

A Comparative Study on the Infiltration and Cultivation of the Spirit of Scientists in Science Textbooks

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ABSTRACT

The spirit of scientists is a synthesis and summary of the spiritual strength demonstrated by countless scientific workers over long-term scientific research and practice. This study focuses on the primary science textbooks of the People's Education Press and the Jiangsu Education Press, aiming to explore how the spirit of scientists is integrated and cultivated in these textbooks. From the perspective of background information about scientists, 'the study analyzes the presentation of background information, such as the nationality and era of scientists, in both textbooks. Based on' the presentation of scientist materials, 'it compares the length of scientist-related content in the textbooks. It also focuses on' the content of the spirit of scientists, 'summarizing and defining the specific connotations of the spirit of scientists, such as innovation and empirical thinking. Through content analysis and other research methods, the study finds that both textbooks have their unique characteristics in integrating the spirit of scientists, but there are also areas for improvement. This study provides theoretical and practical references for further enhancing the integration of the spirit of scientists into primary school science textbooks and for effectively cultivating students' spirit of scientists in science education.

KEYWORDS

scientific spirit; scientific spirit; primary school science teaching material

The spirit of scientists is a synthesis and summary of the spiritual strength demonstrated by countless scientific workers over a long period of scientific research and practice. However, in China's compulsory education system, science is not given enough importance. Science courses still focus primarily on scientific knowledge, neglecting the development of the spirit of science and the spirit of scientists. This results in primary school students merely memorizing subject knowledge, unable to develop an independent exploration of science, and even less likely to develop an interest in it.

Therefore, enhancing the cultivation of scientific literacy in primary schools is a crucial approach to improving and elevating the national level of scientific literacy. Based on this, this article analyzes various aspects of the scientific materials, content, and writing characteristics related to the spirit of scientists in the primary school science textbooks of the People's Education Press and Jiangsu Education Press. It focuses on the integration of the spirit of scientists in different versions of primary school science textbooks, aiming to provide reasonable suggestions for the current stage of Chinese primary school science textbook compilation, summarize past shortcomings, and better improve the content of primary school science education in our country.

1 Research methods

1.1 Analysis framework

Scholar Ma Junwei primarily analyzes the image of scientists from three perspectives: the natural dimension, the social dimension, and the textbook dimension. In the natural dimension, the analysis focuses on the scientist's name and gender. In the social dimension, the analysis centers on the country the scientist is from and their profession^[1]. Ma Luyan, in her study on the content of the spirit of scientists in textbooks, categorizes the background information of scientists into three dimensions: nationality, era, and gender^[2]. This study primarily adopts Ma Luyan's framework for categorizing the background information of scientists, dividing it into nationality, era, and gender dimensions. Regarding the division of eras, scholars from different fields have varying approaches; this paper adopts Joseph Needham's time framework for the study of Chinese science and technology, dividing eras into ancient, modern, and contemporary^[3]. The content related to the spirit of scientists in primary school science textbooks is coded and analyzed using Ma Luyan's research framework for high school chemistry textbooks. As shown in Table.

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Table 1 The connotation and operational definition of each dimension of the study of scientists' spirit

Primary indicators	Secondary indicators	operational definition
Scientific background information	nationality	The textbook contains references to the nationality of scientists
	a period in one's life	The period before 1600 was defined as ancient times. The period from 1600 to 1895 is defined as modern times. The period after 1895 was defined as modern
	sex	If the words "male" and "female" appear, those that do not appear are judged by consulting data
The performance of science and technology spirit textbooks	length	A sentence describing the spirit of scientists, one sentence is relatively short; Two sentences are short. Sentences 3 to 5 are medium in length. Sentences 6 to 10 are relatively long. It is 11 sentences long
	Presentation mode	The presentation mode is pictures, text and graphic combination
	Content dimension supporter	Words such as "patriotism", "dedication", "experiment" and "innovation" appear
The spirit of scientists	Fullness	The research process of scientists is the carrier that embodies their spirit
		The degree of embodying one kind of scientific spirit is thinness; The degree of embodying the two kinds of scientific spirits is relatively rich. Three or more kinds are considered plump.

