

Investigation and Reflection on Gender Stereotyped Illustrations in Elementary School Mathematics Textbooks: From the Perspective of Textbook Development

A Case Study of Senior Mathematics Textbooks (People's Education Press Edition)

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ABSTRACT

Elementary school is a critical period for the formation of students' gender concept. Illustrations in textbooks have an important impact on the formation of their gender concept. Study on gender orientation in the textbook illustrations shows educators' great concern for education equality from the micro level and should be taken seriously in the new round of curriculum reform of elementary education. This paper takes the figure illustration of senior mathematics textbooks in elementary school as samples, makes quantitative statistics and qualitative analysis by adopting content analysis method. The investigation findings showed that phenomenon of gender stereotypes did exist in the illustrations to a certain extent, which is embodied in such aspects as the color of clothing, social occupation, domestic division of labor, gesture behavior, mathematical culture, etc. Therefore, relevant institutions and personnel should take some measures to eliminate the possible gender bias in the course of textbook compilation.

Keywords: elementary school mathematics, textbooks, senior grades, gender stereotypes, illustrations

I. INTRODUCTION

Social gender equity is an important aspect of educational equity and an important indicator of harmonious education development. Therefore, it has been highly valued by people recently. Along with the new round of Curriculum Reform of Elementary Education, eliminating the gender stereotypes that exist in curriculum and teaching and establishing a new social concept is becoming increasingly prominent. People's gender is naturally born, but their social gender consciousness and the concept of gender equality is not [1]. Elementary school is a critical period for the formation of gender concept. Therefore, it is particularly important to permeate the concept of gender equity in textbooks in elementary school [2]. The content of current research on textbooks can be summarized into the following aspects: research on a certain section or knowledge field, usage of textbooks, and comparative study on textbooks [3-8]. Researchers mainly conducted their researches on textbooks

compilation from the macro view, and seldom of them conducted researches on the long-term impact of textbooks nor specific section of textbooks. By the means of the content analysis method, quantitative statistics and qualitative analysis, the author of this paper tries to conduct the research from the micro level of figure illustrations in mathematics textbooks to explore whether implicit gender bias and gender stereotypes really exist, and make reflection accordingly.

II. STATISTICS AND ANALYSIS OF GENDER STEREOTYPED ILLUSTRATIONS

A. Statistical distribution of the number of gender stereotyped illustrations

Gender roles are defined as the sum of expected appropriate actions of males and females from the society [9]. Stereotype is defined as the conclusion, generalization and summary of characteristics of a certain group. Gender stereotype refers to people's

expectations, requirements and general judgments on behaviors and personality characteristics of male and female respectively. Gender stereotypes exert direct influence on male and female's perceptions, attributions, motivations, behaviors, and different types of occupations choices [10].

This paper takes the elementary school mathematics textbooks from senior grades (i.e. grades 4, grades 5 and grades 6), which was published by the people's education as the subject of research. The illustrations in the textbooks can be divided into 5 aspects, including cover pictures (illustrations on textbook covers), illustrations that appears on the title page (page after the cover and before the texts), text illustrations (illustrations that appears in the texts), exercise illustrations (illustrations that appears in the exercises), supplementary illustrations (illustrations that fill the margins of the textbook). (P.S.: Illustrations whose number of figures is blurred has been excluded). The author makes qualitative analysis of the above 5 types of illustrations and tries to find out the gender stereotype phenomenon that hidden in the textbooks.

Due to the new round of compulsory education mathematics curriculum reform, the compilation of mathematics textbooks of elementary school has changed a lot. For example, the number of figures illustrations in textbooks from grade 4, 5 and 6 has been increased significantly to 586, which can be regarded as an obvious feature of elementary school math textbooks. These illustrations exert important and positive influence on enriching the content of the textbooks, improving the quality of the textbooks and

enhancing educational effect. What is more, these illustrations have played a replaceable role in simplifying abstract knowledge and improving students' mathematical literacy. In addition, the illustrations distributed in different sections of the textbooks can directly deepen students' understanding of different genders. Statistical results from "Table I" show that there are 234 illustrations of gender stereotypes, accounting for 39.93% of the total number of illustrations. These gender stereotyped illustrations mainly distributed in the exercise part, text part and supplement part. To be specific, there are 51 illustrations in the supplement part, 29 of which are characterized with gender stereotypes, accounting for 56.86% of its category. Gender stereotyped illustration in text part and exercise part accounts for 41.12% and 38.04% of their categories respectively. The distribution of gender stereotyped illustrations in each textbook is shown in "Fig. 1". In general, gender stereotyped illustrations exist in each edition of the senior textbooks, but the specific number of gender stereotyped illustrations of textbooks from different grades is uneven. (As is shown in "Fig. 1"), Gender stereotyped illustrations in the textbook from grade four account for the largest proportion. There are 87 illustrations in textbooks from grade four and 43 of them are stereotyped, accounting for 49.43%. Comparatively speaking, the proportion of gender stereotyped illustrations in the second volume of the fifth grade is smaller. But still there 35 out of 101 illustrations are gender stereotyped, with a percentage of 34.65%.

