the participants' thoughts on the question tree.

In the study, it was stated that a group should bring questions related to every subject that was covered during eight weeks. Students are released regarding the form, level and type of questions. In this process, the teacher guided both classes in research-based teaching. Central exams are applied in transition to higher education in the country. These exams consist of distracting tests. They are also known as multiple choice tests. Therefore, multiple choice tests are generally used in the education process. The aim here is to prepare children for the exam in transition to higher education. More than half of the evaluation section in the textbook consists of these tests. All of the test books that students take for themselves and which are commonly used at school consist of these tests. Almost all teacher assessments consist of these tests. In addition, all of the trial exams held once a month is composed of these tests. In general, these tests are not capable of measuring higher-order thinking skills. They are especially of the type that can determine the level of students' remembering and understanding. It is known that some questions in this test are at the applying level.

**Table 1.**

*Activities Applied in the Experimental Group Throughout the Research*

Weeks	Topics
1. week	Random groups were selected, pre-test was applied
2. week	The planning of the study was explained, the question tree technique was introduced and the students were shown what to do during the study.
3. week	Support and Movement system Students brought questions related to the subject and hung them on the question tree. At the end of the topic, these questions were solved by the class and teacher.
4. week	Digestive system Students brought questions related to the subject and hung them on the question tree. At the end of the topic, these questions were solved by the class and teacher.
5. week	The circulatory system Students brought questions related to the subject and hung them on the question tree. At the end of the topic, these questions were solved by the class and teacher.
6. week	The respiratory system Students brought questions related to the subject and hung them on the question tree. At the end of the topic, these questions were solved by the class and teacher.
7. week	Excretory system Students brought questions related to the subject and hung them on the question tree. At the end of the topic, these questions were solved by the class and teacher.
8. week	Post-test was applied

As can be seen in Table 1, the subjects covered every week are seen in the experimental group. During each subject

process, students bring the questions they find or create about the subject to the class and hang them on the

question tree. At the end of the subject, these questions are answered by the volunteers in the classroom or by the teacher. At the stage of answering the questions, discussions and opinions are made in the classroom.

### Participants

Random sampling was used in the study. The aim of this sample is to involve selecting random units from a mass or a particular subgroup in a mass. This selection requires that the probability of being included in the audience can be determined for each individual in the audience (Baki & Gökçek, 2012; Creswell, 2013). As a matter of fact, the research was conducted in a public school in the Malazgirt District of Muş Province during the 2019-2020 academic years. A total of 60 students participated in the study, depending on the volunteerism principle. Experimental group 30, control group 30 participants (It was determined that some students did not come to the school at different times during the application. This situation is also understood in the tables). The socio-economic status of the participants was similar. The families of the majority of the participants are engaged in farming. Farming means a small number of agriculture and animal care. In the final applications of the Academic achievement test and the Question tree test, it was determined that some students were absent.

### Data collection tools

A fully structured interview form was preferred in the

collection of qualitative data. With this form, it was aimed to determine the opinions and thoughts of the participants regarding the question tree. The fully structured interview form includes the following questions.

1. *Why are you using the question tree?*
2. *What are the positive or negative effects of the question tree on you?*

Question tree questions and academic achievement test were used to collect quantitative data. Both tests were used to determine the effect of the question tree technique on academic success.

Academic achievement test questions were chosen from the textbook unit evaluation questions. It was used as a pre and posttest in the research. The question tree questions test was chosen from the questions from the participants. The question tree questions test was applied only as a posttest. Since it is prepared by choosing from the questions collected during the application, it is not possible to apply it as a pre-test before the application. Question tree questions, questions from all students, are classified and selected according to the subject acquisition, indicator table (Table 2).

**Table 2.**  
*Subjects Gains Indicator Table*

Subjects	Lesson Hours	Number of Gains	Bloom Taxonomy steps		
			Remembering	Understanding	Evaluating
Support and Movement system	4	1		X	
Digestive system	6	3	X	XX	
The circulatory system	6	5	XX	XX	X
The respiratory system	4	1		X	
Excretory system	4	1		X	

As can be seen in Table 2, it is understood that the achievements of the subjects are at the levels of recall, comprehension and evaluation (There is no gain at the level of applying, analyzing and creating). Within the scope of these gains, the questions asked by the participants were

classified and Table 3 was created. The question tree questions test has been prepared taking into account Table 3.

