Representations of Nature of Science in New Korean Science Textbooks: The Case of ‘Scientific Inquiry and Experimentation’

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Abstract Nature of science (NOS) is becoming a core component of both science education research and curriculum policy around the globe. In particular, how textbooks should portray NOS aspects have been of keen interest to science educators. This chapter outlines the background and motivations for Korea’s new compulsory subject, scientific inquiry and experimentation (SIE), and analyses how textbooks for this subject present NOS aspects using historical episodes. The aim is to help textbook authors and policymakers by examining the opportunities and challenges of Korea’s new NOS curricular initiative. The results indicate that textbooks tend to focus on the cognitive and epistemic characteristics of science, with limited representation of social and institutional NOS aspects. While textbooks often included multiple NOS aspects that underlie each historical episode, in most cases these aspects were implicitly addressed without proper cues for students’ reflection about them. Based on these findings, we discuss implications for textbook authors and science teachers.

Introduction

Korea has recently been drawing attention from the global educational community with its diverse science education reform initiatives. The Korean Science Education Standards (KSES) have been developed as the first official standards for science education in the country and were published in 2018, and the newly revised 2015 national science curriculum has been implemented nationwide in elementary, middle and high schools since March 2018 (MOE 2015a). Korea is striving to incorporate new knowledge that emerges in rapidly changing science and technology into the curriculum while trying to emphasize content other than traditional scientific knowledge, such as scientific inquiry and nature of science (NOS), as important elements of the science curriculum. At the moment this chapter is being written, it has been three years since scientific inquiry and experimentation (SIE) was first announced and seven months since it was first implemented to Grade 10 Korean students. The research literature has reported that science teachers have high expectation about this new curricular initiative and concerns about the radical shift in terms of assessment and teacher training (Son 2016, Yoon & Kang 2016).

Under the slogan of ‘science education standards for future generations’, KSES emphasizes scientific literacy as a key ability for the future society and states that NOS is an important constituent of scientific literacy (Korea Foundation for the Advancement of Science and Creativity [KOFAC] 2018). Furthermore, in the 2015 national science curriculum, a new subject, scientific inquiry and experimentation (SIE), was introduced to facilitate the students’ understanding of NOS through inquiring how scientific knowledge is produced and applied (Ministry of Education [MOE], 2015a). SIE deserves attention since it is the first curricular initiative in Korea—also among the first around the globe—to teach NOS and scientific inquiry as a separate compulsory school subject.

In many countries, science textbooks are the main teaching and learning resources for teachers and students (Chiappetta and Koballa 2002). This is particularly true in countries such as Korea, where education is highly centralized and standardized, and teachers are thus asked to strictly commit to the curricular content (Pang 2008). Given that science textbooks significantly influence teachers’ practice of NOS instruction (e.g., Chiappetta et al. 1993; McDonald and Abd-El-Khalick 2017), it is important to examine how textbooks are representing the various NOS aspects. However, most studies to date have reported that representations of NOS in textbooks are insufficient and are expressed in an inappropriate manner (Abd-El-Khalick et al. 2008, 2017; BouJaoude et al. 2014; Rodriguez and Niaz 2002). In addition, because most textbooks analysed so far have focused on science content knowledge rather than NOS itself, most NOS references in these textbooks were given in an ‘implicit’ way (Abd-El-Khalick et al. 2008; Li et al. 2018; McDonald 2017). This means that NOS was only implied in the text but not made ‘visible’ to students by explicit statements (Abd-El-Khalick et al. 2017). These research reports led us to ask two research questions, respectively, on the content and methods of SIE textbooks’ NOS representations: (a) What aspects of the NOS are represented in Korean SIE textbooks? (b) How are these NOS aspects presented in terms of instructional approach?

Scientific Inquiry and Experimentation: A New Compulsory Subject

The 2015 national curriculum of Korea lists and defines ‘core competences’ that students are expected to develop through learning subjects that are essential in preparing students for the future society (MOE 2015a). In particular, the science curriculum states that there are five core competencies: scientific thinking ability, scientific inquiry ability, scientific problem-solving ability, scientific communication ability, scientific participation and lifelong learning ability (MOE 2015a, p. 4). The importance of learning through inquiry in science education has a long history (Anderson 2002; Bruner 1966; Schwab 1963). However, despite the efforts by researchers and policymakers and the emphasis in science education documents, inquiry learning is being practiced only to a limited extent in school science classrooms, Korea not being an exception (Cho et al. 2008; Park et al. 2004; Stake and Easley 1978).

