ORIGINAL ARTICLE

Comparative Study on HPSS Content in Current and Previous Chinese High School

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***Abstract**: Chinese 2017 General High School Physics Curriculum Standards explicitly include understanding the nature of science (NOS) as core literacy for students. History, philosophy of science, and sociology of science (HPSS) education is an important way to promote students' understanding of the nature of science. In this context, this study analyzed the content of HPSS in two physics textbooks before and after the promulgation of the new curriculum standards using a content analysis method based on the analytical framework of HPSS. The analysis compares the number and copiousness of HPSS content in the current high school physics textbooks published in 2019 and the previous edition of high school physics textbooks published in 2004. The presentation of this HPSS content was also analyzed. It was found that there was an increase in HPSS content in the new edition of the textbook compared to the old edition, mainly a decrease in the history of science content and an increase in both the philosophy of science and sociology of science content. The HPSS content copiousness was low in both the old and new editions of the textbook. Finally, the distribution of the respective sub-dimensions of the HPSS was very uneven.*

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Introduction

IN THE LATEST round of curriculum reform in mainland China, the objectives of the science curriculum have shifted from knowledge and skills, attitudes and methods, and emotional-attitudinal values to developing students' core literacies, and understanding the nature of science (NOS) has been explicitly included as part of the core literacies of the physics subject in the *Physics curriculum standards for senior high school* (Ministry of Education, 2017). The curriculum standards are the main basis for guiding the development of textbook content, and following the promulgation of the 2017 senior secondary physics curriculum standards, a new version of the physics textbook was published and put into use in 2019. In the latest physics textbooks, the representation of the NOS is mostly implicit, with the consensus view of the nature of science being embedded in stories for expression (Zhuang et al., 2021). This is not surprising, as direct descriptions of the NOS can be difficult for teenagers to understand (X. Li et al., 2020). Integrating History, Philosophy and sociology of Science (HPSS) into the science curriculum effectively promotes a better, more comprehensive, and richer understanding of the NOS (Matthews, 1992).

History, Philosophy, and Sociology of Science (HPSS) education examines the social and cultural context in which scientific knowledge is produced, disseminated, and used. This includes exploring the history of science, the philosophical foundations of science, and the sociological factors that shape the practice of science (Zhang, 2017). In 1895, Mach first suggested that 'no science education can be conducted without attention to the history and philosophy of science (Yuan, 2005), and in the following decades there was a debate about the effective integration of the history and philosophy of science (Laudan, 1989). Following the emergence of the sociology of scientific knowledge, there was a growing awareness of the need for the public to be aware of the various social factors in the social formation and construction of science and for HPSS to support science education as a community (Wylie, 1994). A new model of HPSS education was formed by emphasizing the significance of the sociology of science based on the history and philosophy of science (Monk & Osborne, 1997).

Helping students understand the NOS properly has always been an important goal of science education (Lederman et al., 2002). Much of the current understanding of NOS comes from scholarship in HPSS (Abd-El-Khalick, 2012). Initially, the NOS was considered to be related to the philosophy of science, mainly the epistemology, methodology and ontology of science. Later, the NOS network expanded to include the history and philosophy of science, as it was necessary to understand the history of science to study science, and then the NOS network was further expanded to include the sociology of science (Matthews, 2017). There has been an intense debate among scientists and science education researchers about what NOS is and from what perspective it is understood (Abd-El-Khalick et al., 1998; Alters, 1997; Wong & Hodson, 2010). We endorse some of these views, namely, that the HPSS is the basis for developing a consensus view of the NOS and that helping students understand the NOS is the goal of HPSS education (Abd-El-Khalick et al., 1998; Abd-El-Khalick, 2012; Abd-El-Khalick et al., 2008).

In recent years, international science education research has begun to focus more on specific pedagogical content rather than macro-level thinking when it comes to HPSS education (Y. Li & Zheng, 2009). Many papers have focused on issues related to the implementation of HPSS education in the classroom in the context of educational reform (Henke & Höttecke, 2015; Monk & Osborne, 1997). However, textbooks are rarely seen as a key element of educational reform. In school science education, textbooks are often one of the most reliable sources of knowledge for students and teachers, and indeed, the effectiveness of integrating the history of science into science education depends largely on which history of science is used and how it is used (Höttecke & Silva, 2011). Often, physics teachers lack relevant knowledge in the history of science, philosophy of science and sociology of science. As a result, their teaching practice in this area relies heavily on what is in textbooks. Teachers will rely on the content of HPSS in textbooks, how the texts in textbooks portray science, and what ideas about NOS are conveyed by textbooks (Leite, 2002).

Textbooks, as the primary source of instructional content, are an effective way to present NOS implicitly through HPSS as instructional content. Therefore, based on the results of a direct analysis of the scientific nature of physics textbooks, it is meaningful to analyse the differences in HPSS content in the two versions of physics textbooks before and after the introduction of the curriculum standards and to compare the changes. Previous studies of HPSS content in textbooks have mainly examined a particular discipline within the HPSS in textbooks or a particular science story in textbooks (Brush, 2000; Gardner, 1999; Klassen et al. 2012; Leite, 2002; Montgomery & Kumar, 2021; Simon , 2016; Persson, 2018; Lin et al. 2022), this study will simultaneously count the history of science, philosophy of science, and sociology of science in textbooks, bringing together the three disciplines and being able to complement past research and visualise similarities and differences between the three disciplines. Being able to analyse the changes in HPSS content in two versions of physics textbooks will allow us to understand how physics textbooks have changed under the guidance of the new curriculum standards and how teachers should respond to the HPSS content in current textbooks.

Literature Review

HPSS Education

What was needed to better advance students' understanding of the NOS was a greater collaboration between historians, philosophers, sociologists, and science educators in training teachers, developing classroom materials, conducting research, and analyzing textbooks (Matthews, 1989). This integration is of course not the use of HPSS as another thematic curriculum but the wider integration of HPSS themes and pedagogy into the science curriculum (Matthews, 1992).

One key aspect of HPSS education is the study of integrating the history of science into the classroom, which seeks students to understand how scientific knowledge has evolved over time and how it has been shaped by social, cultural, and political factors (Clary & Wandersee, 2015). In some science classrooms, scientific knowledge is often presented to students in a completed form, and students lack an understanding of the history of science and therefore of the processes and laws of development of science (Bybee et al., 1991). Integrating the history of science into the classroom can help students understand the nature of scientific knowledge and how it evolves over time (Abd-El-Khalick & Lederman, 2000; Bybee et al., 1991). By studying the history of science, students can learn about the development of key scientific theories, the scientists who developed them, and the social and cultural contexts in which these theories were developed. This can help students see science as a dynamic and ongoing process rather than a fixed body of knowledge (Abd-El-Khalick & Lederman, 2000; Leite, 2002).

Another important aspect of HPSS education is the study of examining science from a philosophy of science perspective in the science classroom, which focuses on enabling students to analyze science and the development of scientific processes from a philosophical perspective (Zhang, 2017). This includes four senses of philosophy of science that students need to understand: (1) worldview presented by science; (2) scientific investigations of science; (3) investigation of science as a social institution; and (4) analysis of science concepts (Martin, 1972). An important aim of the integration of the philosophy of science into science education is to make better scientists out of those students who will be engaged in scientific research, and it is hoped that students will approach their scientific practice more critically after studying the philosophy of science (Grüne-Yanoff, 2014; Boniolo & Campaner, 2020). By studying the philosophy of science, students will enhance their own pluralistic and critical analysis of science and will be able to constantly reflect on existing scientific theories rather than taking them as the ultimate truth (Matthews, 2009).

Integrating the sociology of science into the science classroom is another key component of HPSS education, which examines the social factors that shape the practice of science, including the roles of institutions, power dynamics, and cultural values (Zhang, 2017). This includes studying the ways in which scientific research is funded, conducted, and disseminated, as well as the social and cultural impacts of scientific knowledge and technology (Kelly et al., 1993). The inclusion of the sociology of science in science education can illuminate the social nature of scientists in the construction of scientific theories and will undoubtedly lead to a new understanding of science as students learn about the social context of science (Kelly et al., 1993). Past research has found that the integration of the sociology of science into the curriculum can benefit students by

"*(1) preparing all students for the problems and decisions they will face in our increasingly science-dependent society; (2) engendering more interesting and accurate views of science; (3) attracting, interesting, and retaining more students in science, especially women and minorities; and (4) encouraging students to explore new methods and problem spaces"* stated by Cunningham & Helms (1998, p.497).

