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Analysing Science Textbooks in Terms of Inquiry Levels of Activities and The Nature of Scientific Inquiry

Etkinliklerin Sorgulama Düzeyleri ve Bilimsel Sorgulamanın Doğası Açısından Fen Ders Kitaplarının İncelenmesi

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Abstract: Textbooks are one of the main elements determining student experiences during science classes.The importance of textbooks in gaining the knowledge (nature of scientific inquiry) and the skills needed in scientific inquiry (SI) cannot be denied. This research aims to analyze science textbooks in terms of inquiry levels of activities and the nature of scientific inquiry (NOSI). Document analysis was used as the research method. A descriptive analysis technique is used to analyze the data. The textbooks were analyzed regarding the level of inclusion of NOSI themes using a framework developed by the researchers. The inquiry levels of the activities, which are thought to be inquiry activities, were determined according to the classification suggested by Rezba et al. (1999). It is found that some of the NOSI aspects are not included in the textbooks. Some expressions were found in textbooks that may cause misconceptions in students. It is concluded that the activities considered scientific inquiry are mainly at the confirmation level and the structured level.

Keywords: Document analysis, nature of scientific inquiry, inquiry levels, science textbooks

Öz: Ders kitapları fen derslerinde öğrenci deneyimlerini belirleyen temel unsurlardan biridir. Bilimsel sorgulamada ihtiyaç duyulan bilgi (bilimsel sorgulamanın doğası) ve becerilerin kazandırılmasında ders kitaplarının önemi yadsınamaz. Bu araştırma, fen bilimleri ders kitaplarını etkinliklerin sorgulama düzeyleri ve bilimsel araştırmanın doğası açısından incelemeyi amaçlamaktadır. Araştırma yöntemi olarak doküman incelemesi kullanılmıştır. Verilerin analizinde betimsel analiz tekniği kullanılmıştır. Ders kitapları, araştırmacılar tarafından geliştirilen çerçeve kullanılarak NOSI temalarının dâhil edilme düzeyi açısından analiz edilmiştir. Sorgulama etkinliği olduğu düşünülen etkinliklerin sorgulama düzeyleri Rezba ve diğerleri (1999) tarafından önerilen sınıflandırmaya göre belirlenmiştir. Bilimsel araştırmanın doğasına ilişkin bazı hususların ders kitaplarında yer almadığı tespit edilmiştir. Ders kitaplarında öğrencilerde kavram yanılgısına sebep olabilecek bazı ifadelere rastlanmıştır. Bilimsel araştırma olarak değerlendirilen etkinliklerin ağırlıklı olarak doğrulama ve yapılandırılmış düzeyde olduğu sonucuna varılmıştır.

Anahtar Kelimeler: Döküman analizi, bilimsel sorgulamanın doğası, sorgulama düzeyleri, fen ders kitapları

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Introduction

In the information age and economic competition environment, citizens are greatly affected by today's employment problem and cannot make informed decisions on many issues on which there is no consensus. Individuals benefit from new business opportunities based on innovation, not being open to pseudo-scientific views, heir ability to make informed decisions on issues such as diet, smoking, vaccination, screening programs, and safety at home and at work depends on their scientific literacy (Laugksch, 2000; Thomas & Durant, 1987; Walberg, 1983).

Scientific literacy represents the information general people need to know about science (Durant, 1993), it requires to appreciate the nature of science and its aims and general limits and understand more (Jenkins, 1994). Scientific literacy, an internationally well-known educational slogan, buzzword, catchphrase, and contemporary education goal, means everyone should have a helpful idea about science and its role in society. The term is generally accepted to be synonymous with 'science conception of public' and is mainly used in this way in England. As the 'scientific literacy' term is used in the United States of America, the 'La Culture Scientifique (scientific culture)' is used in France (Durant, 1993). Literacy in science and scientific literacy terms can be confused. Literacy in science and scientific literacy are not the same, though they are interconnected. Literacy in science refers to literacy strategies and practices that enable people to understand, synthesize, and communicate science content knowledge through viewing, reading, writing, listening, and speaking practices used to obtain, understand, and transfer scientific knowledge. Scientific literacy refers to individuals understanding the scientific terms, phenomena, and processes and using this knowledge in nonscientific cases from time to time (OECD, 2018).

Scientific literacy is closely related to the welfare of a country. National prosperity depends on competing in international markets accomplished in one aspect (Laugksch, 2000; Walberg, 1983). Global competitiveness is to produce the technologies to maintain this competition and rely on a complex national research and development program to take advantage of minor markets (Laugksch, 2000). Access to scientists, engineers, and technically educated staff forms the basis of such a research and development program. Only the nations whose citizens have scientific literacy at the proper level can maintain this supply (Walberg, 1983). In this context, the science education offered in schools must raise scientifically literate individuals to meet this need. With the rising importance of scientific literacy, the primary vision of many science curricula, including our country, Türkiye, is

determined to raise science literate individuals ([Western Australia] Curriculum Council, 1998; National Research Council [NRC], 2012; Ministry of National Education [MoNE], 2018).

Scientifically literate individuals are the ones who possess scientific knowledge and understand the nature of scientific knowledge and how this knowledge is produced. They have positive attitudes and values about science and technology and realize how science-technology society affects each other. Scientifically literate individuals also use this knowledge and awareness to solve the problems faced in daily life (NRC, 1996). An individual's understanding of how scientific knowledge is produced refers to scientific inquiry (SI) procedures and having knowledge and skills about the characteristics of these procedures. Researchers have a consensus that SI is one of the essential components of scientific literacy (Flick & Lederman, 2006; Lederman et al., 2014). With the revision carried out in 2018, two special aims were added to the Turkish Science Curriculum to raise science-literate individuals. These are 'exploring nature and understanding the human-environment relationship, adopting scientific process skills and scientific research approach, and problems encountered in these areas in the process of solving' and 'helping to understand how scientists produce scientific knowledge, the procedures of the generated knowledge and how it is used in new research'. As seen from these special objectives, the usage of SI and understanding the nature of scientific inquiry (NOSI) are emphasized separately and particularly (MoNE, 2018).

SI generally states the concrete procedures the scientist experiences producing the scientific knowledge (Lederman et al., 2014); at the school level, it refers to the activities in which students structure various research questions, collect and analyze different data accordingly, and answer research problems. In some inquiry activities, the teacher can define research questions and methods. Accepting an activity at the school level as SI is considered decent to begin with a research question and make a data analysis. The inquiry level differentiates from the confirmation level to open inquiry according to procedures being structured by students (Bell et al., 2005). Inquiry levels can be summed up as shown in Figure 1.