The necessity of teaching inquiry as a separate subject arose from these considerations, along with the changing demands of the times.[1] SIE is introduced as a compulsory subject for Grade 10 students in order to help them 'recognize the value of science as well as its impact on scientific inquiry and social, technological development' by providing opportunities to experience authentic scientific inquiry activities. The ultimate aim of SIE is to assist students to 'raise scientific literacy and thus solve individual and social problems scientifically and creatively' (MOE 2015a, pp. 111–112). To achieve this aim, SIE consists of three chapters: 'science inquiry in history', 'science inquiry in human life' and 'frontier science inquiry'. The content structure of SIE is presented in Table 1.

Table 1 The content structure of SIE (MOE, 2015a, p. 113)

Chapter	Key concept	Generalized knowledge
I. Science inquiry in history	Nature of science	We explore the various aspects of nature of science in students' inquiry experiments and experience the nature of science in the process of scientific inquiry.
	How scientists investigate	A variety of scientific inquiry methods are used depending on the topic.
II. Science inquiry in human life	Scientific attitude	Through science inquiry and experimentation, we foster interest, curiosity and joy in science.

[1] The introduction of SIE lies in the context of a larger curricular move from the traditional two-track (humanity track and science track) system to an integrated system that allows students to experience diverse domains of human knowledge (MOE 2015b; Song and Na 2015). SIE serves this aim by bringing together the 'human' aspects of science, including its method, relevance and social impact.

		Scientific inquiry requires a variety of scientific attitudes, including interest, curiosity, cooperation and interpretation of results based on evidence.
		Scientific inquiries include research ethics and safety precautions such as respect for life, research integrity and respect for intellectual property rights.
	The process of scientific inquiry	Establish a variety of inquiry action plans based on question of inquiry and situation characteristics.
		Scientific inquiry activities consist of finding problems, establishing inquiry activity plans, conducting inquiries and displaying results.
III. Frontier science inquiry	Application of science	Apply science knowledge to life and various situations through scientific inquiry.
		The outputs of science inquiry are shared and spread in various fields such as frontier science and technology.

SIE textbooks are designed in a workbook style that could lead to inquiry activities such as experiments and observations (see Fig. 1). The excerpt shown in Fig. 1 (see the translation) encourages students to become Galileo and figure out the results of the thought experiment from which he discovered the concept of inertia.

The following describes Galileo's thought experiment on an object moving on a slope without friction. Based on Galileo's thoughts, let's figure out the results of a thought experiment.

[Galileo's thought]