Overall, HPSS education is important because it helps students understand the complexity and diversity of scientific knowledge and the ways in which it is shaped by social and cultural factors. It also promotes critical thinking and encourages students to consider the ethical and social implications of science and technology.

HPSS Context in Science Textbooks

Over the past few decades, the HPSS has been recognized as an important and valuable addition to science education, and as such, analyzing the HPSS content in science textbooks has been a topic of interest for scholars (Vojíř & Rusek, 2019).

In an early study, researchers began to examine the content of HPSS in science textbooks; for example, Brush (2000) qualitatively examined 28 American college physics textbooks. He found that some of the historical facts of modern physics had been ignored and distorted in these textbooks (Brush, 2000). Two recent papers have also qualitatively discussed the relevant history of science in physics textbooks (Montgomery & Kumar, 2021; Simon, 2016). Both Montgomery & Kumar (2021) and Simon (2016) advocate that physics textbooks should present historical information to help students understand the process of scientific inquiry. Rather than analyzing the history content throughout the textbook, Persson (2018) focuses on the history of Planck's blackbody radiation equation in physics textbooks. He found that the history of science in textbooks did not follow the development of history but presented physical concepts as a result of an incorrect historical context, and such descriptions were not conducive to students' understanding of the NOS (Persson, 2018). In addition to the qualitative analysis, researchers began to quantitatively study the content of the history of science in physics textbooks. For example, Leite (2002) developed an analytical framework with eight dimensions: (1) Type and organization of the historical information, (2) Materials used, (3) Correctness and accuracy of the historical information, (4) Contexts to which the historical information is related, (5) Status of the historical content, (6) Learning activities dealing with the history of science, (7) Internal consistency of the book, and (8) Bibliography on the history of science (Leite, 2002). Leite (2002) selected five Portuguese secondary school physics textbooks for the study, which showed that the history of science content in these textbooks was not sufficient to give students a good understanding of how science has developed and how scientists work. Twenty years later, Lin et al. (2022) used this framework to analyze the history of science in six Chinese high school physics textbooks. However, Lin et al. (2022) removed "Correctness and accuracy of the historical information" from the original framework because they believe that Chinese textbooks have undergone multiple reviews by different authorities to ensure the scientific correctness of the content. They found that the history of science in Chinese textbooks was too monotonous and rigid, lacking in imagery and authenticity (Lin et al., 2022).

Some studies analyze the origin and development of a concept in a textbook from the perspective of the history and philosophy of science. These concepts include the "Photoelectric Effect" (Klassen et al., 2012; Niaz et al., 2010), "Structure of the Atom" (Farías Camero et al., 2012; Justi & Gilbert, 2000; Niaz, 1998; Niaz & Coştu, 2009), "Covalent Bond" (Niaz, 2001), "Oil Drop Experiment" (Niaz, 2000b; Rodríguez & Niaz, 2004), "Periodic Table" (Brito et al., 2005), and "Kinetic Molecular Theory of Gases" (Niaz, 2000a). These studies usually develop a number of evaluation criteria for a concept based on the theoretical framework of the history and philosophy of science. For example, Klassen et al. (2012) have developed four evaluation criteria for the photoelectric effect: (1) Einstein's Quantum Hypothesis to Explain the Photoelectric Effect, (2) Lack of Acceptance of Einstein's Quantum Hypothesis in the Scientific Community, (3) Millikan's Experimental Determination of the Einstein Photoelectric Equation and Planck's Constant, and (4) Millikan's Presuppositions About the Nature of Light, with four levels for each evaluation criterion (Excellent, Satisfactory, Mention, and No Mention). They analyzed 38 laboratory textbooks based on these criteria and found that these physics textbooks were at best at a satisfactory level and that the vast majority of them stayed at the No Mention level (Klassen et al., 2012). The results of other studies are similar in that details of the history and philosophy of science are often omitted from science textbooks (Niaz, 1998, 2000b, 2001; Niaz et al., 2010; Niaz & Coştu, 2009; Rodríguez & Niaz, 2004).

There are also some studies that analyze other related topics from the perspective of the HPSS, such as the scientific method (Blachowicz, 2009), the relationship between science and technology (Gardner, 1999), and the gender of scientists (Laçin-Şimşek, 2011). Overall, current research has analyzed the content of HPSS in science textbooks in both quantitative and qualitative ways; however, most of these analyses have focused on a particular concept or aspect of HPSS and lack an analysis of the book as a whole from the perspective of HPSS as a whole. We believe that HPSS is a holistic concept and therefore it makes sense to be addressed as a whole, but history of science, philosophy of science, and sociology of science can each be a separate discipline, and therefore we want to use a set of criteria to measure the content of HPSS in textbooks, and in particular, to understand the similarities and differences of the three disciplines of, the history of science, the philosophy of science, and the sociology of science in textbooks, which will be beneficial to help researchers to have a more all-encompassing understanding of the content of HPSS in textbooks.

Research Questions

Previous studies on HPSS content in physics textbooks have mainly focused on a particular concept or aspect of HPSS (Brush, 2000; Gardner, 1999; Klassen et al., 2012; Leite, 2002; Montgomery & Kumar, 2021; Simon, 2016; Persson, 2018; Lin et al., 2022). The three disciplines of history of science, philosophy of science and sociology of science are often discussed together because of their close relationship, making it necessary to analyze physics textbooks from a holistic perspective. In previous studies, the content of HPSS in physics textbooks has been mostly unsatisfactory. Interviews with textbook editors revealed that curriculum standards are an important factor in the variation of HPSS content in textbooks (Ma & Wan, 2017). Given that understanding the NOS is explicitly stated as core literacy in physics in China's 2017 high school physics curriculum standards, it is important to analyze the HPSS content in the two editions of physics textbooks before and after the promulgation of the curriculum standards.

RQ1: What is the number of HPSS content in physics textbooks after the implementation of the new curriculum standards? How has it changed from the old physics textbooks?

RQ2: What is the copiousness of HPSS content in physics textbooks after the implementation of the new curriculum standards? How did it change from the old version of the physics textbook?

RQ3: What is the presentation of HPSS content in physics textbooks after the implementation of the new curriculum standards? How has it changed from the old version of the physics textbooks?

Method

This study used content analysis to first develop a list of HPSS content categories based on existing research, then categorized and coded textbooks for content related to HPSS education.

Materials

In this study, the Physics textbooks published by People's Education Press in 2019 were selected as the sample of current textbooks (CT) after the introduction of the new curriculum standards, The textbooks published by the People's Education Press have been approved by the national primary and secondary school textbook authorization committee. Books 1, 2, and 3 of the high school physics textbooks published in 2019 have been chosen because the content in these three textbooks is compulsory for all students, not just those who will work in science and technology in the future. Therefore, it is important to analyze these three volumes of physics textbooks. The physics textbooks published by People's Education Press in 2004 were selected as the sample physics textbooks before the introduction of the new curriculum standards. As the chapter structure of physics textbooks varied from period to period, six volumes of the 2004 edition of the Renminbi version of the general high school physics textbooks (later referred to as the previous textbooks (PT), including the corresponding chapters of Book 1, Book 2, Book 3-1, Book 3-2, Book 3-4 and Book 3-5, which corresponded to the scope of knowledge in the 2019 edition of the textbooks, were selected for this study.

Analytical Framework

The analytical framework used in this study was developed based on the structural diagram of science meta-knowledge systems proposed by Professor Zhang (2017), in which HPSS education corresponds to the structure of the science education system. Based on relevant studies (Matthews, 2018; Vesterinen et al., 2014; Zhang, 2017), the conceptual definition of HPSS education and the actual situation in physics were adapted to define the analytical framework for the HPSS content of this study. To make the analytical framework suitable for textbook analysis, three scholars in science education (including a Ph.D. supervisor) discussed it in several rounds and finally defined it as **Table 1**.