Students need more than just the SI procedures and get involved in SI experiences with activities at the school level to reach aimed outputs at the school level (Lederman, 2006). The SI at the school level must have two primary outputs: to conduct the scientific procedures in the SI process and to understand the characteristics of these procedures. It means that SI must be structured on two primary outputs: skill and knowledge (New Generation Science Standards [NGSS], 2013). Understanding the characteristics of SI procedures is called the NOSI. The characteristics of SI procedures, in other words, the aspects of the NOSI can be summarized in Table 1:

Table 1. Aspects of NOSI (Lederman et al., 2014)

1	All scientific investigations must begin with a question and do not necessarily test a hypothesis
2	There is no single scientific method or sequence of steps followed in all investigations
3	Inquiry procedures are guided by the question asked
4	All scientists performing the same procedures may not get the same results
5	Inquiry procedures can influence results
6	Research conclusions must be consistent with the data collected
7	Scientific data are not the same as scientific evidence
8	Explanations are developed from a combination of collected data and what is already known

Students can conduct inquiry experiences without knowing the characteristics of inquiry procedures (Lederman et al., 2019). Thus, providing SI experiences does not ensure that students understand these procedures (Lederman et al., 2014). The characteristics of SI procedures must be emphasized during inquiry experiences in an explicitly reflective way (Crawford, 2014).

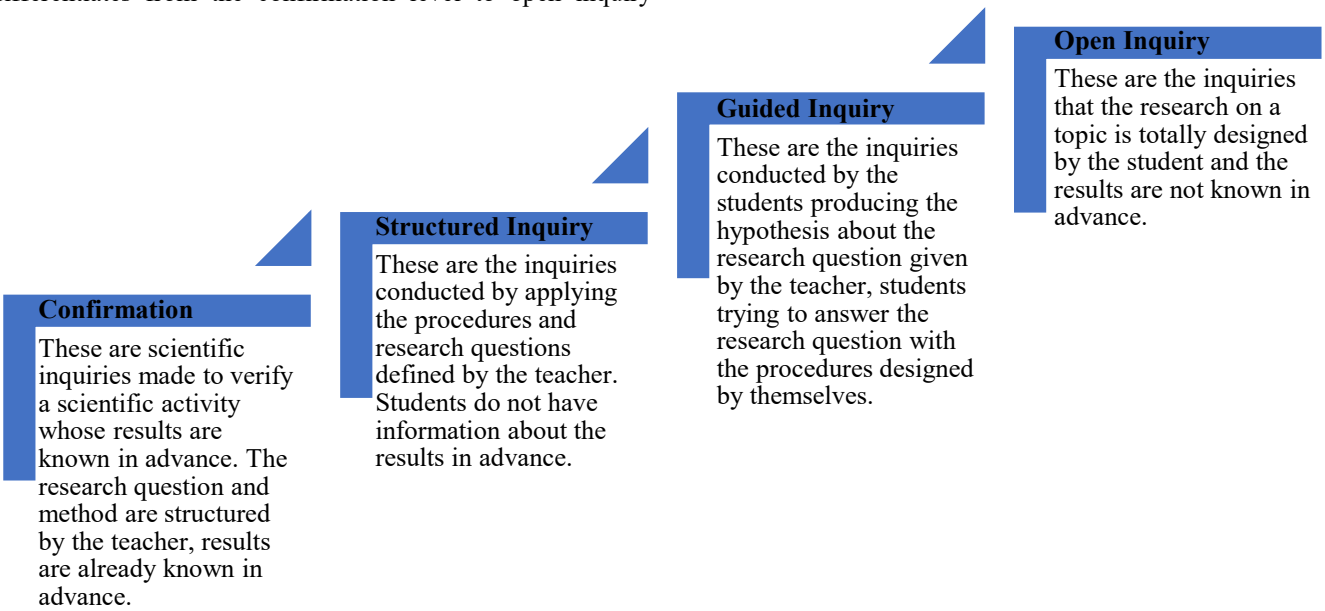

Figure 1. Levels of the SI (Bell et al., 2005; Rezba et al., 1999)

The Importance of Textbooks in Teaching SI and NOSI

The learning outcomes in the curriculum are concretized via textbooks. Textbooks are one of the main elements determining the student experiences during science classes (Chiang-Soong & Yager, 1993; Devetak & Vogrinc, 2013). Teachers mainly compose the content of science classes based on textbooks. Teachers care more about the content of the textbook than the curriculum. Textbooks are considerable tools for teachers to make contact between students and teachers. Textbooks guide teachers in teaching students in their individual learning experiences (Güzel & Şimşek, 2012). The importance of the textbook can not be denied in achieving the vision and aims of the curriculum and realizing the outputs aimed in accordance. Therefore, it can be said that equipping students with the needed information and skills about SI and the NOSI depends on structuring the textbooks in a qualified way. In the literature, studies investigating the inclusion of NOSI themes in textbooks, the level of expressions that may lead to misunderstandings on this subject, and the questioning levels of the activities in the textbooks are quite limited. The findings of this study are considered as essential both in terms of filling the gap in the literature and the potential of guiding book writing studies in the future.

Aim of the Study

This study aims to analyze the middle school textbooks in terms of the NOSI and the SI levels. In this context, the questions below are searched for an answer;

1. What is the inclusion level of the NOSI aspects in science textbooks?
2. What is the inclusion level of the statements that may cause misunderstanding about the NOSI in science textbooks?
3. What is the inquiry level of the activities included in science textbooks?
4. What is the inquiry level of the activities included in science textbooks?
5. What is the inquiry level of the activities included in science textbooks when the textbooks are examined separately according to grade levels?

Methodology

Research Design

Document analysis was used as the research method. According to Yıldırım and Şimşek (2021), document analysis enables examining and analyzing the written or visual materials including information about the facts and events aimed at the research. Document analysis can be used with observation and interview, or can be used alone. In this study, only the document analysis method was used.

Sample

Table 2. The identity disc of middle school science textbooks taught in Türkiye

Grade	Year of Publication	Publishing House
5	2018	MoNE Publishing
5	2018	SDR Dikey Publishing
6	2019	MoNE Publishing
6	2018	Sevgi Publishing
7	2019	MoNE Publishing
7	2018	Aydın Publishing
8	2018	Adım Adım Press Publishing

The sample of the study consists of 5th, 6th, 7th, and 8th-grade science textbooks offered by the MoNE since the 2018-2019 education year. The information about the textbooks is as shown in Table 2.