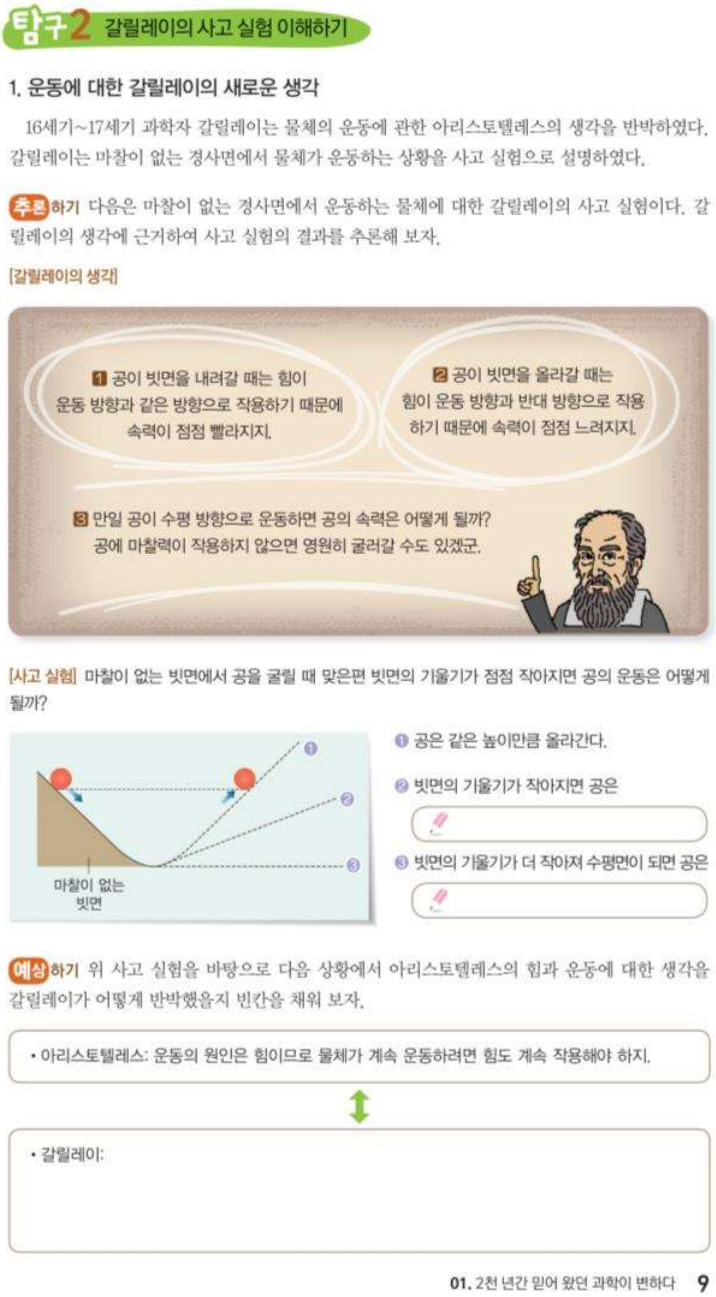
1. When the ball goes down the slope, the force acts in the same direction as the direction of motion, so the ball's speed becomes faster.
2. When the ball climbs up the slope, the force acts in the opposite direction to the direction of motion, so the ball's speed becomes slower.
3. What happens to the speed of the ball if the ball moves horizontally? If there is no friction acting on the ball, it could be rolling forever.

[Thought experiment]

When the ball is rolled on a slope without friction, if the inclination of the opposite side is getting smaller, what will happen to the ball's motion?

1. The ball goes up to the same height.
2. When the slope's inclination becomes smaller, the ball ___________________.
3. When the slope's inclination becomes even smaller and it becomes flat, the ball ___________________.

(Textbook C, p. 9)


탐구2 갈릴레이의 사고 실험 이해하기

1. 운동에 대한 갈릴레이의 새로운 생각

16세기~17세기 과학자 갈릴레이는 물체의 운동에 관한 아리스토텔레스의 생각을 반박하였다. 갈릴레이는 마찰이 없는 경사면에서 물체가 운동하는 상황을 사고 실험으로 설명하였다.

추론하기 다음은 마찰이 없는 경사면에서 운동하는 물체에 대한 갈릴레이의 사고 실험이다. 갈릴레이의 생각에 근거하여 사고 실험의 결과를 추론해 보자.

[갈릴레이의 생각]

[사고 실험] 마찰이 없는 빗면에서 공을 굴릴 때 맞은편 빗면의 기울기가 점점 작아지면 공의 운동은 어떻게 될까?

① 공은 같은 높이만큼 올라간다.

② 빗면의 기울기가 작아지면 공은

③ 빗면의 기울기가 더 작아져 수평면이 되면 공은

예상하기 위 사고 실험을 바탕으로 다음 상황에서 아리스토텔레스의 힘과 운동에 대한 생각을 갈릴레이가 어떻게 반박했을지 빈칸을 채워 보자.

• 아리스토텔레스: 운동의 원인은 힘이므로 물체가 계속 운동하려면 힘도 계속 작용해야 하지.

• 갈릴레이:

01. 2천 년간 믿어 왔던 과학이 변하다 9

Fig. 1 Inquiry activity on Galileo's thought experiment (Textbook C, p. 9)

Among the three chapters, Chapter 1, 'science inquiry in history', particularly focuses on the historical episodes to highlight different NOS aspects while engaging students in the inquiry process that scientists carried out in the past (MOE 2015a). This curricular approach is in line with the research findings that using historical experiments can foster students' NOS understanding as well as their inquiry skills (Höttecke 2000; Kipnis 1998; Mets and Stinner 2006). This use of experiments from the past is a means of contextualizing NOS. While the curriculum explicitly lists the target NOS aspects as achievement standards, in terms of instructional approach, it encourages teachers to engage students in the experimental processes rather than just having teachers explain them (MOE 2015a, p. 115).