Table 1. Analytical Framework of the HPSS.

Categories	Sub-categories	Working definitions
History of Science	The evolution of physical concepts, principles, and laws	Describe the historical context of the changing connotations and development of certain concepts, ideas, and laws in the discipline of physics.
	The laws of science and technology occurrence and development	Describe the historical context of the process of the creation, change, and development of science and technology.
	Significant technical achievements related to physics	A description of the major achievements and technical accomplishments made in the history of physics.
	The evolution of the approach to the science	Describes the historical context of the scientific method used in physics and the process of change and development of paradigms.
	Scientific thought and scientific spirit	Describes the historical content that embodies scientific thought and the spirit of science, including the life of the physicist.
Philosophy of Science	Discussion on the nature of science	Directly describe what scientific knowledge is in the content or explicitly discuss what science is about.
	Scientific and logical structure	Direct describes the existing science are not purely objective but are mixed with subjective elements.
	Scientific epistemology and methodologies	Direct describes the philosophical epistemology and methodology of human knowledge of science.
	Acquisition and testing of scientific knowledge	Direct describes the scientific knowledge created by humans in dynamic practice, something that can be predicted and inferred and can be verified in practice.
	The laws of growth in scientific theory	Direct describes scientific knowledge as the result of an accumulation over time, which does not remain constant but is in a process of relatively absolute evolution.
Sociology of Science	The impact of science and technology on society	Describe the various types of impact of science and technology on the productive life of society.
	The social responsibility of science and technology	Describe the need for science and technology to take on social responsibility, including social security and sustainable development.
	The impact of social activities, and social decisions on science and technology	Describe the place and role of social factors, such as political, economic, cultural, faith, and even religious and personal emotions, in the development of science.
	Social issues related to science and technology	Describe issues in society as they relate to science and technology.

It is undeniable that there is an overlap between the history and philosophy of science, and that much of the philosophy of science is implicitly expressed in the history of science (Reiss, 2020). We are more cautious about coding the philosophy of science, instead of coding philosophical ideas that are hidden in scientific stories, we coded only those sentences that explicitly referred to, for example, expressions such as the epistemology of science and the nature of science. Here is an example of coding, described in a paragraph in CT-Book1.

After using logical reasoning to show that heavy and light objects fall equally fast, Galileo did not stop there but further investigated the laws of free-fall motion through experiments.

While it is also evident in this passage that scientific knowledge is acquired through practice, it is not an explicit expression of a passage that focuses on Galileo's ongoing verification of the laws of free-fall motion, and thus we encode it only as a history of science, not a philosophy of science.

Counting only the quantity of HPSS content is insufficient, as some content contain very rich information, such as using images, tables, and long paragraphs to describe a historical story. In contrast, other content might only include a simple sentence describing basic information about a scientist. This study also developed coding rules for analyzing the copiousness of HPSS content in past editions of textbooks versus new editions of textbooks. Copiousness in the context of this study refers to the richness and depth of information presented in textbook content. This is measured by various elements, including text length, the inclusion of images, tables, and student activities.

(1) The length of the text usually determines the amount of information it contains. In physics textbooks, a complete sentence of HPSS content is typically around 25-30 words. In textbooks, only a single sentence or two very simple descriptive sentences will fall below 50 words. Therefore, this study uses 50 words as the standard to distinguish whether the text is rich in information. (2) Content that includes images is assigned an additional point because images can convey complex information more effectively and enhance understanding. However, the number of images does not entirely reflect the amount of information covered; thus, even if multiple images appear in a section, only one point is added in this study. (3) Including tables in the content also adds an extra point, as tables organize information in a structured manner that aids in comprehension and analysis. Similarly, even if multiple tables appear in a section, only one point is added in this study. (4) Student activities actively engage learners and often include practical applications of the content, enriching the learning experience. Likewise, even if multiple student activities appear in a section, only one point is added.

The final scoring rules for content copiousness are determined as follows:

- The text under 50 words +1 point
- Text over 50 words +2 points
- Content containing images +1 point
- The table included in the content + 1 point
- Student activities included in the content +2 points

The way in which the content is presented is partly a reflection of the importance attached to the content. In Chinese physics textbooks, content is typically presented in three formats: Main body, Column, Note. The main body is always present, describing the primary content of each chapter. Depending on the learning material, the textbook selectively includes various columns, which may consist of reading materials, exercises, and other resources. If additional information is needed to enhance understanding of

Table 2. The Results of the Reliability Test.

	Published in 2019	Corresponding chapters publish in 2004
Book 1	0.83	0.84
Book 2	0.86	0.87
Book 3	0.86	0.85

the content in the main body or columns, a note is added alongside to provide supplementary explanations.

(1) Main Body, which contains the essential material that students must read in class, indicating that the content in this section is given the highest priority.
(2) Columns, of which there are various types, each designed for optional student use, meaning that the content in these columns might be covered in class.
(3) Notes, which are supplementary explanations of the content in the Main Body or Columns. Notes are intended for optional student reading after class, implying that the content in this section is generally given the least priority.

Analysis Procedures

The two encoders used in this study consisted of two master's students. In the first step, under the guidance of a physics education specialist, the two encoders discussed the analytical framework and coding details. In the second step, they selected the first section of the new version of the Compulsory 1 Physics textbook for precoding and compared the results produced by the different encoders to ensure consistency of coding practices between them. In the third step, they precoded both old and new versions of the Compulsory 1 physics textbook and analyzed the results for reliability. In the fourth step, each encoder analyzed and coded all textbooks independently. The coding reliability was checked again. Finally, the two encoders and the physics education specialist discussed each item analyzed. Differences between the analyses of the encoders were analyzed and discussed until a consensus was reached between the researchers.

Coding reliability referred to the content analysis reliability formula proposed by (K. Li & Xie, 1990), and the stability coefficient R was used as the reliability of this category list; the higher the value of stability R, the higher the reliability of the category list. The reliability of the textbooks analyzed was all at an acceptable level, and the reliability test results are shown in **Table 2**.

Table 3. Number of HPSS Contents of Current and Previous Physics Textbooks.

Book		History of Science		Philosophy of Science		Sociology of Science		Total
		Number	Percentage	Number	Percentage	Number	Percentage	Number
CT-Book1		21	41%	13	26%	17	33%	51
PT-Book1		25	51%	8	24%	16	36%	49
CT-Book2		29	39%	21	28%	24	33%	74
PT-Book2		30	48%	14	23%	18	29%	62
CT-Book3		28	42%	13	20%	25	38%	66
PT-Book3		32	51%	12	19%	19	30%	63
Total	PT	78	41%	47	25%	66	34%	191
	CT	87	50%	34	20%	53	30%	174

Results

In order to answer the research question, this study describes the amount of HPSS content as well as Copiousness in physics textbooks before and after the promulgation of the new curriculum standards through quantitative data analysis.

Overview of HPSS

Table 3 summarizes the amount of HPSS content in current and previous physics textbooks, with statistics on the percentage of each of the three HPSS disciplines.

As shown in **Table 3**, the CT shows a small increase in the amount of HPSS content compared to the previous physics textbooks, with all physics textbooks analyzed combined increasing from 174 to 191 HPSS content. The largest increase in HPSS content occurred in Book 2, with 12 additions. Unlike the general changes, the history of science is less represented in current textbooks than in previous textbooks, with Book 1, Book 2, and Book 3 having fewer corresponding chapters in older textbooks. The changing trends in the philosophy of science and the sociology of science are similar, both in total and per physics textbook, with the number of current textbooks being greater than the number of previous textbooks.

The amount of sociology of science content has increased in Book 2 and Book3, from 18 to 24 and 19 to 25, respectively. The current textbooks have added several questions on social activities related to science and technology, and the current textbooks incorporate these questions into exercises for students to discuss.