TABLE I. STATISTICAL TABLE OF POSITION DISTRIBUTION OF ILLUSTRATIONS OF GENDER STEREOTYPES

Illustration distribution	cover	title page	text	exercise	supplement	total
Character illustration	6	6	197	326	51	586
Character illustration with gender stereotypes	0	0	81	124	29	234
Percentage	0%	0%	41.12%	38.04%	56.86%	39.93%

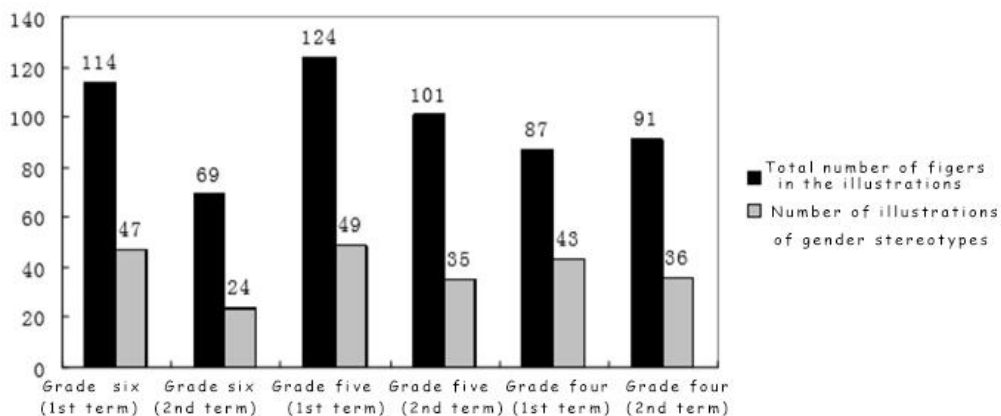


Fig. 1. Statistical distribution of gender stereotyped illustrations in each volume of textbook.

B. Statistics of figures

The number of figures of different genders in the textbook is an important clue to analyze the phenomenon of gender stereotypes. The author finds that the number of male figures and females figures in the six volumes of textbooks is 848 and 746 (As is shown in "Table II"), accounting for 53.20% and 46.80% of its total respectively. By analyzing the

textbooks, the author finds that the appearance of the male figures is much more frequent than that of female figures, especially in the textbook of fifth grade, there were 359 male and 292 female figures, and the number of the former one is 22.95% more than that of the latter one. Only the second volume textbook of sixth grade presents more female figures than male figures, the former one is 20% more than that of the latter one.

TABLE II. A STATISTICAL TABLE OF THE NUMBER OF FIGURES IN THE ILLUSTRATION

Category	Grade six (the 1st term)	Grade six (the 2nd term)	Grade five (the 1st term)	Grade five (the 2nd term)	Grade four (the 1st term)	Grade four (the 2nd term)	Total
The number of males	110	100	213	146	122	157	848
The number of females	106	120	162	130	110	118	746

The author conducts chi-square test for the number of figures from different genders and grades. The following statistical "Table III" shows the probability value of the gender difference. Sig = 0.440 > 0.05 shows that there is no significant difference. The number of students in 3 grades is different. The probability value sig = 0.324 > 0.05, which shows that there is no significant difference among the number of figures

from different grades. Despite the fact that the number of male figures is more than that of the female figures in the illustration, there is no significant difference in terms of statistics. As a result, simple quantitative statistics based on the number of figures cannot reflect the gender stereotypes in textbooks. Gender stereotypes in the textbooks needs to be further studied by other methods.

TABLE III. CHI-SQUARE TEST STATISTICAL ANALYSIS TABLE OF THE NUMBER OF CHARACTERS (PEARSON CHI – SQUARE)

	Value	df	Asymp. Sig. (2 - sided)
<i>Gender * number</i>	10a	10	0.440
<i>10Grade * number</i>	54a	50	0.324

^a. PS: a. (gender) 22 cells (100.0%) have expected count less than 5. The minimum expected count is .50.