**Table 3.**

*Statistics for the Questions Hanging on the Question Tree by the Participants*

Numbers / Subjects	Support and Movement system	Digestive system	The circulatory system	The respiratory system	Excretory system	Total
Number of incoming questions	17	20	63	69	23	192
Number of gains	1	3	5	1	1	11
Number of questions selected	3	6	10	3	3	25

As understood in Table 3, 192 questions in total were hanged by the participants throughout the application. It was determined that 26 of the 31 students in the experimental group brought questions. Some of the students brought at least one question, while others brought at most 34 questions. It was determined that all of the questions brought by the participants were test questions with distractors. In addition, it was determined that the participants cut these questions from sources such as books, magazines or test books used in the school. In addition, it was determined that very few of these questions were written by the participant on his own. In the questions written by the participants, it was determined that they either wrote from the test book or wrote in a distracting test style. Numerical codes were given to the questions from the students and analyzed in terms of the subject and the person bringing them. 192 questions collected were tested by taking expert opinion (doctorate, two people in specialist science education) and taking into account the table of indicator (Table 2). 25 of these questions were used in the question tree questions test at the end of the application. One of these questions was removed from the test due to its low discrimination index. The question tree questions test is scored out of 24 questions. While preparing this test, firstly, the level of subject gains and their levels were determined according to the level of Bloom taxonomy. The questions were selected based on the gains of the subject, based on expert opinion. It was paid attention to the fact that the selected questions are different from each other and that they make different measurements in line with the gains. Then the questions were written. While writing the questions, language editing (language teacher) was made with additions such as drawing and painting. Necessary arrangements were made by examining the distracters and the correct option of the questions. In addition, the answers were distributed equally over the options. The content validity, appearance and structure validity of the prepared test were thus provided.

### **Analysis of data**

The data obtained from the measurement tools were analyzed descriptively and content. In these analyzes, assistance was taken from Microsoft Excel and SPSS 17 programs. It has been determined that the data (the data are homogeneous, normally distributed and the number of participants is appropriate) are suitable for the use of parametric tests. T-Test, ANCOVA, frequency and percentage and participant citations were used to interpret the data.

### **Reliability and Validity**

To ensure the reliability of the research; the study is explained conceptually and theoretically. Methods and participants in the research are specified and their roles are explained. In addition, data collection, tools, analysis and presentation are specified (Glesne, 2013; Merriam, 2013). The consensus principle was followed for the codes and ratings used in the content analysis. The consistency between the coding and scoring of the two academicians with a doctorate in education was determined as 95 %. Already (according to Miles and Huberman (1994)) 80 % and above is an acceptable value (Arik & Yilmaz, 2017). In addition to all these, participant expressions are used as they are, and quotations are not allowed to be corrupted. The names of the participants were coded. In addition, Academic achievement test was selected from the textbook evaluation questions whose reliability and validity study were conducted. Despite this, the item analysis of the academic achievement test used in practice was repeated. According to this; It was determined that the academic achievement test had item difficulty index 0.58 and item discrimination index was 0.51. The Cronbach Alpha value of the academic achievement test was found to be 0.83. Five topics have been covered throughout the application. In the achievement test, there are 25 questions in total, five questions from each subject.

*The question tree questions test was written with the*

participation of language and field experts. Necessary corrections were made to write the test. Question roots and distractions were examined in detail. In the item analysis made at the end of the application, one question with a very low item discrimination index (0.19) was removed from the test. In general, item difficulty index of the test was determined as 0.53 and item discrimination index as 0.52. In addition, the tests the Cronbach Alpha value of the question tree questions test was found to be 0.82. In addition, the gains coverage of the test, appearance and structure validity were obtained by receiving expert opinion (Metin, 2014; Yıldırım & Şimşek, 2013). In the last case, there are 24 questions in the question tree questions test.

## Results

Findings in line with the research problems are presented below. Firstly, the results of the pre-test determining the academic success level of the application groups are given in Table 4.

**Table 4.**

*Independent Sample T-Test Results of the Pre-Test Scores of the Research Groups*

Groups	N	Mean	Std. Deviation	df	p
Experimental group	30	5.23	2.96	57	0.012
Control group	29	7.24	2.96		

As seen in Table 4, when the pre-test results of the experimental and control groups are examined, it is seen that the value of "p" is less than 0.05 ( $p = 0.012$ ). This shows

that there is a significant difference between the score. When the average scores of the groups are examined, it is understood that the average grade of the control group is higher than the average of the experimental group. In general, it is seen that the control group gives more successful results than the experiment group before the application. In order to determine whether there is a significant difference between the post-test scores of secondary school students in the experimental and control groups, a single-factor Analysis of Covariance (ANCOVA) test was performed and the results are given in Table 5.