Data Collection Method

In qualitative research, the data collection tool is the researcher. In accordance with the aim of this qualitative study, the middle school science textbooks are obtained from EBA (Education Informatics Web) which is affiliated with MoNE. In analyzing the textbooks, (1) completed paragraphs, (2) figures with subtitles, (3) tables with subtitles, (4) images with subtitles, (5) interpretations and explanations on the page margins, (6) steps of the experiment or activities are identified as analysis units (Chiappetta et al., 2004).

Data Analysis Method

The descriptive analysis technique is used in analyzing the data. In the descriptive analysis, the data are analyzed according to the themes determined in line with the research problem and subproblems (Yıldırım & Şimşek, 2021). In this study, a frame was developed by the researchers to analyse the textbooks in terms of the level of inclusion of NOSI themes. The analysis frame used to analyze the books in terms of the NOSI includes the themes of the NOSI on one side of the frame and a section to mark whether these themes are found in the relevant context on the other side. The presence of the NOSI aspects in textbooks is symbolized with √, the presence of an explanation conflicting with these aspects is symbolized with X, and the absence of aspects in textbooks is symbolized with NR. The textbooks were analyzed according to these frames. In analyzing the inquiry levels of the activities in the textbooks, firstly it is evaluated whether the activity is appropriate to the nature of inquiry. Secondly, the inquiry levels of the activities which are thought to be inquiry activity are determined according to the classification suggested by Rezba et al., (1999). The SI activities' number and the range of these activities according to inquiry levels are stated with percentages and frequencies.

Validity and Reliability

To increase the persuasiveness (internal validity) of the findings, the researcher worked together with two domain experts. To increase the study's transferability (external validity), all the textbooks suggested by MoNE and taught in the middle school classes were analyzed and the sample size was kept at a maximum level. While presenting the findings, the data analysis process was explained in detail, and direct quotes from the textbooks were used. To evaluate the consistency (internal reliability) of the study 10 percent of the data were analyzed independently by the researchers and a domain expert (Neuendorf, 2002). The inter rater reliability was calculated as 84 percent by using the reliability formula of Miles and Huberman'ın (1994) [Reliability = Concencus / (Agreement + Disagreement)]. A standard view was tried to be adopted by taking the opinion of the field expert regarding the differences between the coders. With the aim of increasing verifiability (external reliability), the information about the textbooks was presented in a detailed way.

Findings

The Inclusion Level of The NOSI Aspects in the Textbooks

It is determined that, in the 5th-grade science textbook of MoNE Publishing, most of the NOSI aspects are not mentioned, and among the mentioned ones the 'explanations are developed from a combination of collected data and what is already known' aspect is mentioned more than the others (Table 3).

It is seen that half of the NOSI aspects are not mentioned in the SDR Dikey Publishing 5th grade science textbook, and among those mentioned, the 'there is no single scientific method' part of the 'there is no single scientific method or sequence of steps followed in all investigations' aspect is mentioned more than the other aspects (Table 4). However, as seen in the table, there are contrasting statements with the 'there is no sequence of steps followed in all investigations' part (Table 4).

Table 3. The inclusion level of the NOSI aspects in the 5th-grade textbook of MoNE publishing

	5th grade textbook	
Aspects of the NOSI	Case	Reference (Page,Paragraph, Sentence)
All scientific investigations must begin with a question and do not necessarily test a hypothesis		
All scientific investigations must begin with a question	√	(p11, 1st, s2)
All scientific investigations do not necessarily test a hypothesis	×	(p11,4th)
There is no single scientific method or sequence of steps followed in all investigations.		
There is no single scientific method	NR	
There is no sequence of steps followed in all investigations	NR	
Inquiry procedures are guided by the question asked.	NR	
All scientists performing the same procedures may not get the same results.		
All scientists performing the same procedures may not get the same results.	√	(p22, 1st, s1-s4)
The scientists performing the different procedures may get the same results.	NR	
Inquiry procedures can influence results.	√	(p22, 1st, s1-s4)
	√	(p56, 2nd, s4)
Research conclusions must be consistent with the data collected.	√	(p11)
Scientific data are not the same as scientific evidence.	NR	
Explanations are developed from a combination of collected data and what is already known.	√	(p102,1st,s7-s8)
	√	(p105, 3rd, s3)
	√	(p182, 3rd, s3)
	√	(p260, 2nd, s5)

√: *Explanations verify this statement. X: Explanations contradict with this statement. NR: There is no reference.*

Table 4. The inclusion level of the NOSI aspects in the 5th-grade textbook of SDR Dikey publishing

	5th grade textbook	
Aspects of the NOSI	Case	Reference (Page, Paragraph, Sentence)
All scientific investigations must begin with a question and do not necessarily test a hypothesis		
All scientific investigations must begin with a question	√	(p12, 1st, s10-12)
	√	(p13, 2nd, s1)
All scientific investigations do not necessarily test a hypothesis	×	(p176, 2nd, s2-3)
There is no single scientific method or sequence of steps followed in all investigations.		
There is no single scientific method	√	(p12, 1st, s8)
	√	(p12, 1st, s15)
	√	(p13, 3th, s1)
	√	(p23, 2nd, s3-5)
	√	(p81, 2nd, s1-2)
	√	(p125, 1st, s1)
There is no sequence of steps followed in all investigations	x	(p12, 2nd, s1-6)
	x	(p125, 7th, s1)
	x	(p160, 6th, s1)
	x	(p179, 7th, s1)
Inquiry procedures are guided by the question asked.	√	(p12, 1st, s13)
	√	(p13, 3rd, s2)
	√	(p29, 1st, s5-6)
	√	(p176, 2nd, s2-3)
All scientists performing the same procedures may not get the same results.		
All scientists performing the same procedures may not get the same results.	√	(p16, 2st, s3-4)
	√	(p140, 3st, s6)
The scientists performing the different procedures may get the same results.	NR	
Inquiry procedures can influence results.	NR	
Research conclusions must be consistent with the data collected.	NR	
Scientific data are not the same as scientific evidence.	NR	
Explanations are developed from collected data and what is already known.	NR	

√: *Explanations verify this statement. X: Explanations contradict with this statement. NR: There is no reference.*

When the 6th-grade science textbook of MoNE Publishing is analyzed, it is determined that all of the NOSI aspects are not mentioned, and among the mentioned ones, the 'there is no sequence of steps followed in all investigations' part of the 'there is no single scientific method or sequence of steps followed in all investigations' aspect is mentioned more than the others (Table 5).

When the 6th-grade science textbook of Sevgi Publishing is analyzed, it is determined that most of the NOSI aspects are not mentioned, and among the mentioned ones the 'research conclusions must be consistent with the data collected' and 'all scientific investigations must begin with a question' aspects are mentioned more than the others (Table 6).