^b. b. (grade) 66 cells (100.0%) have expected count less than 5. The minimum expected count is. 17.

C. Statistics of the color of figures' clothes

Color is an important element of illustrations. We can get more important information of gender by analyzing the color of figures' clothes in the illustration. In this paper, the author only takes the figures' top clothes as the research object. (as is seen in "Fig. 2"), the author takes the color which takes up the main body of the color of the clothes as the research object when the figure is in a mixed color. The colors of the figures' clothes in the illustration mainly consist of red, orange, yellow, green, blue, white and purple, the color red, blue and green takes up the largest percentage. The female figures in the textbooks are mainly in red, with a percentage of 24.9%; The male figures are mainly in blue and green, with a percentage of 18.7% and 16.12%, respectively. The other frequently used colors of the figures' clothes in the illustration are yellow and orange, but there is mere difference in the figures' clothes color between different genders. Colors are "beautiful," and different colors possess different meanings. Red is the most frequently used color in

textbooks. The female figures are mainly in (pink) red, accounting for 53.22% of all female figures; therefore, the color red always presents female figures in the textbooks.

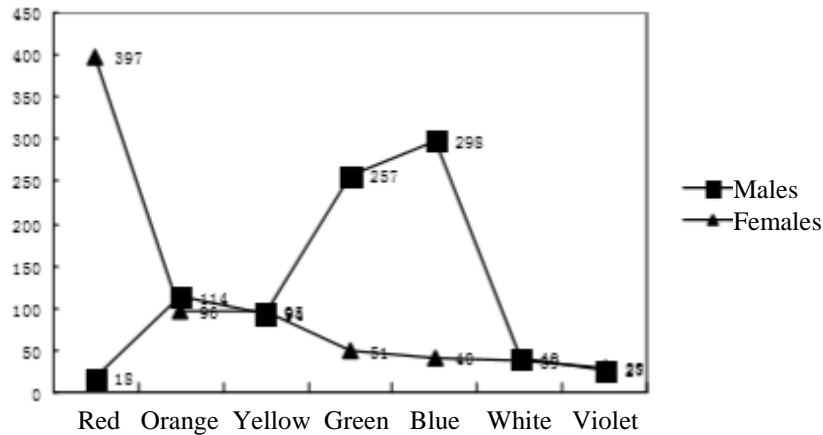


Fig. 2. Statistical graph of the color of figures' clothes in illustration.

Only 2.12% of male figures are in red. In color culture, (pink) red is a traditional female color, symbolizing tenderness, softness and obedience. Although there are 18 male figures are in red, but they are all in dark red, which symbolizes male strength, vitality and aggressiveness. Most of the male figures are in blue, accounting for 35.14% of all male figures. This is because blue symbolizes male character and spirit in social culture and it is always considered as the color of intelligence, knowledge, coolness, rationality and the pursuit and desire for life. The number of female figures who are in blue only accounts for the 2.51% of all female figures.

In addition, the color green represents longevity and charity, the season spring, thriving business and prosperity. Therefore, green is also the symbol of male. The male figures who are in green tops accounts for 30.3 % of all male figures, and female figures who are in green tops only accounts for 5.96% of their category . In addition, certain number of figures of both genders is in orange and yellow in that these two colors are eye-catching colors which can attract students' reading interest and give them sensory pleasure. Color, as a kind of culture, affects people's emotion and evokes people's natural and unconscious reactions and associations. In color culture, the most respected color is often used to describe males; the less respected colors are used to describe females. Textbook editors and writers tend to use the most popular color to describe male figures, which plays a suggestive role in the awareness of the gender stereotypes of elementary school students.

D. Classified statistics of the contents of gender stereotyped illustrations

According to the content of the illustrations, there are 234 gender stereotyped illustrations which can be

divided into the following four categories: social occupation, gesture behavior, family division of labor, and math culture. The statistical results can be seen in "Fig. 3".

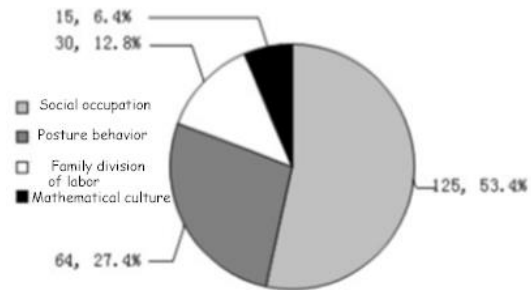


Fig. 3. Statistical table of classification of content of illustrations of gender stereotypes.