**Table 5.**

*ANCOVA Results of the Scores Obtained from the Academic Achievement Test According to the Group*

Variance Source	Squares total	SD	Squares average	F	p
Pre	164.889	1	164.889	6.52	0.013
Group	1.594	1	1.594	0.63	0.803
Error	1415.069	56	25.269		
Total	11251.559	59			

When the ANCOVA results were examined, it was concluded that there was no significant difference between the post-test scores corrected according to the pre-test scores of the secondary school students in the experimental and control groups ( $F(1.56) = 0.63, p > .05$ ). In other words, there is no significant difference between the post-test scores of the experimental and control groups. The general situation of the questions from the participants is given in Table 6.

**Table 6.**

*General Analysis of the Questions from the Participants*

Number of questions	Level		Type		Originality		Guidance	
	Remembering	Understanding	Multiple choice	Other	from the source	Original	Free	Teacher control
	70	122	192	0	192	0	192	0

Table 6 shows the general characteristics of the questions the students hang on the question tree. Accordingly, it is understood that the teacher is not in control of all the questions are from the lower steps, all of them are multiple choice (with distractions), the questions are not original and the introduction of the questions is released. Apart from that, the question tree questions test post-test results created from these questions are given in Table 7.

**Table 7.**

*Independent Sample T-Test Results of the Test Consisting of Questions Prepared by the Experimental Group Throughout the Study*

Groups	N	Mean	Std. Deviation	df	p
Experimental group	29	11.86	4.52	55	0.375
Control group	28	13.12	5.72		

As can be seen in Table 7, when the question tree questions

test results of the experimental and control groups are examined, it is seen that the value of "p" is greater than 0.05 ( $p = 0.375$ ). This shows that there is no significant difference between the score. When the average scores of the groups are analyzed, it is seen that the average grade of the control group is slightly higher than the average of the experimental group. The qualitative data collected as well as the quantitative data above are presented below.

### Theme 1. Reasons for Using the Question Tree

Under this theme, the reasons for the participants to use the question tree were determined. Firstly, the reasons for using the question tree in the descriptive analysis of the fully structured interview form are given in Table 8.

**Table 8.**

*Reasons of Participants' Use of the Question Tree*

Causes	Participants	Frequency (f)	Percent (%)
For useful and fun repetitions	5,6,7,8,18,20,21,23,25,26,27	11	39.29
To share and solve together	1,2,3,4,10,11,12,17,19	9	32.14
To learn the topics that are not understood	9,13,15,16,22,24,29	7	25.00
Because the teacher wants	28	1	3.57

According to the data in Table 8, the reasons for the participants to use the question tree are grouped in four categories. According to this, it is seen that it is "for useful and fun repetitions" (39.29 %), "to share and solve together" (32.14 %), "to learn the topics that are not understood" (25.00 %) and "because the teacher wants" (3.57 %). Content analysis for these data is given below.

#### Category 1. For useful and fun repetitions

In this category, excerpts about the participants used the question tree as useful and entertaining was analyzed. According to this;

*Because it is useful to us... (P6).*

*We use it to solve more questions and repeat what we have learned (P8).*

*It helps me a lot and my friends. We prepare and hang questions with my friends (P21).*

*It affects my success in lessons. I am satisfied (P23).*

*Both fun and enjoyable (P25).*

*It is fun to solve the questions I do not know in the classroom. Sometimes there are questions that challenge me, I can solve them (P26).*

As it is understood from the quotations, it is understood that it is used for reasons such as "repetition" of the learning, its effect on lesson "success", help and "benefit" to the participant, and "fun" in the classroom. In general, it can be said that almost half of the participants use the question tree because it sees it useful and fun. Apart from this, quotations for reasons such as sharing and solving are presented below.