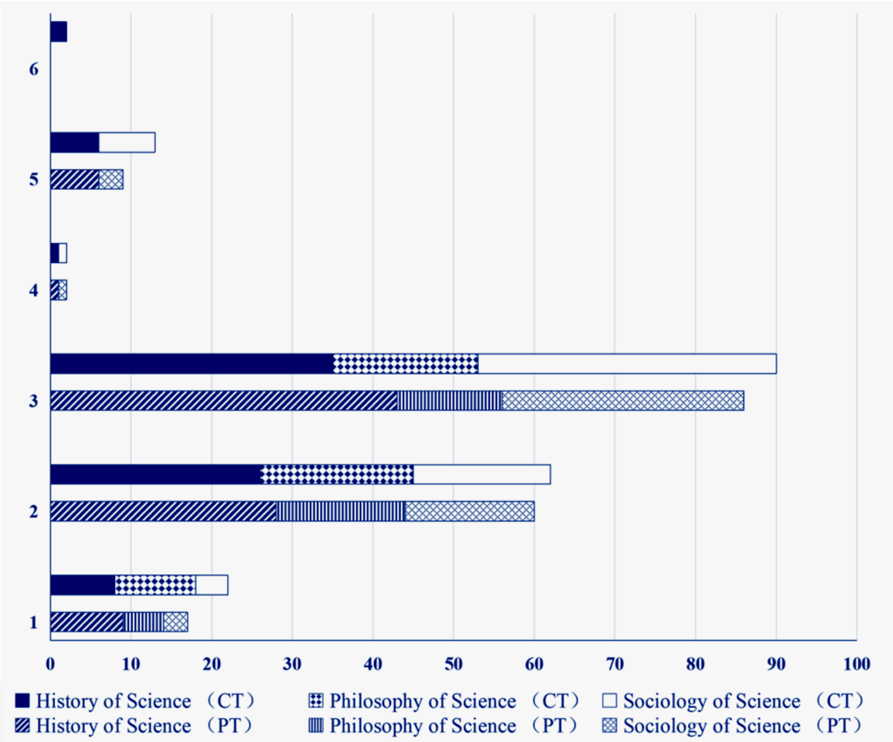

Figure 1. Copiousness of HPSS Contents of Current and Previous Physics Textbooks.

In terms of the proportion of the total in the three disciplines, the trend is similar in all three books; the content of the history of science is declining as a proportion of the total, and the content of the philosophy of science and sociology of science is increasing as a proportion of the total. In total, the current physics textbooks still have the highest percentage of the history of science content, but the percentage has dropped from 50% in the past to 41%. In contrast, the current physics textbooks, although still the smallest in terms of the philosophy of science, have increased their share, from 20% in the past to 25%. This trend is reflected in all three books, particularly in Book 2, where the difference between the history of science, the largest component, and the philosophy of science, the smallest component, is only 11%.

The HPSS content of copiousness of CT and PT is presented in **Figure 1**.

As shown in **Figure 1**, the HPSS content Copiousness of both CT and PT is mainly concentrated in two to three scores, and comparing the HPSS content Copiousness of CT and PT, it can be seen that there is no significant difference between CT and PT in terms of overall content

Copiousness. Focusing on each content, the content of two scores mainly consists of plain text with more than 50 words, while the content of three scores mainly consists of plain text with more than 50 words and images. Only 2 elements were achieved with a score of 6, and both were history of science in CT. Comparing the content of History of Science, Philosophy of Science, and Sociology of Science, it can be noticed that Copiousness is higher in History of Science and Sociology of Science than in Philosophy of Science.

The total number of history of science content in CT is less than that in PT, but the number of history of science content with Copiousness scores of 5 and 6 is more in CT than in PT, the number of history of science content with a Copiousness score of 4 is the same in CT as in PT, and the number of history of science content with a low level of Copiousness scores of 3, 2, and 1 is greater in PT than in CT. The most notable were the two history of science cases with a Copiousness score of 6 in CT, one of which was in p50-p53 of CT-Book1, which contained a total of over 50 words describing the process of Galileo's investigation of the motion of free-fall, several images related to the principle of free-fall, a table of the acceleration of gravity around the world, and a table that required students to measure the acceleration of gravity using a modern tool (smartphone) to measure the acceleration of gravity and compare it to Galileo's idea of measuring the acceleration of gravity.

The highest Copiousness of Philosophy of Science content in both CT and PT only went up to a score of 3. There was more Philosophy of Science content with a Copiousness of 3, 2, and 1 in CT than in PT, and the largest increase was in content with a Copiousness of 1. There was twice as much Philosophy of Science content with a Copiousness of 1 in CT (Number = 10) was twice as high in CT as in PT, and most of this increased Copiousness score of 1 Philosophy of Science content was some additional information to the learning content, usually one or two short sentences. One such case is in CT-Book 3, p4, which expresses the philosophical methodology of human understanding of scientific knowledge in an annotated form next to the introduction of the law of conservation of charge.

The search for conserved quantities is one of the most important methods of physics in the study of the material world, and it often leads to the revelation of objective laws hidden behind physical phenomena.

The number of science sociology with a Copiousness score of 4 in CT and PT is the same as in PT, which is 1 item, and the number of science sociology with a Copiousness score of 1, 2, 3, and 5 is greater in CT than in PT. There are 4 more items of science sociology content with a Copiousness score of 5 in CT than in PT, and there are 7 more items of science sociology content with a Copiousness score of 3 in CT than in PT. Sociology content CT has 7 more items than PT, these 3-point science sociology are some

Table 4. Presentation of HPSS Contents of Current and Previous Physics Textbooks.

		History of Science		Philosophy of Science		Sociology of Science		Total	
Presentation	Book	Number	Percent	Number	Percent	Number	Percent	Number	Percent
Note	CT	11	14%	18	38%	0	--	29	15%
	PT	12	14%	8	24%	0	--	20	12%
Column	CT	24	31%	15	32%	34	52%	73	38%
	PT	28	32%	10	29%	22	42%	60	34%
Main Body	CT	43	55%	14	30%	32	48%	89	47%
	PT	47	54%	16	47%	31	58%	94	54%

illustrated content, one of the more special is the content in p105 of CT-Book1, which has the same textual description in p91 of PT-Book1, it is an exercise on the civil airliner escape airbags, in CT-Book1, in addition to the textual description there is also attached a picture of the real thing to make the content richer.

The HPSS content of the Presentation of CT and PT is presented in **Table 4**.

As shown in **Table 4**, CT and PT have some similarities in the presentation of HPSS content; the most HPSS content in both CT and PT appears in Main Body, followed by Column, and the least in Note. CT and PT are a little different in the specific proportion of HPSS content, the proportion of HPSS content in Note and Column is more, and the proportion of HPSS content in Main Body is less for CT than PT. The proportion of HPSS content appearing in Note and Column is greater for CT than for PT, and the proportion appearing in Main Body is less for CT than for PT.

The amount of history of science content presented in CT and PT is the same, with Main Boby more than Column more than Note, and more than half of the content is presented in Main Body.

In PT, 47% of the philosophy of science content is presented in the Main Body, while 38% of the philosophy of science content in CT is presented in Note. It can be found that CT is presented in the form of a note adds explicit philosophical thinking to the original content on the history of science. For example, in previous textbooks, the scientific history of the establishment of the law of universal gravitation is described in detail. In the current textbook, the author adds a text in the form of a note next to these histories of science,

Scientific arguments need to be supported by evidence. Kepler’s law of motion of the stars, based on the observations of Tycho, supported the law

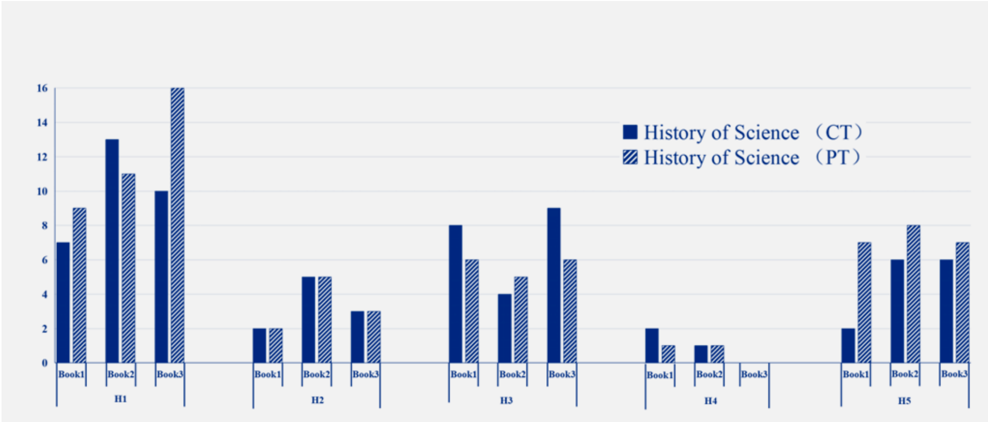

Figure 2. Number of History of Science Contents of Current and Previous Physics Textbooks.

of universal gravitation by the law of planetary motion, and the "Moon-Earth test" further validated the law of universal gravitation.