1.2 Selection of research subjects

This study focuses on the compulsory education textbooks 'Science' (Teaching Edition) and the Jiangsu Education Press primary school science textbook, both officially published by the Educational Science Press in July 2018. Each set consists of 12 volumes. The study will comprehensively organize the content of these textbooks, focusing on the portrayal of scientists' spirit. This will be done from the perspectives of the scientists' image, their presentation, and the dimensions of content. Based on this, specific data and quantitative methods will be used to conduct an in-depth analysis of these elements of the scientists' spirit, clearly presenting their distribution and characteristics. The study aims to explore how the spirit of Chinese scientists is cultivated in primary school science textbooks, thereby providing better suggestions for integrating this spirit into the writing of primary school science textbooks in China.

1.3 Analysis rules

This study employs text analysis to systematically process, analyze, and interpret text data, uncovering the information, meaning, structure, and internal relationships it contains, to meet the needs of various fields in understanding, decision-making, and prediction^[4]. At its core, text analysis delves into human language expression, encompassing a range of operations from simple text feature extraction to complex semantic understanding and knowledge discovery. Feature extraction involves statistical word and phrase analysis, such as calculating word frequency to identify core themes and performing part-of-speech tagging to lay the groundwork for subsequent analysis. In terms of semantic understanding, natural language processing technology and semantic theory are used to analyze the semantic relationships between words, sentences, and texts, such as semantic role labeling to clarify component semantic roles and semantic similarity calculations to aid in text classification and clustering, enabling precise retrieval of relevant information during information searches. Structural analysis focuses on the organization and logical relationships of texts, analyzing the structure, paragraphs, levels, and thematic coherence of texts to aid in understanding the overall framework, such as identifying the structure of academic papers and extracting key information. By constructing syntactic trees, it presents the syntax and semantic dependencies of sentences, aiding in understanding sentence generation and meaning.

In the study of the embodiment of scientific spirit in the textbook, the author first carefully read and meticulously analyzed the content of the textbook. Then, based on the dimensions of the analysis of the spirit of scientists established in the previous section, the author read and analyzed each indicator of the spirit of scientists in each unit. The entire analysis process was conducted independently by the author to avoid the impact of cognitive differences among individuals on the results, ensuring the consistency and accuracy of the experimental outcomes. After the analysis was completed, professional data processing tools like Excel were used to systematically carry out data entry, classification and integration, as well as multi-dimensional in-depth statistical analysis.

2 Results and Discussion

According to the analysis and statistics, the information of scientists in different versions of primary school science textbooks is shown in Table 2, the analysis of the presentation of scientists' content in the textbooks is respectively shown in Table 3, and the analysis of the presentation of the spirit of scientists in the textbooks is shown in Table 4.

Table 2 Statistics of Scientists' Information in Different Versions of Primary School Science Textbooks

Primary indicators	Secondary indicators	Three levels of indicators	Education and Science Edition (Frequency/Proportion%)	Jiangsu Education Edition (Frequency/Proportion%)
Scientific background information	Nationality	China	8/4.21	8/15.38
		America	1/5.26	7/13.46
		France	1/5.26	3/5.76
		Britain	3/15.79	18/34.61
		Germany	0/0.00	4/7.69
		Italy	1/5.26	1/1.92
		Austria	0/0.00	1/1.92
		Denmark	1/5.26	0/0.00
		Greece	1/5.20	4/7.69
		Holland	2/10.53	1/1.92
		Poland	1/5.26	1/1.92
		Portuguesa	0/0.00	1/1.92
		Spain	0/0.00	1/1.92
		Russia	0/0.00	1/1.92
		Sweden	0/0.00	1/1.92
	a period in one's life	ancient	4/21.05	13/25.00
		modern times	8/42.10	30/57.69
		modern	7/36.84	9/17.30
	sex	man	18/94.73	52/100
		woman	1/5.26	0/0.00

Table 3 Presentation of Scientists' Content in Textbooks

Primary indicators	Secondary indicators	Three levels of indicators	Education and Science Edition (Frequency/Proportion%)	Jiangsu Education Edition (Frequency/Proportion%)
The content of scientists is presented in the textbook	the length of an article	shorter	4/8.89	24/53.33
		short	2/4.44	12/26.67
		middle	1/2.22	10/22.22
		longer	12/26.67	5/11.11
		long	0/0.00	0/0.00
	Presentation mode	Text presentation	0/0.00	12/23.07
		Image shows	0/0.00	0/0.00
		The picture and its accompanying essay are both excellent.	19/100	33/63.46

