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The Statistical Analysis and Thinking of the Illustration of High School Physics Textbook in Human Education Edition

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Abstract: Select the compulsory part of the 19-person edition of the physics textbook as the research object, adopt the text analysis method and design a double-layer classification model to analyze the illustrations in two dimensions of quantity and content. It is found that the illustration density of the three textbooks is high, exert importance to the value of illustrations. However, there are some shortcomings, such as not adhering to the principle of spatial continuity, too few explanatory illustrations and organizational illustrations, too few portrait historical figures, a lack of expressive force of experimental illustrations, and too few knowledge structure charts. Therefore, some teaching suggestions are put forward.

Keywords: Human teaching version; Senior high school physics; Physics textbooks; Illustrations

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1. Introduction

Illustrations are pictures interspersed in the text to provide background information or to decorate, characterize, explain, and organize the text content [1]. They are an important tool for teachers to disseminate knowledge. Through illustrations, students can accept and understand the concepts and contents of the text as soon as possible. Therefore, illustrations, as the second language of textbooks and the intuitive part of textbooks, play a vital role in teaching activities. In the face of constraints, including the limitations of educational resources, teaching equipment, and subject concepts, textbook illustrations can make up for these limitations [2]. For example, in poor mountainous areas where there is no multimedia equipment, illustrations become the main educational resource. The 2017 edition of physics curriculum standards for senior high schools requires that textbooks properly deal with the relationship between layout and content, and strive to balance and complement each other; The selection of pictures should be made in the scientific and contemporary aspects; Pay attention to the selection of illustrations, so that it is closely combined with the teaching purpose and teaching content [3]. Under such a research background, this paper uses the double-layer classification model to carry on the data statistics and analysis of the illustrations in

the high school physics textbooks for human education edition, and provides suggestions for the use of textbook illustrations and future improvement.

2. Statistics of textbook illustrations

2.1. Selection of statistical objects

The statistical objects are Compulsory 1, 2 and 3 Physics Textbooks of 2019 edition of People's Education Press (hereinafter referred to as the 19-person Edition of Compulsory Physics Textbooks) [4–6]. The physics textbooks published by People's Education Press are divided into 9 volumes, and the first 3 volumes are compulsory textbooks, which are well-known textbooks with the largest circulation and the highest usage rate in China, so they are selected as the research object.

2.2. Illustration of quantity statistics

Table 1. Statistical table of the number of illustrations in the compulsory physics textbooks of the 19th edition

	Number of illustrations (pieces)	Number of body pages (pages)	Density of illustrations (sheet/page)
Compulsory 1	200	105	1.90
Compulsory 2	179	105	1.70
Compulsory 3	280	134	2.09

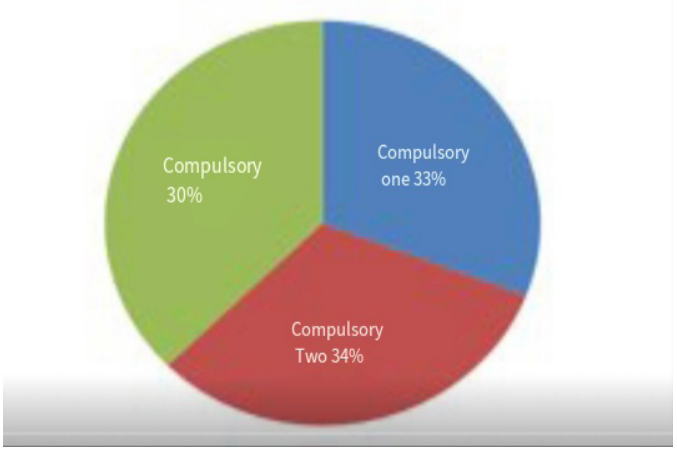

Figure 1. Statistics of the proportion of exercise illustrations in the 19-person edition of the compulsory physics textbook.

There are a total of 674 illustrations in the three textbooks, of which there are 105 pages of text and 200 illustrations in compulsory one, with a density of 1.90 pieces/page; There are 105 pages of text and 179 illustrations in compulsory Course 2, with a density of 1.70 pages/page. There are 134 pages of text and 280 illustrations in compulsory 3, with a density of 2.09 copies/page (**Table 1** and **Figure 1**).

2.3. Analysis of illustration content

2.3.1. Classification basis

In the "Textbook Illustration Analysis Record Table" by Chen Yunbao *et al.*, illustrations are divided into decorative illustrations, representative illustrations, organizational illustrations and explanatory illustrations in

terms of function, and terms of content, illustrations are divided into chapter first diagram, column diagram, text diagram, science and technology life diagram, data diagram, historical data class diagram, guide diagram, experiment diagram, structure diagram and principle simulation diagram [7]. On this basis and in combination with the characteristics of high school physics textbook illustrations, illustrations are classified twice in terms of content, thus generating the "double-layer classification model" used in this paper, as shown in **Table 2**.