Methods

Content Selection

We analysed the seven SIE textbooks authorized by Ministry of Education of Korea. Chapter 1 was chosen for our analysis, since the national curriculum states that the key concept of this particular chapter is NOS (see Table 1). This chapter is designed to help students experience various NOS aspects through four historical episodes: Galileo's thought experiment, Mendeleev's periodic table, Mesozoic mass extinction and Pasteur's biogenesis. A total of 212 pages from the seven textbooks (24 to 34 pages from each) were subjected to analysis. Table 2 shows the achievement standards for each historical episode in the national curriculum.

Table 2 Topics and achievement standards for Chapter 1 (MOE 2015a, p.114, italics added)

Chapter	Topic	Achievement standard
I. Science inquiry in the history	Galileo's thought experiment	Students can understand the crucial experiments in the history of science that led to *paradigm shifts* and can explain the progress of science.
	Mendeleev's periodic table	Students can conduct a historical experiment performed by *serendipitous discoveries* and explain the NOS found in the process.
	Mesozoic mass extinction	Students can conduct inquiry through direct observation and explain the *inductive inquiry method.*
	Pasteur's biogenesis theory	Students can perform historical experiments that employ hypothesizing and explain the features of the *deductive inquiry method.*

Analytical Framework

Erduran and Dagher's (2014) reconceptualised family resemblance approach (FRA)-to-NOS (RFN) was used as theoretical ground for the textbook analysis.

FRA has its origin in Wittgenstein's (1958) philosophy of language, and this concept has recently been rediscovered by several science educators as a theory to explain NOS in terms of similarities and differences among science disciplines (Irzik and Nola 2011). Erduran and Dagher (2014) reconceptualised the theoretical discussion about NOS idea based on Irzik and Nola's (2011, 2014) proposal. In this approach, science is viewed as a cognitive-epistemic (innermost circle in Fig. 4) and social-institutional system (middle and outermost circles in Fig. 4). Table 3 provides a detailed description of the 11 RFN categories.

Fig. 2 FRA wheel: Science as a cognitive-epistemic and social-institutional system (Erduran and Dagher 2014, p. 28)

Table 3 Cognitive-epistemic and social-institutional NOS categories

RFN category	Description (Kaya and Erduran 2016)
Cognitive-epistemic aspects	
Aims and values	The key cognitive and epistemic objectives of science, such as accuracy and objectivity
Methods	The manipulative as well as non-manipulative techniques that underpin scientific investigations
Scientific practices	The set of epistemic and cognitive practices that lead to scientific knowledge through social certification

Scientific knowledge	Theories, laws and explanations that underpin the outcomes of the scientific inquiry
Social-institutional aspects	
Social certification and dissemination	The social mechanisms through which scientists review, evaluate and validate scientific knowledge, for instance, through peer review systems of journals
Scientific ethos	The norms that scientists employ in their work as well as in interaction with colleagues
Social values	Values such as freedom, respect for the environment and social utility
Professional activities	How scientists engage in professional settings such as attending conferences and doing publication reviews
Social organizations and interactions	How science is arranged in institutional setting such as universities and research institutes
Political power structures	The dynamics of power that exist between scientists and within science cultures
Financial systems	The underlying financial dimensions of science including the funding mechanisms

Analytical Procedure

Content analysis was conducted by two researchers. First, we examined in detail all textbook elements such as text, inquiry activities, figures, photographs, sidebars and illustrations to identify whether the sentences that included references to NOS. In this process, we identified to which aspect of the RFN framework an identified sentence as reference to NOS corresponds. Finally, each identified reference to NOS aspects was coded as an explicit or implicit representation. At the same time, we examined whether textbooks present each aspect of NOS, including reflective activity for NOS. An explicit representation of this NOS aspect is a general statement about science (e.g., 'scientific knowledge is tentative'); an implicit representation of this NOS aspect is the presentation of historical cases, activities and so on from which relevant NOS views can be inferred; and a reflective activity is the textbook part that prompts students' understanding of NOS through activities such as explanation, discussion and speculation (e.g., 'discuss why scientists work in collaboration').