- Social occupation is termed as the specific and clearly defined behavior pattern of each individual's rights and obligations in social relations such as doctors, teachers, farmers, library managers and so on .The number of gender stereotyped illustrations of this type is 125, accounting for 53.4% of the total number of gender stereotyped illustrations. The social occupations of the male figures in the illustrations are generally higher ranked, intellectually demanding, physically demanding, such as a state leaders, headmasters, astronauts , doctors, construction workers, farmers and so on; The social occupations of the female figures in the illustrations are tend to be more tedious, service-centered, amiable such as packager, finance staff, waitress, salesclerks, teachers, librarians and so on.
- Posture behavior refers to the appearance and expression of the individual body, such as

playing basketball, rope skipping, repairing bicycles, watering flowers, etc. The number of gender stereotyped illustrations is 64, accounting for 27.4% of total. The posture of the male figures in the illustration is mostly rough and strong. Postures of this type include higher intellectual games or sports which require movements with larger amplitude and great changes in speed, such as chess, model design, basketball games, relay races, etc.; And the gesture of female figures in the illustration is much more meticulous, graceful, compassionate and careful. Postures of this type means the sports requires small movement and small changes in speed, such as drawing, watering flowers, measuring, scoring, shuttlecock kicking, rope jumping, etc.

- Family division of labor is defined as the understanding of kinship and the specific morality and behavior of each individual in a family. Illustrations of this type include the scene of a grandpa is taking his grandson to do morning exercises, a grandma is paying water bill, a father is buying his son a bike, a mother is cooking a meal. The number of illustrations of this type is 30, accounting for 12.8%. Among these illustrations, female figures generally have more opportunities to play the leading role in family division of labor, such as teaching their daughters to wash clothes, taking care of the old, taking their children to the park, paying bills, buying household goods, etc.; While male figures in the illustrations only occur in activities such as paying bills or taking their sons to participate in sports related events.
- Mathematical culture mainly includes the origin and development of mathematics, the story of mathematicians, mathematical applications, mathematical ideas and methods, such as "the chicken and rabbit question", rod-arithmetic, Zhou Bi, the story of Euclid. The number of illustrations of this type is 15 and all of the figures of this type are males. Even the figures of clever calculation, mathematical problem conjecture, and arrangement of systematical knowledge in daily life are all males. For the students, this phenomenon means that only men can make great contribution in the mathematical history. In reality, however, women's ability and wisdom is as good as that of men. Females can also make great contribution in the mathematical history as long as they are provided with a proper educational environment. Females do not merely play a supporting role in the mathematical history. Greek female mathematician Hypatia's famous statement of "using my shadow to measure the height of the

pyramid" and the correspondence between Germain and Gauss, etc. are all good examples.

III. NEGATIVE EFFECTS CAUSED BY ILLUSTRATIONS OF GENDER STEREOTYPES

Through quantitative statistics, it is obvious to notice the gender stereotypes do exist in figure illustrations in mathematics textbooks of elementary school. To be specific, people believe that certain characteristics in behavior, personality, professional role should only belong to certain gender. For example, females are always described as emotional, unenterprising, uncreative, dependent and tender. Males are always described as rational, aggressive, creative and independent. Although this kind of description partly reflects the general characteristics of both genders, but it cannot fully reflect the characteristics of both genders and it simplifies the characteristics of each gender. This kind of description is unfair for those whose characteristics have not been finalized. The illustrations in the textbooks, as kind of implicit culture, have subtle influence on the formation of students' gender concept [12].

A. Self-image

Self-image refers to the "image" or "portrait" of a person's self-recognition. Self-image is a person's perception and evaluation of who he is and what does he do, including self-esteem, confidence and the sense of control over one's life. Self-image is not innate, and it unconsciously develops on the basis of one's own experience. Gender stereotypes often lead to negative self-images. For example, females tend to regard themselves as a secondary role in society and they even look for similar evidence of this type. They are lack of confidence in learning mathematics and lack of competition with males. Finally, when the gap between males and them is really widening, practical experience and self-image is consistent with the gap. Therefore, many females unconsciously accept the fact that males are better than them in the above mentioned aspects. This view is a wrong attributional pattern.