Table 5. The inclusion level of the NOSI aspects in the 6th-grade textbook of MoNE publishing

	6th grade textbook	
Aspects of the NOSI	Case	Reference (Page, Paragraph, Sentence)
All scientific investigations must begin with a question and do not necessarily test a hypothesis		
All scientific investigations must begin with a question	√	(p12)
All scientific investigations do not necessarily test a hypothesis	×	(p12)
There is no single scientific method or sequence of steps followed in all investigations.		
There is no single scientific method	√	(p12)
	×	(p12, 1st, s2)
There is no sequence of steps followed in all investigations	×	(12p)
	×	(p39, 2nd, s3)
	×	(p81, 3rd, s1-s2)
	×	(p105, 2nd, s1-s2)
	×	(p145, 2nd, s1-s2)
	×	(p161, 2nd, s1-s2)
	×	(p192)
Inquiry procedures are guided by the question asked.	NR	
All scientists performing the same procedures may not get the same results.		
All scientists performing the same procedures may not get the same results.	NR	
The scientists performing the different procedures may get the same results.	NR	
Inquiry procedures can influence results.	√	(p28, 2nd, s1)
Research conclusions must be consistent with the data collected.	√	(p12)
Scientific data are not the same as scientific evidence.	NR	
Explanations are developed from a combination of collected data and what is already known.	NR	

√*: Explanations verify this statement. X: Explanations contradict with this statement. NR: There is no reference.*

Table 6. The inclusion level of the NOSI aspects in the 6th-grade textbook of Sevgi publishing

	6th grade textbook	
Aspects of the NOSI	Case	Reference (Page, Paragraph, Sentence)
All scientific investigations must begin with a question and do not necessarily test a hypothesis		
All scientific investigations must begin with a question	√	(p12,1st, s1)
	√	(p262,2nd, s2-3)
All scientific investigations do not necessarily test a hypothesis	×	(p12,4th, s1)
There is no single scientific method or sequence of steps followed in all investigations.		
There is no single scientific method	NR	
There is no sequence of steps followed in all investigations	×	(p12)
Inquiry procedures are guided by the question asked.	NR	
All scientists performing the same procedures may not get the same results.		
All scientists performing the same procedures may not get the same results.	NR	
The scientists performing the different procedures may get the same results.	NR	
Inquiry procedures can influence results.	NR	
Research conclusions must be consistent with the data collected.	√	(p146,4th, s1)
	√	(p170,3rd, s3)
Scientific data are not the same as scientific evidence.	NR	
Explanations are developed from a combination of collected data and what is already known.	NR	

√*: Explanations verify this statement. X: Explanations contradict with this statement. NR: There is no reference.*

It is determined that most of the NOSI aspects are mentioned in the 7th-grade science textbook of MoNE Publishing; however, the 'inquiry procedures are guided by the question asked' aspect is never mentioned. It is determined that 'all scientific investigations must begin with a question and do not necessarily test a hypothesis' aspect is mentioned more than the other aspects (Table 7).

It is determined that most of the NOSI aspects are not mentioned in the 7th-grade science textbook of Aydın Publishing, and among the mentioned ones the 'all scientists performing the same procedures may not get the same results' aspect is mentioned more than the others (Table 8).

Table 7. The inclusion level of the NOSI aspects in the 7th-grade textbook of MoNE publishing

	7th grade textbook	
Aspects of the NOSI	Case	Reference (Page, Paragraph, Sentence)
All scientific investigations must begin with a question and do not necessarily test a hypothesis		
All scientific investigations must begin with a question	√	(p14, 2nd, s1)
	√	(p111,2nd, s2)
All scientific investigations do not necessarily test a hypothesis	×	(p14, 2nd, s3)
	√	(p111, 2nd, s4)
	√	(p111, 3rd, s1)
	√	(p112, 1st, s3)
There is no single scientific method or sequence of steps followed in all investigations.		
There is no single scientific method	√	(p111, 3rd, s1-2)
	√	(p112, 1st, s3)
There is no sequence of steps followed in all investigations	×	(p14, 15, 16)
	×	(p28, 3rd, s1)
	×	(p36, 3rd, s2)
	×	(p52, 2nd, s2)
	×	(p100, 2nd, s2)
	×	(p114)
	×	(p137, 2nd, s2)
	×	(p176)
	×	(p216)
Inquiry procedures are guided by the question asked.	NR	
All scientists performing the same procedures may not get the same results.		
All scientists performing the same procedures may not get the same results.	√	(p37, 1st, s2)
The scientists performing the different procedures may get the same results.	√	(p56, 2nd, s3)
Inquiry procedures can influence results.	√	(p56, 3rd, s2)
	√	(p57, 4th, s3)
	√	(p112, 3rd, 1st)
Research conclusions must be consistent with the data collected.	√	(p14, 3nd, s5)
Scientific data are not the same as scientific evidence.	√	(p111, 4th, s1)
Explanations are developed from a combination of collected data and what is already known.	√	(p26, 1st, s1)
	√	(p57, 2nd, s1)
	√	(p100, 5th, s1)

√: *Explanations verify this statement. X: Explanations contradict with this statement. NR: There is no reference.*

Table 8. The inclusion level of the NOSI aspects in the 7th-grade textbook of Aydın publishing

	7th grade textbook	
Aspects of the NOSI	Case	Reference (Page, Paragraph, Sentence)
All scientific investigations must begin with a question and do not necessarily test a hypothesis		
All scientific investigations must begin with a question	√	(pXII)
All scientific investigations do not necessarily test a hypothesis	×	(pXIII,1st, s1)
There is no single scientific method or sequence of steps followed in all investigations.		
There is no single scientific method	NR	
There is no sequence of steps followed in all investigations	×	(pXII)
Inquiry procedures are guided by the question asked.	NR	
All scientists performing the same procedures may not get the same results.		
All scientists performing the same procedures may not get the same results.	√	(p16,4th)
	√	(p82-83)
The scientists performing the different procedures may get the same results.	√	(p29,2nd, s1-2)
Inquiry procedures can influence results.	NR	
Research conclusions must be consistent with the data collected.	√	(p200, 4th, s4)
Scientific data are not the same as scientific evidence.	NR	
Explanations are developed from a combination of collected data and what is already known.	√	(p30, 2nd, 1st)

√: *Explanations verify this statement. X: Explanations contradict with this statement. NR: There is no reference.*

It is determined that most of the NOSI aspects are not mentioned in the 8th-grade science textbook of Adım Adım Publishing, and among the mentioned ones the 'explanations are developed from a combination of collected data and what is already known' aspect is mentioned more than the others (Table 9).