Neither the CT nor the PT has any of the Sociology of Science content in Note form, whereas the percentage of Sociology of Science content in Column form in the CT has increased by 10 percent compared to the PT, and this content is more in the form of exercises, where several questions on social activities related to science and technology have been added to the CT and incorporated into the exercises for student discussion. For example, on p123 of CT-Book 3, there is an exercise:

Welding operations produce welding arc light, which is harmful to humans. The welding arc temperature is 3,000℃ and radiates a large number of electromagnetic waves with a frequency of 1.0 × 10^{15} Hz. Which type of electromagnetic wave does it belong to, judging by its wavelength? Why is it necessary for welders to wear professional protective helmets when working?

Sub-categories of History of Science

The amount of content in textbooks for the five sub-dimensions of the History of Science is presented in **Figure 2**.

As can be seen from **Figure 2**, the distribution of History of Science content across the five dimensions is similar in CT and PT.

H1: The evolution of physical concepts, principles, and laws has the most items in the five dimensions of the History of Science in both CT and PT, with 30 and 36 items, respectively. They are often placed alongside textbook explanations of concepts, such as in Book 1 when explaining the calculation of the coefficient of elasticity of a spring, it is mentioned that

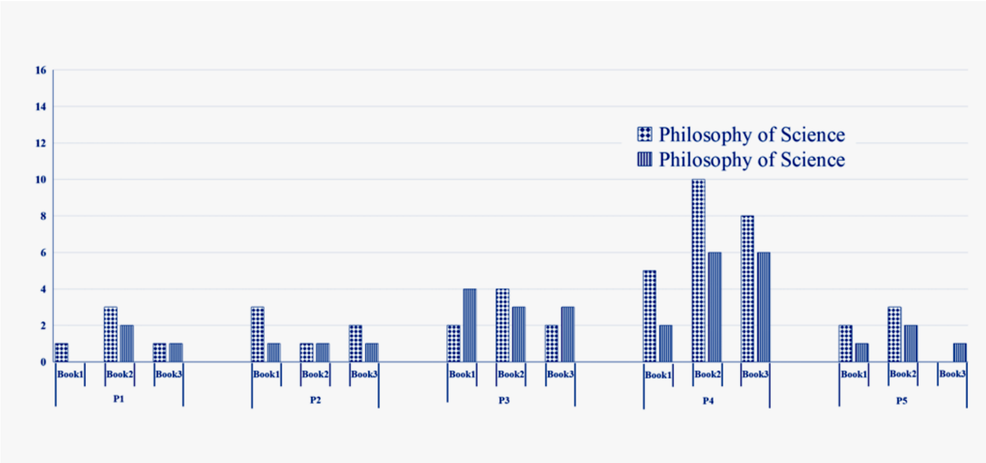

Figure 3. Number of Philosophy of Science Contents of Current and Previous Physics Textbooks.

The law F = kx was discovered by the British scientist Hooke.

In PT H5: Scientific thought and scientific spirit has the second highest number of items among the five dimensions of the History of Science, but in CT the number of items in this dimension drops drastically, especially in Book 1, from seven items in PT-Book 1, to CT- two items in Book1. The main reason here is that some scientists' biographies have been removed.

Although the amount of history of science in CT is generally less than that in PT, the amount of content in H3: Significant technical achievements related to physics is more in CT than in PT, and the amount of content in H3 is more in both CT-Book1 and CT-Book3 than in PT. These contents introduce some scientific and technological achievements and their development history, for example, p126-p127 of CT-Book3 describes in detail the development history of the radio telescope FAST and its impact on the scientific community.

The number of H2: The laws of science and technology occurrence and development in CT and PT are the same. These contents have not been changed much in telling the laws of science and technology occurrence and development.

In both CT and PT, H4: The Evolution of the Approach to the Science has the least amount of content among the five dimensions, especially Book 3, which has no relevant content in both CT and PT

Sub-Categories of Philosophy of Science

The number of contents of the five sub-dimensions of Philosophy of Science in the three books is presented in **Figure 3**.

As can be seen in **Figure 3**, the distribution of Philosophy of Science content across the five dimensions is similar in CT and PT.

P4: Acquisition and testing of scientific knowledge is the most frequent item among the five dimensions of Philosophy of Science in both CT and PT, with 23 and 14 items respectively. The content of this section mainly emphasizes the fact that scientific knowledge is acquired from practice, so it often appear in the laboratory activities section of textbooks, for example, in the first section of CT-Book1 that consists entirely of experimental activities, Experiment: Investigating the Laws of Speed of a Cart as a Function of Time, it is written in the form of a comment that

The laws of physics cannot be obtained by thinking alone, but should also be devoted to observation and experimentation.

The other four dimensions of the philosophy of science in CT and PT have a small amount of content, 0-3 places in each book. It is worth mentioning that P2: Scientific and logical structure than in CT-Book1 has 2 more places than in PT-Book1, and in CT-Book3 has one more place than in PT-Book3, which is the dimension with the most additions except P4. This section reflects the subjective nature of science, for example CT-Book1 p125 has a note on Planck's constant

Planck's energon hypothesis was a breakthrough in the ideas and concepts of classical physics that even Planck himself was hesitant to accept, and most physicists of the time naturally had difficulty accepting it.

Sub-Categories of Sociology of Science

The number of contents of the five sub-dimensions of the Sociology of Science in the three books is presented in **Figure 4**.

As can be seen from **Figure 4**, the four dimensions of the sociology of science are unevenly distributed in both CT and PT, with S1: The impact of science and technology on society being the most numerous items in both CT and PT, with 29 and 24 items respectively. S4: Social issues related to science and technology had 23 and 20 items in CT and PT respectively. These two sub-dimensions of the sociology of science have some similarities in content, but S1 refers to the fact that science and technology have impacts on human society that do not necessarily create social issues. S4, on the other hand, refers to a social problem that is related to science and technology, where the relationship between science and technology and the social problem is merely one of correlation, not one-way influence.