Table 4 Presentation of the content on the spirit of scientists in the textbook

Primary indicators	Secondary indicators	Three levels of indicators	Education and Science Edition (Frequency/Proportion%)	Jiangsu Education Edition (Frequency/Proportion%)
The spirit of scientists is presented in the teaching materials	Content dimension	Patriotism	2/8.00	0/0.00
		Creative spirit	10/40.00	25/73.52
		The spirit of seeking truth	8/32.00	9/26.47
		The spirit of collaboration	4/16.00	0/0.00
		The spirit of dedication	1/4.00	0/0.00
		Educational spirit	0/0.00	0/0.00
		Direct evaluation	0/0.00	0/0.00
	The spirit of scientists is embodied	Scientific research	18/81.81	38/79.16
		Academic exchange	3/13.63	10/20.83
		Humanistic thought	1/4.54	0/0.00

Table 4 Presentation of the content on the spirit of scientists in the textbook (Continued).

Primary indicators	Secondary indicators	Three levels of indicators	Education and Science Edition (Frequency/Proportion%)	Jiangsu Education Edition (Frequency/Proportion%)
The spirit of scientists is presented in the teaching materials	The spirit of scientists is full	Thin	10/52.6	38/84.4
		More plump	5/26.3	2/4.44
		Plentiful	3/15.7	0/0.00
		do not appear	1/5.26	5/11.11

2.1 Gender imbalance

In the textbooks of the Education Science Edition and the Jiangsu Education Edition, the proportion of male scientists far exceeds that of female scientists. On the one hand, historically, the concept of male superiority and female inferiority prevailed, and women had few educational opportunities, making it difficult for them to accumulate the knowledge and training needed for scientific research. As a result, the number of women who made outstanding contributions in the history of science was limited. On the other hand, traditional educational habits take male scientists with wide influence as the main role models, ignoring the role model value of female scientists, resulting in the scarcity of female scientist images in textbooks.

2.2 Trend of era selection

Both editions of the teaching materials focus on selecting modern scientists. Modern science has made breakthroughs in theory and method, establishing systematic frameworks, such as Newton's classical mechanics system and Darwin's theory of evolution, which are closely related to primary school science knowledge and thus are presented in large numbers. In contrast, ancient science was mostly preliminary observations and summaries of experiences of natural phenomena, without forming a complete system or research methods. Its achievements were relatively scattered and it was weaker than modern science in terms of the systematicness and depth of knowledge as well as the connection with modern science education. Therefore, it accounted for a relatively small proportion in textbooks.

2.3 Innovation and pragmatism are highlighted

The two editions of the teaching materials mostly draw on the materials of modern scientists to demonstrate the spirit of innovation and pragmatism. Modern science is independent from philosophy, and many fundamental fields require pioneering research. Newton constructed the classical mechanics system with innovative thinking and mathematical methods, and Copernicus challenged the geocentric theory supported by the church and proposed the heliocentric theory. Both are exemplary cases of innovation. Ideological liberation movements such as the Renaissance and the Reformation broke the shackles of theology, advocated humanism and rational thinking, and inspired scientists to break through traditions and explore natural science from new perspectives.

2.4 Lack of patriotism, dedication and education spirit

In the textbooks of the Education Science Edition and the Jiangsu Education Edition, the spirit of patriotism, dedication and education, especially the spirit of education, is insufficiently reflected. Primary school science textbooks focus on imparting scientific knowledge, cultivating scientific thinking and inquiry abilities, and place more emphasis on presenting the innovative and realistic spirit directly related to scientific exploration, helping students understand the process and methods of scientific research. To a certain extent, this weakens the display of other spirits. Qian Wei pointed out that there is an imbalance in the dimensional distribution of the spirit of scientists in textbooks. The spirit of patriotism, the spirit of educating people and the spirit of collaboration have been "neglected", which to a certain extent ignores the humanistic essence and contemporary value contained in the spirit of scientists [5]. The scientific spirit constitutes the core elements of the scientist's spirit. Qualities such as rationality, questioning, independence and rigor are the essence accumulated by scientific and technological workers in long-term practice. However, it should be made clear that the spirit of scientists is not a simple replication of the scientific spirit, but rather the result of the deep integration of the scientific spirit and the humanistic spirit. The construction of scientific rationality cannot do without the support of humanistic spirit. The spirit of scientists always reflects the humanistic brilliance of scientists as individuals. Therefore, when promoting the spirit of scientists, it should not be equated with the scientific spirit, nor should it be confined to being an extension of scientific rationality. Instead, emphasis should be placed on exploring the humanistic

care value it contains.