When all the textbooks are analyzed together and according to their grades, it is determined that during middle school education, 'scientific data are not the same as scientific evidence' aspect is mentioned quite limitedly (just once) in the textbooks (Figure 2). Similarly, the 'inquiry procedures are guided by the question asked' aspect is only mentioned in 5th-grade textbooks. It is seen that most of the NOSI aspects are not mentioned in all grades. It is determined that 6th-grade textbooks are more limited than the textbooks of the other grades in terms of emphasizing the NOSI aspects explicitly (Figure 2).

Table 9. The inclusion level of the NOSI aspects in the 8th-grade textbook of Adım Adım publishing

	7th grade textbook	
Aspects of the NOSI	Case	Reference (Page, Paragraph, Sentence)
All scientific investigations must begin with a question and do not necessarily test a hypothesis		
All scientific investigations must begin with a question	√	(p9, 1st, s2)
	√	(p9, 4st, s1)
	√	(p35, 2nd, s3)
All scientific investigations do not necessarily test a hypothesis	NR	
There is no single scientific method or sequence of steps followed in all investigations.		
There is no single scientific method	√	(p9, 1st, s1)
	√	(p160,3rd-5th)
There is no sequence of steps followed in all investigations	×	(p9,2nd, s11-19)
	×	(p10,1st, s4)
Inquiry procedures are guided by the question asked.	NR	
All scientists performing the same procedures may not get the same results.		
All scientists performing the same procedures may not get the same results.	√	(p58,4th, s1-3)
The scientists performing the different procedures may get the same results.	√	(p88,1st, s3)
Inquiry procedures can influence results.	√	(p160,2nd-4th)
Research conclusions must be consistent with the data collected.	√	(p105, 6th, s1-2)
Scientific data are not the same as scientific evidence.	NR	
Explanations are developed from a combination of collected data and what is already known.	√	(p35,2nd)
	√	(p88,2nd, s1-2)
	√	(p138,2nd, s1)
	√	(p151,3rd, s2)
	√	(p160,3rd-5th)

√: *Explanations verify this statement. X: Explanations contradict with this statement. NR: There is no reference.*

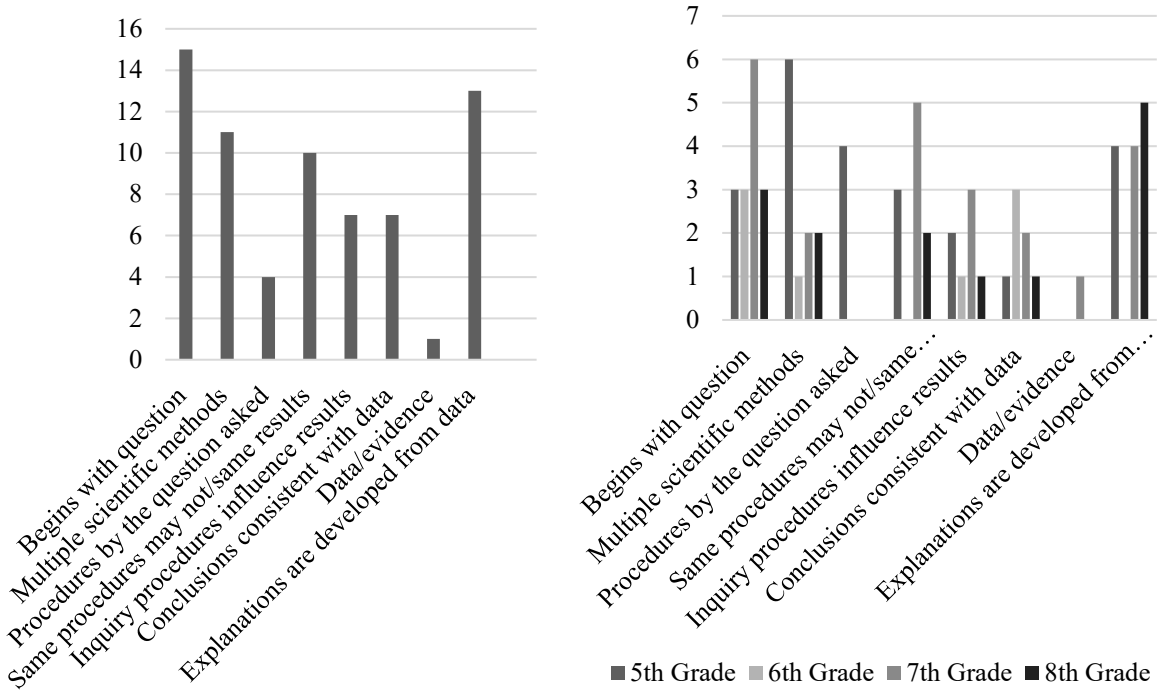

Figure 2. Frequency of the NOSI aspects in the textbooks

It is determined that, during middle school education *'all scientific investigations must begin with a question and do not necessarily test a hypothesis'* aspect is emphasized (Graph 1). A sample of how this aspect is mentioned is as follows:

> *'Scientific research begins with a question and proceeds looking for the answers to these questions.' (7th-Grade, MoNE Publishing, p 111)*

After the *'all scientific investigations must begin with a question and do not necessarily test a hypothesis'* aspect, the *'explanations are developed from a combination of collected data and what is already known'* aspect is the most emphasized aspect in the textbooks (Figure 2). A sample of how this aspect is mentioned is as follows:

> *'The tools we use in daily life were invented as a result of humanity's long-standing knowledge.' (8th-Grade, Adım Adım Publishing, p 138)*

After the *'all scientific investigations must begin with a question and do not necessarily test a hypothesis'* aspect, '*there is no single scientific method or sequence of steps followed in all investigations',* and '*all scientists performing the same procedures may not get the same results'* aspects are mentioned the most respectively (Graph 1). Some samples of how these aspects are mentioned are as follows:

> *'To make a scientific observation, it is not necessary to experiment. Sometimes, to understand the natural world measurements and natural observations are conducted.' (7th-Grade, MoNE Publishing, p 111)*
>
> *'Even if their methods were different, these two scientists had similar findings while unaware of each other.' (8th-Grade, Adım Adım Publishing, p 88)*

A sample of the NOSI aspect *'research conclusions must be consistent with the data collected'* is as below:

> *'Do your evaluation looking at the difference between the measurement at home and school with not insulated bag and the measurement at home and school with an insulated bag.' (6th-Grade, Sevgi Publishing, p 146)*

A sample of the NOSI aspect *'inquiry procedures can influence results'* is as below:

> *'The number of satellites may change due to the studies conducted by scientists. Such as; while Neptune was known to have 13 satellites, it has proven that it has 14 satellites.' (6th-Grade, MoNE Publishing, p 28)*

A sample of how the NOSI aspect *'inquiry procedures are guided by the question asked'* is mentioned in the textbooks is as follows:

> *'To solve a problem, the solutions are compared and the most appropriate one is chosen.' (5th Grade, SDR Publishing, p 13)*

When the textbooks are analyzed separately according to their grades in terms of MoNE Publishing and other publishing houses, it is determined that 5th, 6th, and 7th-grade textbooks of MoNE Publishing are better at mentioning NOSI aspects than the textbooks of other publishing houses (MoNE Publishing does not have a science textbook for 8th-grades). The insufficiency of 6th-grade textbooks in mentioning the NOSI can be seen in the graphic in Figure 3.