Table 2. Statistical table of the number of various illustrations in the 19-person edition of compulsory physics textbooks

	Decorative type (size)	Representational type (width)				Tissue type (width)		Interpretive type
	Column decoration chart	Chart coordinates	Tech Life chart	Portrait historical data map	Situation cartoon	Experimental drawing	Knowledge structure graph	Schematic simulation diagram
Compulsory 1	5	30	44	16	58	10	3	49
	5 in total	148 in total				13 in total		49 in total
Compulsory 2	5	7	48	6	56	6	0	51
	Total 5	Total 117				6 in total		51 in total
Compulsory 3	6	19	41	8	104	24	4	74
	Total 6	Total 172				28 in total		74 in total

2.3.2. Illustration content statistics

It can be seen from **Table 2** that in the three 19-person editions of compulsory physics textbooks, the representational illustrations occupy the largest proportion and the decorative illustrations occupy the least. With the deepening of learning, the proportion of representational illustrations gradually decreases, while the proportion of corresponding organizational illustrations and explanatory illustrations increases to a certain extent.

3. Analysis of textbook illustrations

3.1. Illustration density analysis

According to statistics, the illustration density of the three volumes of the compulsory part of the 19 teaching version of physics textbooks is 1.90 pieces/page, 1.70 pieces/page and 2.09 pieces/page, respectively, with an average of 1.9 pieces/page. In contrast, the Russian version of Physical Science has a total of 849 illustrations, and the average number of illustrations per page is 1.1 [8]. It can be seen that textbook illustrations are widely used in textbooks in different countries, but the illustration density of the 19-person physics textbook is higher. Nowadays, many researchers have pointed out the value of illustrations, such as H. Levie and R. Lentz looked at 3,155 experiments and came up with the following [9]: The teaching effect of illustrated textbooks is better than that of pure text textbooks. The group experiment conducted by American scholars Willows [10] and F.M. Power shows that the reading effect of single-text textbooks and single-illustration textbooks is not very good, and there is no obvious difference between them. The combination of pictures and text textbooks will produce a good effect. On the whole, illustrations are good for reading comprehension, and readers remember illustrated texts more deeply than unillustrated texts [11]. Therefore, the 19-person version of the compulsory physics textbook is more illustrated than the Russian version of Physical Science, and pays more attention to the value of illustrations in the textbook.

3.2. The proportion of explanatory illustrations and organizational illustrations is too small

As shown in **Table 1**, representational illustrations occupy the largest proportion in the three textbooks, all of which are greater than 60%, while explanatory illustrations and organizational illustrations take the second place, and organizational illustrations do not exceed 10%. The number of representational illustrations far exceeds that of explanatory illustrations and organizational illustrations. Meyer divided the learning process of extracting and processing information into three forms: selection, organization and integration. Decorative illustrations do not influence the above three processes; representational illustrations only affect the selection process, organizational illustrations affect the selection and organization process, and interpretive illustrations affect the selection, organization and integration process [12]. Among the three types of illustrations, explanatory illustrations have a higher influence and should occupy the highest proportion of textbook illustrations, but the data shows that representational illustrations occupy the highest proportion. It can be seen that the proportion of each type of illustration is not related to its influence in textbooks. The new curriculum reform requires the emphasis on the construction of a knowledge structure system. Illustrations can help students connect old and new knowledge and form a complete knowledge structure system in their minds, while organizational illustrations can connect the knowledge of each chapter in the course more vividly in this process, which plays a role in promoting this process. Therefore, in the arrangement of textbook illustrations, the proportion of explanatory illustrations and organizational illustrations should be appropriately increased.

3.3. Too few portraits of historical materials

According to the data statistics, the average portrait historical figures of science and technology life diagrams in the three textbooks only account for 4.6% on average, and the number of portraits in compulsory courses is only single digits, which is significantly less than other types. Moreover, the historical figures in the three textbooks are mostly simple portraits of people, without providing corresponding thought-provoking text descriptions. However, the portrait historical maps precisely affect the development process of students' physical core accomplishment. First of all, historical portrait maps are important materials in the history of physics, which can help students to immerse themselves in the historical situation and feel the thinking mode of physicists when solving physical problems. Secondly, students' attitudes towards science can be changed through images of scientists. Finally, the use of historical portraits can help students understand the personal charm of physicists, so as to cultivate the scientific spirit of respecting facts, loving science and seeking truth from facts. The four dimensions of core literacy are closely related and influence each other, so we can't ignore the influence of portrait historical maps in the process of cultivating all-round development of people, and the number of portrait historical maps should be appropriately increased.