#### Category 2. To share and solve together

In this category, it is understood that the participants use the question tree questions in the classroom for reasons such as sharing and solving together. Citations accordingly;

*To share questions in the classroom together (P1).*

*We use the questions we do not understand to solve all together (P3).*

*In order for both me and my friends to learn the questions I made wrong (P10).*

*To get information and share the questions that we couldn't find (solve) (P12).*

*To solve our own questions by showing them to both our friends and teacher (P19).*

According to the quotations, it is seen that the participants use the question tree for reasons such as "solution" of the questions, being "aware" of their friends and "sharing". In general, it can be said that some participants use the question tree to share their questions with the class and solve them together. Apart from this, it was determined that some participants used the question tree to learn the topics that were not understood.

#### Category 3. To learn the topics those are not understood

In this category, it is understood that the participants use the question tree to learn the topics they cannot understand or learn. According to this;

*I can learn the answers to questions I don't understand or know. Thanks to the question tree, I can understand the issues I cannot understand (P9).*

*To learn the answer to the questions and questions I don't know (P15).*

*For our learning, for questions we don't know (P24).*

*Sometimes we can look and read the question that we*

*do not know (cannot solve) from there (question tree) (P29).*

According to the quotations, it is understood that the participants learn the topics or questions they “do not understand”, cannot “solve” or “know” through the question tree. It can be said that some participants use the question tree to learn the topics they cannot understand. Apart from all these, it was determined that only one participant used the question tree because the teacher asked for it by expressing “I use it because my teacher says hang a question to the question tree” (K28). Apart from these data, the data obtained in the analysis made to determine the effect of using the question tree on the participant are given in theme 2.

## Theme 2. Effects of the Question Tree

As a result of using the question tree under this theme, the positive-negative effects of the participants were analyzed. As a result of the content analysis, it was determined that all participants expressed positive effects. These positive effects are classified in two categories in Table 9.

**Table 9.**

*The Effects of the Question Tree Technique According to the Participants*

Effects of the question tree	Participants	Frequency (f)	Percent (%)
I think I learned	1,4,6,12,14,16,17,18,20,21,22,23,24,26,27, 29	16	57.14
I learned new question types and solutions	2,3,5,7,8,9,10,11,13,15,19,25	12	42.86

As seen in Table 9, it is understood that "I think I learned" (57.14%) and "I learned new question types and solutions" (42.86%). These categories are presented with quotations as below.

### Category 1. I think I learned

In this category, it is understood from the quotations below that the participants obtained information through the question tree. According to this;

*It had a positive effect. We solved questions to obtain information (P12).*

*Because we have information (P17).*

*Positive effect, everyone is asking questions and we read and get information. Those who do not have a test (question book) benefit here (P21).*

*It affects me positively. I learn some things I don't know (P26).*

*Sometimes I learn the questions I don't know (P29).*

According to the quotations, it is understood that the question tree has positive effects such as “learning” what they “do not know”, having “information” and “solving” questions. In general, it was determined that almost half of the participants stated that the question tree provided information. Apart from that, it is stated below that the question tree also has an effect on learning question types.

### Category 2. I learned new question types and solutions

In this category, quotations regarding the positive effect of the new and different question types of the participants were analyzed. According to this;

*We see all sorts of questions and do what we don't understand (P3).*

*Our friends who cannot solve questions at home solve it here and do it again (P8).*

*Positive, because I see different questions (P11).*

*If there is a question I do not understand, I understand the similar questions here when the teacher resolves (P15).*

As it is understood from the quotations, it is understood that the participants solved the questions “similar” to the questions they could not understand, different “types” of questions, new types of questions in short by seeing various “kinds of” questions in the question tree. In general, it can be said that some participants learned new, different questions and solutions through the question tree. Apart from all these data, please examine the Picture 1 for the use of the question tree.



**Picture 1.**

*Sample Photos from the Question Tree*

As can be seen in the Picture 1, the questions from the students are hung on the question tree. They remain original throughout the subject. When the topic is over, all are resolved and removed. Then continue with the new subject.

### Discussion

The first results of the academic achievement test (pre-test) applied to randomly selected sample groups were found to be higher than the experimental group of the students in the control group. It is thought that the readiness levels of the control group towards the subject stemmed from their previous learning. It was determined that there was no significance between the post-test results at the end of the study. In fact, this shows that the experimental group students closed the gap in success. In other words, it was determined that the application of the 8-week question tree technique closed the academic success gap between the experimental and control groups. This situation was in favor of the experimental group. From this point of view, it can't be said that the question tree technique has a positive effect on the increase of students' academic achievement. Because no significant difference was found. This result doesn't prove the research hypothesis 1. On the contrary, Cano et. al., (2014) determined that students' asking questions indirectly affected their academic success. This finding is proof that students' asking questions or bringing questions will affect their academic achievement positively, but it does not coincide with the finding of the research. In addition, Bahtiyar (2019) determined that students' questioning can develop from simple to high level with adequate educational support and activities. This finding shows that when students ask questions, it can be said that their mental activities improve and this is reflected in academic success.