The Inclusion Level of The Statements That May Cause Misconceptions About the NOSI in Textbooks

It is considered that some statements in the textbooks may cause students to have misconceptions, like 'scientific research must test a hypothesis', and 'there is a sequence of steps followed in all investigations'. There are conflicting statements with the '*do not necessarily test a hypothesis'* part of the *'all scientific investigations must begin with a question and do not necessarily test a hypothesis'* aspect in all textbooks except the 8th-grade textbook (Table 3-8). Except for the 5th-grade MoNE Publishing textbook, there are conflicting statements with the *'there is no sequence of steps followed in all investigations'* part of the *'there is no single scientific method or sequence of steps followed in all investigations' aspect* (Table 4-9).

The samples of conflicting statements with the '*do not necessarily test a hypothesis'* part of the *'all scientific investigations must begin with a question and do not necessarily test a hypothesis'* aspect in textbooks are as below:

> *'Scientific process skills include observing, classifying, measuring, predicting, saving data, using data and modeling, interpreting data, having a conclusion, defining the variables, changing the variables and controlling, hypothesizing and survey, doing experiment skills.' (5th-Grade, SDR Publishing, p 176)*
>
> *'Scientific research begins with wondering about the mystery lying under the cases and phenomena in the universe. To gain knowledge about the themes wondered, research and observations are conducted. At the end of experiments and observations, new hypothesis are set to be able to test. By conducting experiments, hypothesis are tested whether they are true or not. The information obtained at the end of the observations and experiments is organized and interpreted.' (7th-Grade, MoNE Publishing, p 14)*

A sample of conflicting statements with the *'there is no sequence of steps followed in all investigations'* part of the *'there is no single scientific method or sequence of steps followed in all investigations'* aspect in textbooks is as below:

'The scientific method steps to follow in solving a problem are as follows:

1. *The problem is defined.*
2. *Observation and research are conducted about the problem.*
3. *Hypothesis (temporary solution ways) are set. Predictions depending on the hypothesis are made.*
4. *Experiments are designed and conducted.*
5. *Deductions are made from the results of the experiment.*
6. *The results are evaluated and interpreted. If the results verify the hypothesis, the hypothesis is accepted.*
7. *The hypothesis is not accepted if the results do not verify the hypothesis. The hypothesis is changed, a new hypothesis is set and the steps from the fourth level are repeated' (6th Grade, MoNE Publishing, p 12)*

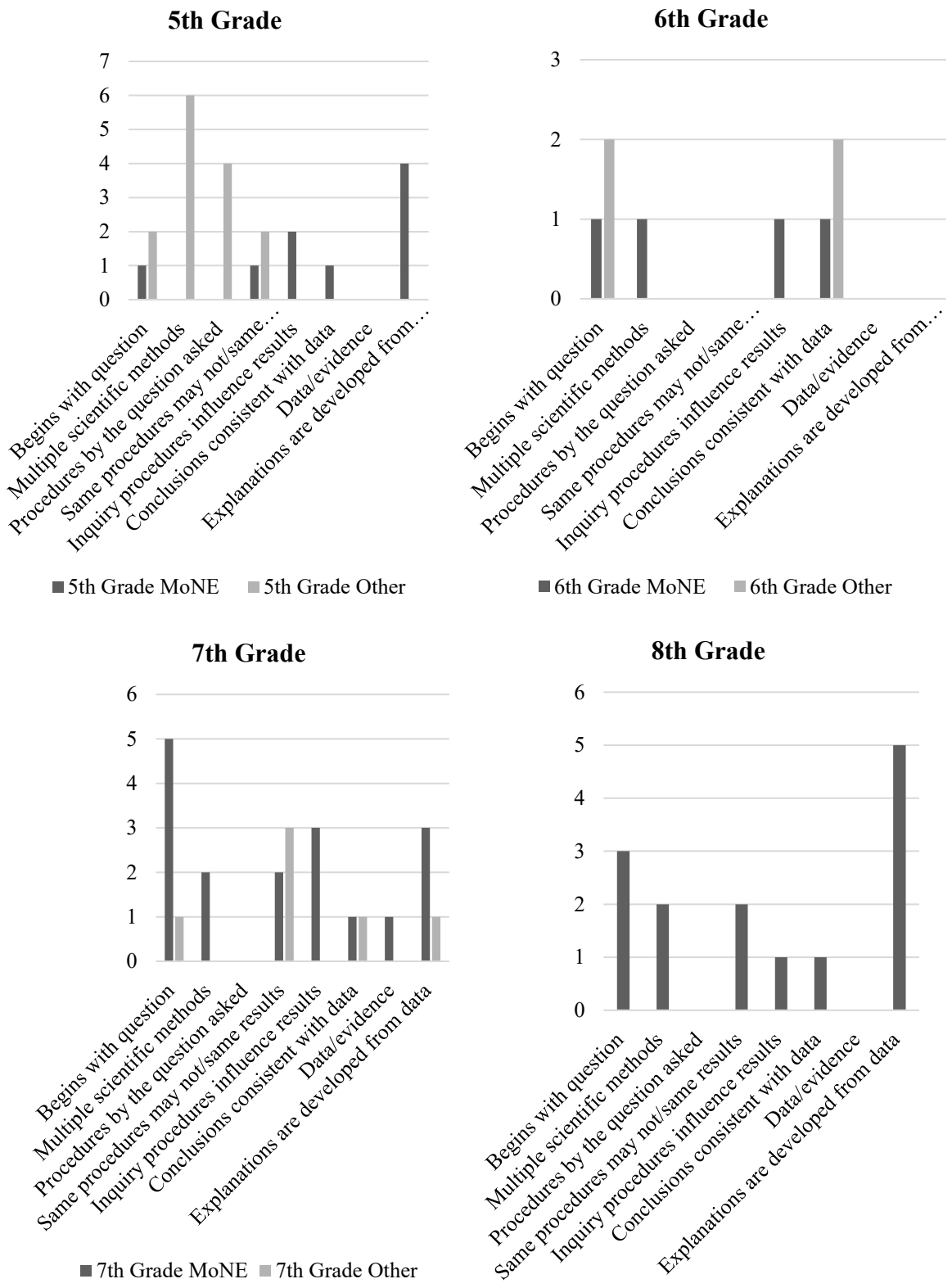

Figure 3. Frequency of the NOSI aspects in terms of the textbooks of MoNE publishing and other publishing