2.5 Presentation carrier is single

The teaching materials mainly present the spirit of scientists from the perspectives of "scientific research" and "academic exchange". Take scientific research as an example. Newton discovered the law of universal gravitation when an apple fell to the ground. Students can learn observation and thinking methods from it, cultivate logical, critical and innovative thinking, and master the ability to scientifically analyze and solve problems. However, presenting only from this perspective is likely to overlook the contributions of scientists in social and humanistic aspects such as patriotism, dedication, and education, resulting in an incomplete display of the image and spirit of scientists. Students' understanding of scientists is limited, and the richness of the image of scientists urgently needs to be improved.

3 Recommendations and reflections

3.1 The textbook should appropriately increase the image of scientists

The 12-volume primary school science textbook only mentions the image and spirit of scientists 19 times, with an average of less than two figures per volume, and the embodiment of the spirit is rather monotonous. The image of scientists should be enhanced and diverse spirits integrated, taking into account different scientific fields, eras and nationalities comprehensively. For instance, Marie Curie in the field of chemistry, through arduous research, discovered the element radium. Her deeds demonstrate her persistent dedication to science. Qian Xuesen, a physicist in the field of physics, gave up generous benefits abroad to return to China and lay the foundation for China's space industry. He is a model of patriotism and dedication. When introducing, it is necessary to fully demonstrate the spiritual qualities of scientists, take into account the physical and mental characteristics of students, avoid lengthy descriptions, and based on the viewpoints of scholars from Ren Yue, shape a three-dimensional and realistic image of scientists from aspects such as cognition, emotion, and morality, promote the integration of humanistic and scientific spirit, and carefully arrange new content.

3.2 The gender ratio of scientists in the teaching materials should be balanced

Female scientists are scarce in the science textbooks of the Education Science Edition and the Jiangsu Education Edition. Relevant studies have shown that domestic primary and secondary school students have male stereotypes about scientists. This affects girls' confidence in learning science, reduces their sense of self-efficacy, hinders boys' development in some scientific fields, and is not conducive to students forming an open and inclusive mindset. Textbooks should, within the layout requirements, enhance the image of female scientists through various forms such as text and photos to eliminate stereotypes.

3.3 Promote the diversity of scientists' spirit

Research shows that the spirit of scientists in the textbooks of the Education Science Edition and the Jiangsu Education Edition mainly focuses on innovation and pragmatism, while the spirit of patriotism, dedication and education is lacking. Furthermore, dedication and the spirit of nurturing are equally important. Textbooks should adjust the proportion of spirit, make up for deficiencies, and enrich the connotation of the spirit of scientists.

3.4 Strengthen the display of scientific spirit

When teaching materials shape the image of scientists, they should highlight their value standards, ways of thinking and behavioral norms in learning and applying scientific knowledge and skills. One can start from multiple aspects to explore the life story, such as introducing that Newton embarked on the path of scientific research due to his interest in mechanical manufacturing; Highlight the scientific method, such as elaborating in detail that Darwin proposed the theory of evolution through methods like observation and induction during his circumnavigation of the globe; Display personal qualities and comprehensively showcase the spirit of scientists.

In conclusion, this study selected the new science textbooks of the Education Science Edition and the Jiangsu Education Edition for the primary school stage in China as the research objects. Based on the previous research results, an analytical framework was constructed, and the coding, data processing and analysis of the textbook content were carried out. Through an in-depth analysis of the teaching materials, the characteristics of teaching material compilation are summarized, and then suggestions for teaching material compilation and teaching implementation are put forward,

aiming to promote the dissemination and promotion of the spirit of scientists in the process of middle school education and teaching. However, this study still has certain limitations. On the one hand, the research focuses on the analysis of teaching materials. Although teaching resources have been developed, only one thematic teaching practice activity has been carried out in primary schools. On the other hand, future research can further enrich the research objects, incorporate more versions of primary school science textbooks and characteristic textbooks of different regions, and comparatively analyze the commonalities and differences in the infiltration of the spirit of scientists. At the same time, it is necessary to deeply explore the hidden connotations of the scientific spirit in the teaching materials, such as the thinking patterns and attitudes towards setbacks of scientists in the cases of the history of science, to provide more comprehensive theoretical support for the compilation of teaching materials and teaching. All these aspects await further in-depth research and improvement in the future.

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