Also, according to the results of the test consisting of questions in the question tree, there is no significant difference between the experimental and control groups. In other words, it was determined that the questions that the students brought independently from the teacher had no effect on academic achievement. Here, hypothesis 2 has been confirmed. The biggest reason for this situation is that the questions brought to the question tree are considered as books and magazines used by both group students. It is assumed that students often bring ready questions to affect this situation. In addition, it is thought that all of the questions brought forward are test questions with distractions. However, the fact that there are questions at a level that will improve the students' intellectual skills may change this situation. Another reason is the system of passing to the upper institution in the country. It is thought that all these exams are in the form of distracting test exams and the participants who are constantly preparing for these exams know this type as a question. In addition, half of the questions in the textbooks, almost all of the magazines or test book questions, all of the experiments in the school, almost all of the teacher evaluations are such questions. For this reason, it can be said that the participants prefer multiple choice tests or tests that are differentiating. It is known that these tests generally do not measure meta cognitive skills and do not activate the student's meta cognitive skills (Dönmez et. al., 2018). For these reasons, according to the question tree questions test, there was no significant difference between the academic achievement of the students in the experimental and control groups. Similarly, in the studies of Chin and Brown (2010), it is determined that students generally produce questions at the level of knowledge. This finding may prove that there is no academic success difference in the question tree questions test. Apart from these, it was determined that the participants brought 192 questions in total for 8 weeks. It is thought that all of these questions are simple and affect the result. Similarly, Bielik and Yarden (2016) found that student-centered practices improved students' questioning skills. In addition, Maskill and Jesus (1997) found that a large number of questions were generated by students. They also stated that these questions mostly stem from the fact that the subjects were not explained more clearly and explicitly. Since the research is student-centered, the active participation of the student shows that it affects the number of questions raised. However, it can be said that most of the questions arise from incomprehensible issues. During the research, it was determined that the most problem came from the circulatory and respiratory system. It is known that the working states of organs such as the heart and lungs are generally not understood. In particular, it is thought that the

viewpoint of the passage and pumping of gas into the blood affects this. In addition, although Eliasson et. al., (2017) determined that open-ended questions positively affect students' cognitive levels in the study, it is thought that mostly lower-level questions affect the result. Apart from these, it is important to realize the questions solved in the classroom with the participation of all students. In their study, Kawalkar and Vijapurkar (2011) found that the majority of students were sought in accepting the correct answers to the questions in the classroom. This indicates that the truths accepted by the majority in the class are accepted by other students. In other words, when students use the technique of preparing or asking questions in the classroom, they get more accurate information because they are the truths accepted by the majority. In addition, it is thought that asking questions and bringing questions should be guided by teachers. As a matter of fact, the fact that all of the questions brought from the books and multiple choice were affected by this result. Similarly, Russell (1983) stated in his study that asking questions should be controlled, or that the confusion in the student's mental structure can lead to situations where students may misunderstand scientific facts. Herranen and Aksela (2019) found that teachers had important duties in increasing the quality of student questions. Apart from these, the levels of the questions under the guidance of the teacher are known to affect the result. Indeed, Günel et. al., (2012) determined that when the teachers' questions were low, students were able to form the questions that could be negotiated with the help of the teacher. In addition, when the teacher questions were at a high level, it was determined that the students were able to create questions on their own in the negotiations. In addition, Çakici et. al., (2012) found that students generally produced low level questions. As it is understood from these findings, it is understood that teacher guidance is extremely important in asking questions or bringing questions.

It can be said that almost half of the participants saw the question tree useful and entertaining, some used the question tree to share it with the class and solve it together, and some participants learned the topics they could not understand. In general, there may be differences between the reasons for using the questions in the classroom (Eshach et. al., 2014). Similarly, Benedict-Chambers et. al., (2017) determined that they asked questions to help students learn about scientific practices, explain evidence and develop explanations. In addition, Aguiar et al., (2009) show that students' questions are important in providing feedback to the teacher and making adjustments in the instructive explanatory structure. These findings show that questions are used for similar reasons in the classroom.