The Inquiry Levels of the Activities in the Textbooks

It is seen that 18 of 76 activities (%38) in the 5th-grade textbook of MoNE Publishing can be considered as SI activities, it is determined that half of the SI activities are confirmation and structured level; in other words, low-level inquiries. In its current state, only half of the inquiry activities allow students to determine the research problem by themselves. Students are directed to inquiries in which they can predict the result of the inquiry activities or the research question, and research procedures are explained step by step (Table 10).

Table 10. Inquiry levels of the activities in the 5th-grade textbook of MoNE publishing

5th grade science textbook		
Inquiry level	**Case**	**Reference (Page)**
Confirmation	√	p23, p147, p199
Structured	√	p35, p92, p138, p165, p257, p259
Guided	X	
Open	√	p44, p71, p86, p103, p109, p155, p200, p241, p265

√: Exists. X: Absent

Table 11. Inquiry levels of the activities in the 5th-grade textbook of SDR publishing

5th Grade Science Textbook		
Inquiry level	**Case**	**Reference (Page)**
Confirmation	√	p65, p76, p118
Structured	√	p79, p88, p91, p105, p114, p120, p172, p174
Guided	√	p149
Open	√	p32, p46, p67,p96, p124, p146, p150, p153, p159, p178

√: Exists. X: Absent

Table 12. Inquiry levels of the activities in the 6th-grade textbook of MoNE publishing

6th grade science textbook		
Inquiry level	**Case**	**Reference (Page)**
Confirmation	√	p89,p115, p159, p160
Structured	√	p23,p96,p116,p117,p153,p154,p155,p156, p163,p169, p188,p211, p215, p216/1st, p216 /2nd
Guided	X	
Open	√	p39,p81,p105,p145,p161,p192

√: Exists. X: Absent

Table 13. Inquiry levels of the activities in the 6th-grade textbook of Sevgi publishing

6th grade science textbook		
Inquiry level	**Case**	**Reference (Page)**
Confirmation	√	p93, p101, p114, p124, p126, p129, p131, p165, p170, p183
Structured	√	p89-90, p92, p138, p163/1, p163/2, p166, p171, p212, p217, p245, p246, p255, p256, p257
Guided	X	
Open	√	p21, p30, p45, p106, p146, p174, p190, p261

√: Exists. X: Absent

It is seen that 22 of 43 activities (%51,2) in the 5th-grade textbook of SDR Publishing can be considered as SI activity, it is determined that half of the SI activities are confirmation and structured level, in other words, low-level inquiries (Table 11). In its current state, only half of the inquiry activities, provide students the opportunity to determine the research method by themselves, and less than half of the activities to determine the research problem by themselves. Students are directed to the inquiries in which the research question and research procedures are explained step by step. Compared to the textbook of MoNE Publishing, the textbook of SDR Publishing is determined to have more inquiry activities and open inquiry activities. Thus, it can be said that the textbook of SDR Publishing is better in terms of including high-level inquiry activities (Table 11).

It is seen that 25 of 49 activities (%51) in the 6th-grade textbook of MoNE Publishing can be considered as SI activity, it is determined that most of the SI activities are at a structured level. It is determined that the open inquiry activities, which allow students to make more decisions during the inquiry process, are included less, the guided inquiry is not included. In most of the activities, students are expected to search for a solution to a question determined by the teacher by following the method determined by the teacher again. There are only six activities in which the research problem and the method are defined by students (Table 12).

It is seen that 32 of 94 activities (%34) in the 6th-grade textbook of Sevgi Publishing can be considered as SI activities, it is determined that most of the SI activities are at structured level. It is determined that the inquiry activities are mostly at confirmation and structured levels, in other words, low-level inquiries. It is determined that the open inquiry activities, which allow students to make more decisions during the inquiry process, are included less, the guided inquiry is not included. Compared to the textbook of MoNE Publishing, the textbook of Sevgi Publishing is determined to have more inquiry activities and open inquiry activities (Table 13).

It is seen that 16 of 42 activities (%38,1) in the 7th-grade textbook of MoNE Publishing can be considered as SI activities, it is determined that half of the SI activities are at a structured level at which students determine the research question and methods by themselves (Table 14). In half of the inquiry activities, students are directed to the inquiries in which they know the result of the research question, or even if they do not know the result, the research procedures are explained step by step (Table 14).

Table 14. Inquiry levels of the activities in the 7th-grade textbook of MoNE publishing

7th grade science textbook		
Inquiry level	**Case**	**Reference (Page)**
Confirmation	√	p70, p131, p162
Structured	√	p47, p127, p131, p153, p166
Guided	X	
Open	√	p27, p36, p51, p100, p114, p137, p176, p216

√: Exists. X: Absent

Table 15. Inquiry levels of the activities in the 7th-grade textbook of Aydın publishing

7th grade science textbook		
Inquiry level	**Case**	**Reference (Page)**
Confirmation	√	p69, p100, p141
Structured	√	p61, p63, p65, p101, p106, p107, p108, p127, p128, p129, p136, p137, p144, p196, p200
Guided	X	
Open	√	p10, p69/2, p114, p115, p148, p201

√: Exists. X: Absent

Table 16. Inquiry levels of the activities in the 8th-grade textbook of Adım Adım publishing

8th grade science textbook		
Inquiry level	**Case**	**Reference (Page)**
Confirmation	√	p70, p75, p76, p95, p99, p103, p106, p114, p116, p118, p140, p142, p144, p161, p199, p203, p205
Structured	√	p74, p78, p107, p115, p119
Guided	X	
Open	√	p150, p182, p213, p224

√: Exists. X: Absent

It is seen that 24 of 52 activities (%46,2) in the 7th-grade textbook of Aydın Publishing can be considered as SI activity, it is determined that a very limited number of the SI activities (%25) enables students to have the opportunity of identifying the research problem and method by themselves (Table 15).

Compared to the textbook of Aydın Publishing, the textbook of MoNE Publishing includes more activities providing high-level inquiries, however, in general, the textbook of Aydın Publishing includes more inquiry activities.