The unit of analysis was a sentence. However, when a series of sentences clearly indicated a specific NOS aspect, we coded them into one category. In addition, when two or more NOS representations were included within one sentence, they are coded into multiple NOS categories. To ensure reliability, in the beginning, two researchers independently analysed one randomly selected textbook from seven textbooks. After that, the analysis results were compared, and the differences were discussed until agreement was reached. In the next phase, all seven textbooks were independently analysed by two researchers and then the results were compared and discussed until consensus was reached.

Results

Tables 4 to 7 describe each textbook's representation of NOS aspects in the four historical episodes. In the table, *e* denotes an explicit reference to the target NOS category, and *i* denotes an implicit reference. An asterisk (*) was used to indicate the presence of reflective prompts (questions or student activities) for the NOS aspect being referred to either explicitly or implicitly.

Table 4 NOS representation in the 'Galileo's thought experiment' episode

NOS aspect		Textbook						
		A	B	C	D	E	F	G
Cognitive-epistemic	*Aims and values*	e	-	-	-	-	-	-
	Methods	-	i	-	-	i	-	-
	Scientific practices	e*	i*	e	i	i*	i	e*
	Scientific knowledge	e*	e*	e*	e	e*	e*	e*
Social-institutional	*Social certification and dissemination*	-	i	-	-	-	-	-
	Scientific ethos	-	-	-	-	-	-	-
	Social values	-	-	-	-	-	i	-
	Professional activities	-	-	-	-	-	i	-
	Social organizations and interactions	-	-	-	-	-	-	-
	Financial systems	-	-	-	-	-	-	-
	Political power structures	-	-	-	-	-	-	-

	Other[2]	e*	-	-	-	-	-	-

Table 5 NOS representation in the 'Mendeleev's periodic table' episode

NOS aspect		Textbook						
		A	B	C	D	E	F	G
Cognitive-epistemic	*Aims and values*	e*	-	-	-	e*	e	i
	Methods	i	i	i	i	e*	i	i
	Scientific practices	e*	e*	e*	e	e*	e	i
	Scientific knowledge	i	-	e*	i*	e*	e*	e
Social-institutional	*Social certification and dissemination*	-	-	-	-	-	-	i
	Scientific ethos	-	-	-	-		-	-
	Social values	-	i	i*	-	i	-	-
	Professional activities	-	i	-	-	i	-	-
	Social organizations and interactions	-	i	-	-	i	-	-
	Financial systems	-	-	-	-	-	-	-
	Political power structures	-	-	-	-	-	-	-
	Other	e	-	-	-	-	-	-

The 'Galileo's thought experiment' episode (Table 4) introduces the thought experiment that Galileo carried out to conclude that all falling objects are uniformly accelerated, which led to a paradigm shift in the field of mechanics. Scientific knowledge and scientific practices were represented in all seven textbooks through this historical episode, but the former was given stronger emphasis. Scientific knowledge was represented explicitly in all seven textbooks mostly with reflective activities (six textbooks), while scientific practices was represented explicitly with

[2] This 'other' category was used to refer to generic references to social-institutional NOS (e.g., 'science is socially and culturally affected'), which could not be classified into one of the seven social-institutional NOS categories.

reflective activities in only two textbooks. In other categories, very few NOS references (one or two) were found. An excerpt in textbook F shows an example of an explicit reference to the tentative and revolutionary nature of scientific knowledge, followed by a reflective activity:

> Crucial moments in science come from new experiments and begin with other ideas. A system of theory, methods, and critical minds shared by people in a certain time is called a paradigm. However, when the phenomenon that cannot be explained by the existing paradigm continues to be observed and the contradictions accumulate, a new paradigm emerges to replace the existing paradigm, which is called the paradigm shift . . . Discuss with peer what changes have occurred since Galileo in the paradigm related to moving objects. (Textbook F, pp. 14–19)

On the other hand, textbook F addressed scientific practices and professional activities in an implicit manner. The example below shows how scientific practices such as experimentation contribute to theory formation and aspects that scientists can share scientific knowledge to academia or public through professional activities such as publication of books. However, these NOS categories were only implied with no explicit references or reflective activities.