3.4. There is an illustration of heterotopic

Illustrations complement the text portion of the textbook [13]. Based on the theory of double coding, Meyer tested the influence of teaching materials on students' learning through controlled experiments, and finally put forward seven principles of multimedia information design. Illustrations that conform to these principles will promote students' mastery and transfer of knowledge [14]. Among them, the principle of spatial continuity points out that the text content of the illustrations is attached near the corresponding illustrations, but there is an anomaly of the illustrations in the 19 compulsory physics textbooks: some illustrations in the three textbooks are not on the same page as the text, and the principle of spatial continuity is not observed, as shown in one of the illustrations in the textbook, **Figure 1**0.1-5 in Compulsory Lesson 3. It is suggested that the principle of spatial continuity should be

observed, and the illustrations placed near the text can make the combination of pictures and texts closer, so as to achieve better learning results.

3.5. Experimental illustrations lack expressiveness

Experimental illustrations can create vivid images and experimental scenes, guide students into the world of physics experiments, and help students feel the fun of physics experiments and the importance of practice more directly through them. This plays an important role in the development of students' core literacy. However, almost all experimental illustrations in textbooks simply show the experimental results and instruments, and only use one experimental result diagram or one experimental instrument diagram to represent the whole experiment, which lacks expressive force and does not play the role that experimental illustrations should play. Compared with Japan, there are not only a large number of experimental diagrams in Japanese textbooks, but also emphasis on cultivating students' ability to observe, compare and summarize through experimental diagrams. In addition, most of the experimental diagrams in Japanese textbooks are experimental phenomenon diagrams and experimental operation diagrams, focusing on showing the operation process of the experiment or the comparison of experimental phenomena. Usually, an experiment is represented by multiple continuous illustrations [7]. They are more expressive. Cognitive psychology surface: In the selection of colors in the compilation of teaching materials, we should fully consider the sensitive colors of human eyes and use these sensitive colors to highlight the main points of illustrations. But in the actual textbook, illustrations are mostly gray and white, almost consistent with the background tone of the textbook, making the illustrations in the textbook not "outstanding," lack of expression. Therefore, while the number of experimental illustrations should be increased, they should be arranged into a series of group drawings reflecting the experimental process, so that students can more easily understand the entire process of the experiment, master the experimental method, and combine the theory and application of what they have learned. At the same time, it is also necessary to use red, yellow, blue and other sensitive colors to make experimental drawings to enhance their expressive force. In addition, it is pointed out in the study that the factors of illustration itself also have an impact on the effect of illustration, and simplified illustration can better promote the understanding and memory of text [15]. Therefore, when compiling textbooks, the principle of simplicity should be followed, and some concise and purposeful pictures should be selected as textbook illustrations.

4. Discussion

Textbook illustrations play an important role in promoting students' learning. Through the statistics and analysis of this study, the following suggestions are made. First, the illustration density of the 19-person edition of the physics textbook is higher, and more attention is paid to the value of illustrations in the textbook. However, some illustrations do not comply with the principle of spatial continuity. For example, the text of the illustration in **Figure 1**0.1-5 on page 30 of Compulsory 3 of the 19-person edition of the Physics textbook is located on page 29. It is suggested that teachers should remind students of the location of illustrations when using illustrations in teaching. And guide students to observe the illustrations purposefully, to improve the combination of illustrations and text. Second, in the arrangement of textbook illustrations, it is necessary to appropriately increase the proportion of explanatory illustrations and organizational illustrations, and teachers can also provide students with corresponding materials in class. Third, the number of historical portraits in the textbook is small, which is not enough to provide students with materials history of physics. For example, when learning about Newton's

first Law, in addition to Newton in the textbook, teachers can also provide students with more photos of relevant physicists, especially real-life pictures and experimental pictures. Fourthly, the experimental illustrations in the textbook lack expressive power. To better understand the experimental process, teachers can provide students with more pictures of real experiments. If conditions permit, they can also lead students to carry out experimental exploration in class. Fifth, in the arrangement of textbook illustrations: explanatory illustrations, organizational illustrations, and knowledge structure diagrams are few, and the number of knowledge structure diagrams should be appropriately increased in textbook compilation. Teachers can also provide corresponding materials for students in class, such as guiding students to jointly make mind maps of the chapter after the chapter teaching is over. In short, textbook illustrations should reasonably increase the number and adjust the proportion of types, teachers should also make full use of textbook illustrations and play the role of illustrations in promoting learning, but also learn to supplement direct experience for students to make up for the deficiency of textbook illustrations, so as to better serve the teaching.

Disclosure statement

The authors declare no conflict of interest.

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