It is seen that 26 of 49 activities (%53,1) in the 8th-grade textbook of Adım Adım Publishing can be considered as SI activities, it is determined that most of the SI activities are at a structured level. In other words, students are directed to the inquiries in which the students can predict the result of the research or research question, and research procedures are explained. In a very limited part of the inquiry activities in the books (%15,1), the students are given the opportunity to determine the research question and method (Table 16).

When the textbooks are analyzed in general, it can be said that the inquiry activities are at a structured level in which the research question and the steps to follow are given to students. Compared to the other grades, in the 8th-grade textbook, it is seen that the scientific inquiries conducted by the students themselves are included less (Figure 4).

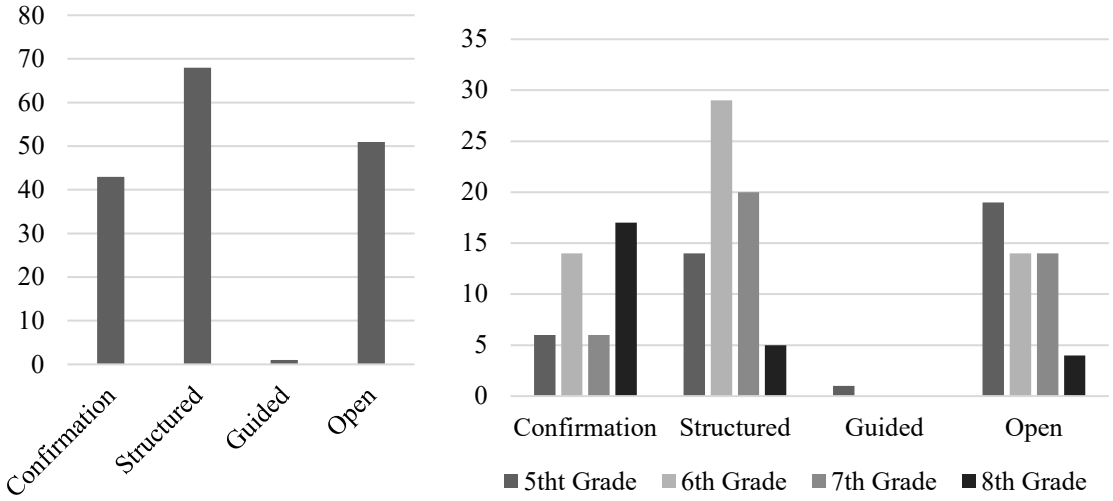

Figure 4. Frequency of the SI levels of the activities in the textbooks

Discussion, Conclusion and Suggestions

In conclusion, it is found that the aspects of NOSI are not emphasized enough, some aspects are not mentioned in some grades in middle school textbooks. Generally, it is determined that 5th, 6th, and 7th-grade MoNE textbooks are better at including NOSI aspects than the other publishing houses. It is determined that 6th-grade textbooks are insufficient in terms of including the NOSI. During middle school education, the *'all scientific investigations must begin with a question and do not necessarily test a hypothesis'* and *'explanations are developed from a combination of collected data and what is already known'* aspects are mentioned the most. However, the emphasis is mainly about the scientific inqueries beginning with a question. There are some statements in the books contradicting the aspect that scientific inqueries do not necessarily test a hypothesis and some statements that may cause students to have some misconceptions about this theme. During middle school education, the *'scientific data are not the same as scientific evidence'* aspect is the most frequently emphasized. Many textbooks contain contradicting statements with the *'there is no sequence of steps followed in all investigations'* part of the *'there is no single scientific method or sequence of steps followed in all investigations'* aspect. It is a common misconception that there is a universal scientific method and this method is composed of standard steps (McComas, 1998). It is not possible to mention procedures followed step by step and unique and universal scientific method in the course of scientific inquiries. The methods scientists use to produce scientific knowledge are affected by individual education, foreknowledge, imagination, and creativity. Imagination and creativity are essential and influential in every step of producing scientific knowledge (Lederman et al., 2014). It can be said that the formation of this misconception was triggered by the scientific method descriptions and steps included in most of the books (İrez & Turgut, 2008). The creating a hypothesis step emphasizes mentioning the scientific research method and may direct the students to think there must always be a hypothesis in scientific research. That is why the books are suggested to be organized in these terms. Emphasizing clearly the relevant aspect in relevant parts may prevent potential misconceptions. When the middle school science textbooks are analyzed in terms of SI levels, it is seen that confirmation and structured inquiry levels are included more often, but guided and open inquiry levels are included limitedly. The science projects prepared to be presented at science festivals can be samples for the activities of open scientific inquiry level (Sadeh & Zion, 2009). Conventional laboratory activities during which both the question and the procedures to be followed step by step used to solve the problem are presented to students can be sampled for the confirmation and structured level (Bell et al., 2005). The activities in the textbooks analyzed are mostly conventional laboratory activities. There is no harm in using low-level inquiries as long as they do not exclude more complex, higher-level inquiries included in the curriculum. Beginning with low-level inquiry and gradually increasing the level of inquiry throughout the term can help students form a basis for themselves about inquiry (Bell et al., 2005). From this point, it is seen that the inquiries at the guided and open level which must be included more often in 8th-grade, are included less compared to the other grades. It is suggested that planning may be done by grades while presenting the inquiry activities in the textbooks and inquiry activities should be included gradually with increasing emphasis according to the grade level. Although teaching science aims to raise students to the open inquiry level, it is suggested that the role of progressing gradually in preparing students for this level of inquiry should not be ignored. Also, it is suggested that all the activities related to inquiry in the classroom should not be expected to be carried out at open inquiry level (Bell et al., 2005). On the other hand, one of the problems with existing textbooks is that guided and open inquiries are clearly included less. The structured inquiry-level activities in the textbooks can be transformed into guided inquiry-level activities by excluding the step-by-step procedures required in these inquiries (Banchi & Bell, 2008; Bunterm et al., 2014). Therefore, it is suggested that instead of changing the activities in the textbooks, the activities in the books can be moved to higher levels in terms of inquiry level by making minor adjustments to the existing activities.

This study attempted to contribute literature by analyzing the NOSI, SI levels, and misconceptions about the NOSI in middle school science textbooks in Türkiye. The research can be expanded by analyzing primary school science textbooks and high school Physics, Chemistry, and Biology textbooks.

Author Contributions

The first author contributed to the writing of the article and the data analysis. Other authors contributed to the data analysis.

Ethical Declaration

Ethics committee permission was not required for the research and the rules determined by the Committee on Publication Ethics (COPE) were followed throughout the study.

Conflict of Interest

The authors have no relevant financial or non-financial interests to disclose.

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