> Galileo's thought experiments on the fall of an object and his analysis of the motion of a horizontally thrown object are contained in his book *Discourses and Mathematical Demonstrations Relating to Two New Sciences*, published in 1638. In this book, Galileo analysed the motion of objects and concluded as follows. 'At the end of hundreds of experiments, I found that the distance of an object is proportional to the square of the time for which it travelled. In addition, the motion of a horizontally thrown object can be divided into vertical and horizontal motions. At this time, I found out that the movement in the horizontal direction is the same as a constant velocity motion and that in the vertical direction it is the same as a free fall'. (Textbook F, p. 19)

In the 'Mendeleev's periodic Table' episode (Table 5), all seven textbooks represented most of the 11 NOS categories. In addition, it was noteworthy that all four categories of cognitive-epistemic NOS were represented in four textbooks. Methods and scientific practices were represented in all seven textbooks, while providing details about the various method employed by scientists (e.g., Lavoisier, Döbereiner, Newlands, and Mendeleev) in the discovery of the periodic table and explaining that serendipity can lead to the development of science by relentless effort. The nature of scientific knowledge such as the tentativeness was also represented in six textbooks. Aims and values of science were found in four textbooks. In terms of social and institutional NOS aspects, textbooks B and E represented three (social values, professional activities, social organizations and interactions) of the seven social-institutional categories, while other textbooks addressed none or only one of them.

Table 6 NOS representation in the 'Mesozoic mass extinction' episode

NOS aspect		Textbook						
		A	B	C	D	E	F	G
Cognitive-epistemic	*Aims and values*	-	e*	-	-	e*	e	-
	Methods	e*	e*	e*	e*	e*	e*	e*
	Scientific practices	e	i	i*	-	i	i	i
	Scientific knowledge	e	-	-	-	i	-	e
Social-institutional	*Social certification and dissemination*	i	-	-	-	-	-	-
	Scientific ethos	-	-	-	-	-	-	-
	Social values	-	-	-	-	-	-	-
	Professional activities	-	-	-	-	-	-	-
	Social organizations and interactions	i	-	e*	-	-	-	-
	Financial systems	-	-	-	-	-	-	-
	Political power structures	-	-	-	-	-	-	-

Table 7 NOS representation in the 'Pasteur's biogenesis theory' episode

NOS aspect		Textbook						
		A	B	C	D	E	F	G
Cognitive-epistemic	*Aims and values*	-	-	-	-	-	-	-
	Methods	e*	e*	e*	e*	e*	e*	e*
	Scientific practices	i	i	i*	i	i	i	i
	Scientific knowledge	e	i	i	i	-	-	i
Social-institutional	*Social certification and dissemination*	-	-	-	i	-	-	-
	Scientific ethos	-	-	-	-	-	-	-
	Social values	-	-	-	-	-	-	i

	Professional activities	-	-	-	-	-	-	-
	Social organizations and interactions	-	-	-	-	-	-	-
	Financial systems	-	-	-	-	-	-	-
	Political power structures	-	-	-	-	-	-	-

In the 'Mesozoic mass extinction' episode (Table 6), a dominant category was methods. Methods was represented explicitly with reflective activities in all seven textbooks, with details of the inductive inquiry methods used in finding the cause of the Mesozoic extinction event. Scientific practices were represented in six textbooks, only one of which textbook included explicit references like that observations contributed to the growth of scientific knowledge.

'Pasteur's biogenesis theory' episode (Table 7) focused on methods, scientific practices and scientific knowledge of NOS categories. The most central NOS aspect among these three categories was methods. Methods was represented explicitly with reflective activities in all seven textbooks while explaining the deductive inquiry method used in Pasteur's discovery of biogenesis. Scientific practices were represented in all seven textbooks but only implicitly, by addressing that the result of Pasteur's swan-neck flask experiment could be evidence of biogenesis. Scientific knowledge was represented in five of seven textbooks but as mostly implicit approach while presenting tentative aspect of scientific knowledge through the confrontation between biogenesis theory' and spontaneous generation theory.