S3: The impact of social activities, and social decisions on science and technology is the same in CT and PT, both have only 1 place, it is about

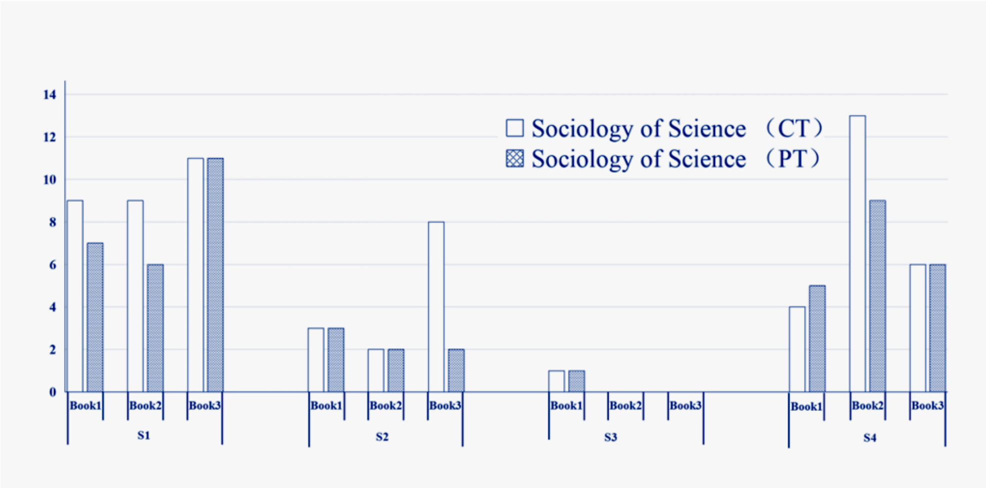

Figure 4. Number of Sociology of Science of Current and Previous Physics Textbooks.

the impact of the social context in which Faraday lived on his subsequent scientific achievements

In PT, this story is described as:

Faraday was born in England to a family of blacksmiths... Faraday lived at a time when the first industrial revolution was being completed. The application of the steam engine gave birth to the great capitalist industries, mankind entered the age of industrial civilization, and the prospect of the application of electricity was beginning to emerge; it was a time when giants were needed and produced. Faraday was born at the right time ……

The story has been retained in CT, and a sentence has been added.

At the time, Britain was at the forefront of scientific, technological, and industrial development.

The original content already contained society's need for technology, and this added information complements the current state of accumulated technology in society at the time of Faraday's discovery of the phenomenon of electromagnetic induction.

Discussion

The results of this study reveal the situation of HPSS content in CT and, by comparing it with PT, some differences in HPSS content in physics textbooks after the introduction of the new standards. Based on the statistical results, we would like to have some discussions on the writing of HPSS content in textbooks and teachers' use of HPSS content in textbooks.

The amount of HPSS content in CT tends to be balanced, but Copiousness did not improve significantly.

The number of HPSS contents in CT increased compared to PT, and the number of the three contents of history of science, philosophy of science, and sociology of science in CT was more evenly distributed, with only two places of difference between history of science and sociology of science, and the proportion of philosophy of science contents increased from 25% to 30%. The HPSS educational model is a holistic concept to execute the function of science education with the coexistence of history of science, philosophy of science, and sociology of science. The similar proportion of the three HPSS content items in CT textbooks can draw students' sufficient attention to these three items. CT's choice of HPSS content is more reasonable than the PT in which nearly half of the content is history of science, and the reduction of the proportion of history of science does not mean that the importance of history of science decreases, but on the contrary, through the supplementation of philosophy of science and sociology of science, students can better understand these historical materials of science. In particular, the CT's addition of several philosophies of science annotations alongside the history of science stories will allow students to approach the history of science in physics textbooks not only by simply reading a historical story but also by hoping to derive methods of scientific inquiry from this historical fact of science.

Although the three main dimensions of the history of science, philosophy of science, and sociology of science are somewhat balanced, the sub-dimensions under each main dimension, CT, still appeared to be highly unbalanced, as did PT. The evolution of the scientific method continues to be very low in number in the CT, which may not be conducive to students' understanding of science, especially the paradigms of scientific research, and may create a false perception in students' minds that the scientific method is fixed and complete. Almost all of the Philosophy of Science section gathers on the fact that scientific knowledge is gained through practice, which can be helpful for students to focus on the importance of experimentation in science, but the insufficient number of several other dimensions of the philosophy of science is not conducive to the development of a complete understanding of the nature of science. In the sociology of science section, the section on the influence of social factors on science is missing in several books, which may allow students to continue to maintain the plain idea of the nature of science as objective.

Unfortunately, the Copiousness of the vast majority of HPSS content in the CT did not change from the PT, except for individual HPSS content that was able to achieve a score of 6. The lack of student activities is one of the reasons for the low Copiousness of the HPSS content, which may lead teachers and students to read this part of the textbook only as reading material without thinking deeply about the meaning. The Copiousness of Philosophy of Science is the lowest among the three items, and the Copiousness of all the contents is below 3. Many of the contents of Philosophy of Science added in the CT are only 1. In future revisions, it may be possible to consider increasing the Copiousness of the contents of HPSS, which will help to increase the attention and interest of teachers and students to the contents of HPSS in the textbook.

Teachers should make full use of the HPSS content in textbooks and supplement them with additional reading materials as appropriate.

Through the study of HPSS content in physics textbooks, students can better perceive the content of the textbooks in the context of the development of science and their own lives, which plays an important role in students' understanding and mastery of knowledge.

Teachers should make full use of the HPSS content in teaching, not only explaining the part of the text and ignoring some notes or columns. The HPPS content in CT has increased compared with that in PT, and many of them are in the form of columns or notes to expand the content, so teachers should selectively explain or allow students to understand some of the HPSS content in class according to the actual situation of the students and the focus of the HPSS content in the new edition of the textbook. Teachers should selectively explain some of the HPSS content in class or let students read it after class according to the actual situation of the students they teach and the focus of the HPSS content in the new textbook, so as not to waste these valuable teaching materials.

Teachers can supplement some HPSS contents according to the actual needs of teaching. Previous studies have pointed out the lack of detail of HPSS content in physics textbooks (Brush, 2000; Klassen et al. 2012; Niaz et al. 2010, Montgomery & Kumar, 2021; Simon, 2016). For the history of science, textbooks appear more often with concepts, principles, and laws related to the history of science and the development of scientific and technological achievements related to the history of science and technology, and when explaining the history of concepts, principles, and laws appearing in textbooks, it would be helpful to add some concepts that have been disproved in the year they were able to be recognized with a reasonable It would be extremely helpful for students to know about NOS and to have a deeper understanding of these concepts, principles, and laws. The development of technology is rapid. When explaining the scientific and technological achievements appearing in textbooks, it is necessary to consult the relevant information in advance and supplement students with the development process and the latest progress of these scientific and technological achievements in the course of teaching. For Philosophy of Science, the new textbook emphasizes the description of the Acquisition and testing of scientific knowledge, which is helpful for teachers to emphasize the importance of experimentation in science learning. CT has also added some content on scientific methodology so that teachers can let students discuss how to apply what they have learned in their teaching. For the sociology of science, CT attaches great importance to the discussion of the relationship between science and society. Teachers can add social hotspots to their teaching, and cultivate students' ability to use their physical knowledge to solve practical problems.

Conclusions

Overall, this study provides us with a picture of the changing nature of HPSS content in physics textbooks and efforts to improve students' understanding of NOS. The results of the study highlight the importance of integrating HPSS education into the science curriculum and the need for continuous assessment and improvement of textbook content to enhance Copiousness in science education. We analyzed the HPSS content in CT and PT using content analysis. One of our study was that the amount of HPSS content in CT increased compared to that in PT, mainly a decrease in the amount of history of science content, with philosophy of science content and sociology of science content both increasing. Finding two is that HPSS content copiousness in CT is consistent with PT as a whole, with the philosophy of science having the lowest copiousness. Finding three is that the sub-dimensions of the HPSS are very unevenly distributed and have their focus in the CT, but may leave students with a lack of understanding of some parts of the NOS.

Limitations and Opportunities for Further Research

Given the limitations of this study, there are two issues to consider when revealing the results. Firstly, there is the issue of the analytical framework; there is a close connection between the historical, philosophical, and sociological sciences, which is why they are discussed together (Zhang, 2017). Coding and discussing them separately in this study may have fragmented the relationship between the three to some extent. In future research, consideration could be given to developing an analytical framework that deeply integrates these three disciplines and analyses textbooks in a way that is more consistent with HPSS research.

The second limitation comes from the fact that this study used uniform Copiousness as a criterion for HPSS content quality, which led to limitations in our results. Future research should develop the development of different quality assessment criteria for different HPSS content, as some studies have already done (Klassen et al., 2012; Niaz et al., 2010), to more effectively understand changes in HPSS content in textbooks.