In general, it was determined that almost half of the participants stated that the question tree provided information. In addition, it can be said that some participants learned new questions and solutions thanks to the question tree. In other words, it is understood that students can learn new, different questions and solutions by hanging questions to the question tree and when they solve these questions by class. Similarly, the questions produced by the student in Billingsley et. al., (2020) and Huang et. al., (2017) helped the student to learn and evaluate the subject. In addition, Huang et. al., (2017) determined that the technique of asking questions in science classes affects critical inquiry.

### **Conclusion and Recommendations**

While the first hypothesis could not be verified within the scope of the research, the accuracy of the second hypothesis was tested. It has been determined that asking many questions in the classroom environment didn't increase academic success. At the same time, it was also determined that the questions that are not under the control of teachers have no effect on increasing academic success. The irony here is that asking too many questions without teacher guidance can close your shortcomings in academic success, but it is insufficient to increase. Therefore, students should be guided in situations such as writing questions and asking questions.

It was determined that the eight-week question tree technique did not make a significant difference to the academic achievement of the experimental and control groups. The effect of asking questions on academic success in science classes should be expanded. Especially, the use of science subjects and daily life questions together with the questioning activity may create alternatives to the solution of global problems.

The question tree questions test did not affect academic success. It is recommended that students write questions under the guidance of a teacher or parent in both their achievements and the development of their originality. Questions should be encouraged to be at levels that can improve cognitive skill. As a matter of fact, they are thought to be more productive in the face of social problems when they grow and join the society.

Students' question tree; It has been determined that they are useful and entertaining, sharing the questions with the class and solving them together, and using them in learning the subjects they cannot understand. It is recommended to include activities that students find entertaining in increasing their attendance. Students' sharing the questions

with their friends or getting help in solving the questions during the lesson increases the learning effect of collaboration and is thought to be a technique that can be used in socializing students.

It has been determined that the questions put on the question tree of the students have effects such as giving them information, learning new and different questions and solutions. It is thought that the question tree may be effective in cases where students see new and different questions and different solutions are shown by their friends. It is recommended to be used especially in countries where central exams are applied in transition to higher education.

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## Genişletilmiş Özet

### Giriş

Öğrencinin ürettiği sorular öğrencinin konuyu öğrenmesine ve değerlendirmesine yardımcı olur (Billingsley ve ark., 2020; Huang ve ark., 2017). Genel olarak öğrencilerin üst düzey düşünmeye meyilli olmadığı düşünülmektedir (Kocaöz, 2019). Ancak yeterli ilgi ve eğitim aldıklarında üst düzey düşünme becerilerinin geliştiği de bilinmektedir (Bahtiyar, 2019). Sınıf ortamında soru sorma, soruların niceliği ve niteliği öğretmenin kontrolünde olmalıdır (Russell, 1983). Öğretmenin sınıfta rehber ya da aktif sorgulayıcı olması önemlidir (Oliveira, 2009). Fen bilgisi öğretmenleri neden ve nasıl gibi kavramların cevaplarını almak için soru sorma tekniğini kullanmalıdır (Huang ve ark., 2017). Vygotsky'nin (1980) sosyo-kültürel öğrenme kuramı, bilginin insanlar arasında belirli bir düzeyde geliştiğini ve daha sonra öğrencinin zihnine geçtiğini göstermektedir (Benedict-Chambers ve ark., 2017). Okullarda öğretmenler birincil bilgi kaynağı olarak kabul edilse de kitaplar, internet, arkadaşlar ve aile bilgi kaynaklarıdır (Chin & Osborne, 2008). Öğrenci bilgi kaynakları ile etkileşime girdiğinde yeni bilgiler öğrenir. En önemlisi merak ve huzursuzluğun kaynağı olan sorularına cevap buluyor. Ayrıca öğrencinin üst düzey düşünme becerilerini geliştirir, kendilerini ve dersi değerlendirmelerini sağlar. (Huang ve ark., 2017). Özellikle fen derslerinde bu etkileşim oldukça yüksektir. Bu teoriye göre okul, sosyo-kültürel etkileşimin yoğun olarak yaşandığı bir ortamdır. Öğretmen-öğrenci, öğrenci-öğrenci etkileşimi bilginin yapılandırılmasını hızlandırır. Soruları işbirlikçi bir ortamdan yanıtlamanın, yeni sorular üretmenin ve öğrenmenin daha kalıcı olduğu da bilinmektedir (Cano ve ark., 2014; Kawalkar & Vijapurkar, 2011; Hoppenbrouwers, 2012). Öğrencilerin grup tarafından oluşturulan veya bireysel soruları, işbirlikçi çalışmayı ve bilgiyi etkiler (Chin & Brown, 2010). Bu çalışmanın temel amacı, fen bilimleri dersinde kullanılan soru ağacı tekniğinin ve öğrencilerin bağımsız olarak getirdikleri soruların akademik başarıya etkisini belirlemektir. Ayrıca soru ağacının kullanımına ilişkin öğrenci görüşlerinin alınmasıdır.