Overall, one dominant trend that overarches the four episodes was that textbooks tend to concentrate on the cognitive-epistemic aspects of science, while social-institutional NOS is largely underrepresented. In each historical episode, most of the four categories of cognitive-epistemic NOS were addressed, but none or only one of the social-institutional NOS categories were addressed. In particular, there were no references to scientific ethos, financial systems, and political power structures categories—which are gaining increasing importance in recent NOS research (e.g., Erduran and Mugaloglu 2013; Kaya et al. 2018). In terms of the methods of representation, cognitive-epistemic NOS aspects were usually addressed explicitly, often with reflective activities. However, in most instances, social-institutional NOS aspects addressed only implicitly.

Within one episode, the explicit representation and reflective activities were concentrated on one dominant NOS aspect. For example, the episode 'Galileo's thought experiment' addressed the scientific knowledge category in an explicit and reflective manner in most textbooks, but the other categories were addressed only implicitly, or not addressed. These specific NOS aspects was identical to the ones specified as achievement standards in the curriculum (see Table 2).

Discussion

Overall, the analysis revealed both the opportunities and challenges of Korea's new subject SIE in teaching NOS as a separate school subject. First, the NOS representations in the textbooks were concentrated in the cognitive and epistemic aspects of science, while social institutional aspects of NOS were very limitedly represented. This could be partly explained by the fact that the national curriculum itself is composed of achievement standards that mainly concerns epistemic aspects of science. Second, textbooks tended to focus on addressing one central NOS idea in each historical episode, which means that diverse NOS aspects were not represented in a holistic manner. Given that the components of cognitive-epistemic and social-institutional NOS interact with each other dynamically (Allchin 2011; Erduran and Dagher 2014; Hodson 2014), for students' richer understanding of NOS, textbooks should embrace NOS aspects that are as diverse as possible and reveal their dynamic interrelations within each historical episode.

Second, the way SIE textbooks addressed NOS aspects and prompted further reflection on them also carried significant implications. While many studies have reported that the explicit-reflective approach is more effective (e.g., Akerson et al. 2000; Khishfe and Abd-El-Khalick 2002), most textbooks have been reported to lack explicit NOS references and reflective prompts (Abd-El-Khalick et al. 2008; McDonald 2017). In this respect, most SIE textbooks gave students proper opportunities to develop NOS understanding by means of reflective activities. However, this effort was usually limited to the 'focal' NOS aspect emphasized in each historical episode. It would be necessary for textbook authors to include activities that can address multiple NOS aspects in one episode to maximize the NOS-learning potentials of historical episodes.

Finally, the value of implicit NOS references should be mentioned. Although the literature on NOS teaching methods has emphasized an explicit approach, this does not necessarily mean that the NOS given implicitly within historical and social context is useless. Rather, implicit representation to NOS can be an important means of contextualizing NOS by linking the individual's scientific knowledge with the dynamics of human society surrounding the science (Allchin et al. 2014). In order to exploit the learning potential of implicit NOS references, the teacher's role is crucial. For example, while discussing the process where Pasteur presented evidence of biogenesis from his swan-neck flask experiment, in addition to describing each step of the procedure, a teacher can refer to the experimental practice in science by pointing out that 'experimental evidence contributes to the birth of new knowledge by supporting the hypothesis', which is implied in the episode. Along with this, teachers can bring up related NOS prompts such as 'Are there any other ways of supporting the hypothesis other than doing experiments?' 'What was the evidence in favour of spontaneous generation, and what was wrong with those experiments?' These would be good ways to deepen students' understanding about the nature of scientific practice. It is also possible to address the social-institutional aspects of NOS by viewing the idea of biogenesis in connection with the religious and cultural worldview in Europe during Pasteur's time.

Not to mention, NOS is now a classical agenda in science education, with its rich history that spans over 100 years (Lederman 2007). The uniqueness and importance of SIE as a NOS- and inquiry-oriented science education reform lies in giving them 'their own lives', instead of treating them as secondary to scientific content knowledge. Placing NOS and inquiry at the center of the subject, SIE becomes an overture to many curriculum reforms that explicitly address these elements of science education. This means that analysing SIE textbooks is more than mere addition to the voluminous literature on textbooks' NOS representation; it allows us a fresh look to NOS. In this sense, the analysis presented in this chapter will be informative to curriculum-makers and textbook authors around the world in transforming the history and nature of science into curricula and educational materials.

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