References

Abd-El-Khalick, F. (2005). Developing deeper understandings of nature of science: The impact of a philosophy of science course on preservice science teachers' views and instructional planning. International Journal of Science Education, 27(1), 15-42. DOI: https://doi.org/10.1080/09500690410001673810

Abd-El-Khalick F. (2012). Examining the Sources for our Understandings about Science: Enduring conflations and critical issues in research on nature of science in science education. International Journal of Science Education, 34(3), 353-374. DOI: https://doi.org/10.1080/09500693.2011.629013

Abd-El-Khalick, F., Bell, R. L., & Lederman, N. G. (1998). The nature of science and instructional practice: Making the unnatural natural. Science Education, 82(4), 417-436. DOI: https://doi.org/10.1002/(SICI)1098-237X(199807)82:4<417::AID-SCE1>3.0.CO;2-E

Abd-El-Khalick, F., & Lederman, N. G. (2000). The influence of the history of science courses on students' views of the nature of science. Journal of Research in Science Teaching, 37(10), 1057-1095. DOI: https://doi.org/10.1002/1098-2736(200012)37:10<1057::AID-TEA3>3.0.CO;2-C

Abd-El-Khalick, F., Waters, M., & Le, A.-P. (2008). Representations of the nature of science in high school chemistry textbooks over the past four decades. Journal of Research in Science Teaching, 45(7), 835-855. DOI: https://doi.org/10.1002/tea.20226

Alters, B. J. (1997). Whose nature of science? Journal of Research in Science Teaching, 34(1), 39-55. DOI: https://doi.org/10.1002/(SICI)1098-2736(199701)34:1<39::AID-TEA4>3.0.CO;2-P

Blachowicz, J. (2009). How Science Textbooks Treat Scientific Method: A Philosopher's Perspective. The British Journal for the Philosophy of Science, 60(2), 303-344. DOI: https://doi.org/10.1093/bjps/axp011

Boniolo, G., & Campaner, R. (2020). Life Sciences for Philosophers and Philosophy for Life Scientists: What Should We Teach? Biological Theory, 15(1), 1-11. DOI: https://doi.org/10.1007/s13752-019-00333-7

Brito, A., Rodr ǵuez, M. A., & Niaz, M. (2005). A reconstruction of the development of the periodic table based on history and philosophy of science and its implications for general chemistry textbooks: PERIODIC TABLE AND GENERAL CHEMISTRY TEXTBOOKS. Journal of Research in Science Teaching, 42(1), 84-111. DOI: https://doi.org/10.1002/tea.20044

Brush, S. G. (2000). Thomas Kuhn as a Historian of Science. Science & Education, 9(1), 39-58. DOI: https://doi.org/10.1023/A:1008761217221

Bybee, R. W., Powell, J. C., Ellis, J. D., Giese, J. R., Parisi, L., & Singleton, L. (1991). Integrating the history and nature of science and technology in science and social studies curriculum. Science Education, 75(1), 143-155. DOI: https://doi.org/10.1002/sce.3730750113

Chen, S.-Y., Chen, C.-H., & Liu, S.-Y. (2022). History of Science Reading Materials as Everyday Homework to Improve Middle School Students' Epistemological Beliefs about Science. International Journal of Science and Mathematics Education, 20(S1), 69-92. DOI: https://doi.org/10.1007/s10763-022-10285-3

Clary, R. M., & Wandersee, J. H. (2015). The History of Science in the Science Classroom: The Past Is the Key to the Future in Science Education. Earth Sciences History, 34(2), 310-332.

Cofré, H., Núñez, P., Santibáñez, D., Pavez, J. M., Valencia, M., & Vergara, C. (2019). A Critical Review of Students' and Teachers' Understandings of Nature of Science. Science & Education, 28(3-5), 205-248. DOI: https://doi.org/10.1007/s11191-019-00051-3

Cunningham, C. M., & Helms, J. V. (1998). Sociology of science as a means to a more authentic, inclusive science education. Journal of Research in Science Teaching, 35(5), 483-499. DOI: https://doi.org/10.1002/(SICI)1098-2736(199805)35:5<483::AID-TEA2>3.0.CO;2-L

DiGiuseppe, M. (2014). Representing Nature of Science in a Science Textbook: Exploring author-editor-publisher interactions. International Journal of Science Education, 36(7), 1061-1082. DOI: https://doi.org/10.1080/09500693.2013.840405

Farías Camero, D. M., Castelló Escandell, J., & Molina Caballero, M. F. (2012). Análisis del enfoque de historia y filosofía de la ciencia en libros de texto de química: El caso de la estructura atómica. Enseñanza de las Ciencias. Revista de investigación y experiencias didácticas, 31(1), 115-133. DOI: https://doi.org/10.5565/rev/ec/v31n1.489

Galili, I., & Hazan, A. (2000). The influence of an historically oriented course on students' content knowledge in optics evaluated by means of facets-schemes analysis. American Journal of Physics, 68(S1), S3-S15. DOI: https://doi.org/10.1119/1.19518

Galili, I., & Hazan, A. (2001). The Effect of a History-Based Course in Optics on Students' Views about Science. In F. Bevilacqua, E. Giannetto, & M. R. Matthews (Eds.), Science Education and Culture (pp. 229-254). Springer Netherlands. DOI: https://doi.org/10.1007/978-94-010-0730-6_16

Gardner, P. L. (1999). The representation of science-technology relationships in Canadian physics textbooks. International Journal of Science Education, 21(3), 329-347. DOI: https://doi.org/10.1080/095006999290732

Grüne-Yanoff, T. (2014). Teaching philosophy of science to scientists: Why, what and how. European Journal for Philosophy of Science, 4(1), 115-134. DOI: https://doi.org/10.1007/s13194-013-0078-x

Henke, A., & Höttecke, D. (2015). Physics Teachers' Challenges in Using History and Philosophy of Science in Teaching. Science & Education, 24(4), 349-385. DOI: https://doi.org/10.1007/s11191-014-9737-3

Höttecke, D., & Silva, C. C. (2011). Why Implementing History and Philosophy in School Science Education is a Challenge: An Analysis of Obstacles. Science & Education, 20(3), 293-316. DOI: https://doi.org/10.1007/s11191-010-9285-4

Justi, R., & Gilbert, J. (2000). History and philosophy of science through models: Some challenges in the case of "the atom." International Journal of Science Education, 22(9), 993-1009. DOI: https://doi.org/10.1080/095006900416875

Kelly, G. J., Carlsen, W. S., & Cunningham, C. M. (1993). Science education in sociocultural context: Perspectives from the sociology of science. Science Education, 77(2), 207-220. DOI: https://doi.org/10.1002/sce.3730770208

Kim, S. Y., & Irving, K. E. (2010). History of Science as an Instructional Context: Student Learning in Genetics and Nature of Science. Science & Education, 19(2), 187-215. DOI: https://doi.org/10.1007/s11191-009-9191-9

Klassen, S., Niaz, M., Metz, D., McMillan, B., & Dietrich, S. (2012). Portrayal of the History of the Photoelectric Effect in Laboratory Instructions. Science & Education, 21(5), 729-743. DOI: https://doi.org/10.1007/s11191-011-9360-5

Laçin-Şimşek, C. (2011). WOMEN SCIENTISTS IN SCIENCE AND TECHNOLOGY TEXTBOOKS IN

TURKEY. Journal of Baltic Science Education, 10(4).

Laudan, L. (1989). Thoughts on Hps—20 Years Later. Studies in History and Philosophy of Science, 20(1), 9-13. DOI: https://doi.org/10.1016/0039-3681(89)90030-7

Lederman, N. G., Abd-El-Khalick, F., Bell, R. L., & Schwartz, R. S. (2002). Views of nature of science questionnaire: Toward valid and meaningful assessment of learners' conceptions of nature of science. Journal of Research in Science Teaching, 39(6), 497-521. DOI: https://doi.org/10.1002/tea.10034

Leite, L. (2002). History of Science in Science Education: Development and Validation of a Checklist for Analysing the Historical Content of Science Textbooks. SCIENCE & EDUCATION, 11, 333-359.