### Yöntem

Çalışmada karma yöntem kullanılmıştır. Bu yöntemle nitel ve nicel verilerin birbirini tamamlanması hedeflenmektedir (Creswell, 2017). Araştırmanın nicel kısmında deney ve kontrol gruplu deneysel desen tercih edilmiştir. Deneysel çalışma; belirli bir müdahalenin kontrollü koşullar altında belirli bir sorunu çözmeye ne kadar etkili olacağını görmek. Deney ve kontrol grupları rastgele seçilmiştir (Büyüköztürk, 2009; Çepni, 2010; Metin, 2014). Uygulama 8 hafta sürmüştür. Bu çalışmada 6. sınıf fen bilimleri konularında vücudumuzdaki sistemler ele alınmıştır. Araştırmanın nitel boyutunda ise tam yapılandırılmış görüşme formu kullanılmıştır. Bu form, katılımcıların soru ağacına ilişkin düşüncelerini belirlemek için kullanılmıştır.

*Katılımcılar:* Araştırmada rastgele örnekleme kullanılmıştır. Bu örneğin amacı, bir küleden veya bir küledeki belirli bir alt gruptan rastgele birimlerin seçilmesini içerir.

*Veri toplama araçları:* Nitel verilerin toplanmasında tam yapılandırılmış görüşme formu tercih edilmiştir. Bu form ile katılımcıların soru ağacına ilişkin görüş ve düşüncelerinin belirlenmesi amaçlanmıştır. Tam yapılandırılmış görüşme formu aşağıdaki soruları içermektedir.

1. Soru ağacını neden kullanıyorsunuz?
2. Soru ağacının size olumlu ya da olumsuz etkileri nelerdir?

Nicel verilerin toplanmasında soru ağacı soruları ve akademik başarı testi kullanılmıştır. Soru ağacı tekniğinin akademik başarıya etkisini belirlemek için her iki test de kullanılmıştır.

Akademik başarı testi soruları ders kitabı ünite değerlendirme sorularından seçilmiştir. Araştırmada ön ve son test olarak kullanılmıştır. Soru ağacı soru testi, katılımcılardan gelen sorulardan seçilmiştir. Soru ağacı soru testi sadece son test olarak uygulanmıştır. Uygulama sırasında toplanan sorulardan seçilerek hazırlandığı için uygulama öncesi ön test olarak uygulanması mümkün değildir. Verilerin analizi: Araştırmada kullanılan ölçme araçlarının verileri Microsoft Excel programı ve SPSS 17 programı yardımıyla analiz edilmiştir. Betimsel ve içerik analizleri ile t-testi, ANCOVA, frekans ve yüzde değerleri gibi teknikler kullanılmıştır. Katılımcıların isimleri sayısal değerlerle kodlanmıştır.

### Sonuç

Soru ağacı tekniğinin deney ve kontrol gruplarının akademik başarıları üzerinde anlamlı bir farklılık oluşturmadığı belirlenmiştir. Soru ağacında bulunan sorulardan oluşan testin akademik başarıyı etkilemediği tespit edilmiştir. Bu sonuç üzerinde soruların kitaptan çıkarılmasının, düşük seviyeli soruların kullanılmasının serbest bırakılmasının ve öğretmenin kontrolünde yapılmamasının etkili olduğu düşünülmektedir. Soru ağacında kullanılan soruların, anlaşılmayan konuların öğrenilmesinde ve sınıfla paylaşılıp çözülmesinin faydalı ve eğlenceli olduğu belirlenmiştir. Soru ağacına konulan soruların öğrencilere bilgi verme, yeni ve farklı sorular ve çözümler öğrenme gibi etkileri olduğu tespit edilmiştir.