Li, X., Tan, Z., Shen, J., Hu, W., Chen, Y., & Wang, J. (2020). Analysis of Five Junior High School Physics Textbooks Used in China for Representations of Nature of Science. Research in Science Education, 50(3), 833-844. DOI: https://doi.org/10.1007/s11165-018-9713-z

Li, Y., & Zheng, C. (2009). The Development of International HPS Education and It's Apocalypse for Reform of Science Education. Comparative Education Review, 31(05), 13-18.

Lin, L., Song, Q., Wang, J., Hu, T., Ping, X., & Ling, Y. (2022). History of Science in Two Recent Versions of High School Physics Textbooks in China. Science & Education. DOI: https://doi.org/10.1007/s11191-021-00307-x

Ma, Y., & Wan, Y. (2017). History of science content analysis of Chinese science textbooks from the perspective of acculturation. Science & Education, 26(6), 669-690. DOI: https://doi.org/10.1007/s11191-017-9914-2

Martin, M. (1972). Philosophy of Science and Science Education. Studies in Philosophy and Education, 7(3), 210-225. DOI: https://doi.org/10.1007/BF00373219

Matthews, M. R. (1989). History, philosophy, and science teaching: A brief review. Synthese, 80(1), 1-7. DOI: https://doi.org/10.1007/BF00869945

Matthews, M. R. (1992). History, philosophy, and science teaching: The present rapprochement. Science and Education, 1(1), 11-47. DOI: https://doi.org/10.1007/BF00430208

Matthews, M. R. (2009). Teaching the Philosophical and Worldview Components of Science. Science & Education, 18(6-7), 697-728. DOI: https://doi.org/10.1007/s11191-007-9132-4

Matthews, M. R. (2017). Reconceptualizing the nature of science for science education. Studies in Science Education, 53(1), 105-107. DOI: https://doi.org/10.1080/03057267.2016.1258108

Matthews, M. R. (Ed.). (2018). History, Philosophy and Science Teaching. Springer International Publishing. DOI: https://doi.org/10.1007/978-3-319-62616-1

Metz, D., Klassen, S., McMillan, B., Clough, M., & Olson, J. (2007). Building a Foundation for the Use of Historical Narratives. Science & Education, 16(3), 313-334. DOI: https://doi.org/10.1007/s11191-006-9024-z

Ministry of Education, P. R. (2017). Physics curriculum standards for senior high school. People's Education Press.

Monk, M., & Osborne, J. (1997). Placing the history and philosophy of science on the curriculum: A model for the development of pedagogy. Science Education, 81(4), 405-424. DOI: https://doi.org/10.1002/(SICI)1098-237X(199707)81:4<405::AID-SCE3>3.0.CO;2-G

Montgomery, S. L., & Kumar, A. (2021). Under the Influence: History in Scientific Training, the Case of Textbooks. KNOW: A Journal on the Formation of Knowledge. DOI: https://doi.org/10.1086/716847

Niaz, M. (1998). From cathode rays to alpha particles to quantum of action: A rational reconstruction of structure of the atom and its implications for chemistry textbooks. Science Education, 82(5), 527-552. DOI: https://doi.org/10.1002/(SICI)1098-237X(199809)82:5<527::AID-SCE1>3.0.CO;2-B

Niaz, M. (2000a). A rational reconstruction of the kinetic molecular theory of gases based on history and philosophy of science and its implications for chemistry textbooks. INSTRUCTIONAL SCIENCE, 28, 23-50.

Niaz, M. (2000b). The Oil Drop Experiment: A Rational Reconstruction of the Millikan-

Ehrenhaft Controversy and Its Implications for Chemistry Textbooks. Journal of Research in Science Teaching, 37(5), 480-508. DOI: https://doi.org/10.1002/(SICI)1098-2736(200005)37:5<480::AID-TEA6>3.0.CO;2-X

Niaz, M. (2001). A rational reconstruction of the origin of the covalent bond and its implications for general chemistry textbooks. International Journal of Science Education, 23(6), 623-641. DOI: https://doi.org/10.1080/09500690010006491

Niaz, M., & Coştu, B. (2009). Presentation of atomic structure in Turkish general chemistry textbooks. Chemistry Education Research and Practice, 10(3), 233. DOI: https://doi.org/10.1039/b914503f

Niaz, M., Klassen, S., McMillan, B., & Metz, D. (2010). Reconstruction of the history of the photoelectric effect and its implications for general physics textbooks. Science Education, 94(5), 903-931. DOI: https://doi.org/10.1002/sce.20389

Persson, J. R. (2018). Evolution of quasi-history of the Planck blackbody radiation equation in a physics textbook. American Journal of Physics, 86(12), 887-892. DOI: https://doi.org/10.1119/1.5054005

Reiss, M. J. (2020). Science Education in the Light of COVID-19 The Contribution of History, Philosophy and Sociology of Science. Science & Education, 29(4), 1079-1092. DOI: https://doi.org/10.1007/s11191-020-00143-5

Rodríguez, M. A., & Niaz, M. (2004). The Oil Drop Experiment: An Illustration of Scientific Research Methodology and its Implications for Physics Textbooks. Instructional Science, 32(5), 357-386. DOI: https://doi.org/10.1023/B:TRUC.0000044641.19894.ed

Sachs, M. (1993). On the Problem of Cosmology. Physics Essays, 6(1), 32-38. DOI: https://doi.org/10.4006/1.3029034

Simon, J. (2016). Writing the DisciplineGanot's Textbook Science and the "Invention" of Physics. Historical Studies in the Natural Sciences, 46(3), 392-427. DOI: https://doi.org/10.1525/hsns.2016.46.3.392

Solbes, J., & Traver, M. (2003). Against a Negative Image of Science: History of Science and the Teaching of Physics and Chemistry. Science & Education, 12, 703-717.

Solomon, J., Duveen, J., Scot, L., & McCarthy, S. (1992). Teaching about the nature of science through history: Action research in the classroom. Journal of Research in Science Teaching, 29(4), 409-421. DOI: https://doi.org/10.1002/tea.3660290408

Teixeira, E. S., Greca, I. M., & Freire, O. (2012). The History and Philosophy of Science in Physics Teaching: A Research Synthesis of Didactic Interventions. Science & Education, 21(6), 771-796. DOI: https://doi.org/10.1007/s11191-009-9217-3

Vesterinen, V.-M., Manassero-Mas, M.-A., & Vázquez-Alonso, Á. (2014). History, Philosophy, and Sociology of Science and Science-Technology-Society Traditions in Science Education: Continuities and Discontinuities. In M. R. Matthews (Ed.), International Handbook of Research in History, Philosophy and Science Teaching (pp. 1895-1925). Springer Netherlands. DOI: https://doi.org/10.1007/978-94-007-7654-8_58

Vojíř, K., & Rusek, M. (2019). Science education textbook research trends: A systematic literature review. International Journal of Science Education, 41(11), 1496-1516. DOI: https://doi.org/10.1080/09500693.2019.1613584

Williams, C. T., & Rudge, D. W. (2016). Emphasizing the History of Genetics in an Explicit and Reflective Approach to Teaching the Nature of Science: A Pilot Study. Science & Education, 25(3-4), 407-427. DOI: https://doi.org/10.1007/s11191-016-9821-y

Wong, S. L., & Hodson, D. (2010). More from the Horse's Mouth: What scientists say about science as a social practice. International Journal of Science Education, 32(11), 1431-1463. DOI: https://doi.org/10.1080/09500690903104465

Wylie, A. (1994). Discourse, Practice, Context: From HPS to Interdisciplinary Science Studies. PSA: Proceedings of the Biennial Meeting of the Philosophy of Science Association, 1994(2), 392-395. DOI: https://doi.org/10.1086/psaprocbienmeetp.1994.2.192950

Yuan, W. (2005). A Summary of Studies on Integration of Scientific Science

Curriculum in Foreign Countreis. Comparative Education Review, 10, 62-67.

Zhang, J. (2017). HPS Education Research. Science Press.

Zhuang, H., Xiao, Y., Liu, Q., Yu, B., Xiong, J., & Bao, L. (2021). Comparison of nature of science representations in five Chinese high school physics textbooks. International Journal of Science Education, 43(11), 1779-1798. DOI: https://doi.org/10.1080/09500693.2021.1933647

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