B. Impression management

Impression management refers to the formation of a person's influence on others in a certain way. In order to be appreciated, accepted and liked by the society and other people, males and females tend to regard the rigid gender stereotyped behavior as their performance requirement. They like to express themselves in a way that can attract the attention and meet the expectations of others. For example, some girls who are good at mathematics may deliberately do badly in their mathematics test to meet the expectations of others. Otherwise they may be regarded as the weirdo among her peers; On the contrary, boys always feel that it is

quite natural for them to become scientists, doctors, engineers and even the leaders of the country in the future. Learning mathematics is only a small part of the great challenges they may encounter, so they rarely lack confidence. The existence of this kind of gender stereotyped illustration exerts negative influence on students' characteristic and behavior in the early stage of their growth. This is also one of the reasons for the absence of true humanistic education in china.

C. Self-realization

Self-actualization means that everyone needs to develop their potential and show their talents. One can only feel fully satisfied when his full potential is shown. Students are always influenced by gender stereotypes and they tend to regard gender stereotypes as the best way to be themselves. For example, males often think that they should be aggressive; Females tend to think they're not good at math and science and thus stop working hard on these subjects, which may influence their lifelong achievements.

IV. DISCUSSION AND CONCLUSION

Textbooks are very important curriculum resources, so we should pay attention to textbooks' problems; especially the subtle phenomena like gender stereotypes and try our best to avoid their harm.

A. Discussion

In 2001, The State Council officially adopted the program for the development of Chinese children (2001-2010). The program stipulated that gender equality awareness should be included in educational content [13], and since then the commonly used math textbooks from elementary school across the country have been revised several times and there have been some progress in the status of women. There's been some progress. Zhang Xun and Zhou Hongmin have made macro analysis of mathematics textbooks of elementary school, finding that there are gender stereotypes in textbooks in some degree. The author finds that there are implicit gender biases and gender stereotypes by analyzing the illustrations, which has always been overlooked. This means that gender equality is far from realized. And the proof can be seen as the following:

- There are certain numbers of gender stereotyped illustrations in mathematics textbooks. Among these gender stereotyped illustrations, the number of males is larger than that of females, but the gap is not statistically significant. This is due to the fact that gender stereotypes have attracted the society or at least the textbook compilation departments' attention [14]. But this does not mean that there are no gender stereotypes in textbook illustrations because

gender stereotypes are always expressed in an implicit way. This paper studies the "sub-obvious features" that imply gender stereotypes by analyzing the colors of the clothes of the male and female characters in the illustrations and finds that gender stereotypes really exist in the textbooks. Textbook writers are more likely to put males in the color blue which symbolizes male masculinity and morality. And the textbook writers are more likely to put females in the color red which symbolizes traditional female characters. These gender stereotypes will affect the individual development of elementary school students.

- By analyzing the social occupation, attitude behavior, family division of labor, mathematical culture, the author finds that there are gender stereotypes in the characters of illustrations in textbooks. This finding is correspond to that of Harris, Satter and Liu Xuan's research. That is, gender stereotypes of males are more obvious than that of females in career and domestic division of labor. [15~16]. In Chinese tradition, males are playing the role of the master of a family and the main worker in the society and females are often regarded as understanding wives and loving mothers. With the uprising of equality of social division of labor and the emancipation of female thoughts, the differences of division of labor and position between males and females are not that clear. This kind of "invisible" hidden danger that exist in mathematics textbooks requires people's attention. Otherwise it may lead to the result that different genders' shall have different expectations on occupations and different positions shall raise different requirements for different genders. At the same time, textbooks convey the students the history and culture of mathematics by the means of pictures and stories. Researches of the textbooks have shown that gender stereotypes of males are much more successful than females in society, which can be taken as a dangerous implication for elementary school students. Of course, the formations of gender stereotypes are closely related to life background, family environment, personality and so on. This research may fail to include every aspect. The previous researchers put their focus on the methodological test to prove the existence of gender stereotypes, few researchers examine the causes and effects of gender stereotypes [17]. By analyzing the illustrations of textbooks, the author of this paper not only finds out the reasons for gender stereotypes, but also provides an operational solution to solve the problem of gender stereotypes.

B. Conclusion

This research have shown that gender stereotypes do exist in textbook figures illustrations in some degree of phenomenon, which can be witnessed in the color of the figures' clothes, social occupation, domestic division of labor, gesture behavior, mathematical culture, etc. Gender stereotypes affect students' aspirations and ability. Researchers should take relevant measures consciously to eliminate possible gender stereotypes in textbooks so that the students can have a brighter future and get away from negative influence from gender stereotypes. First of all, people who are in charging of textbook publishing, including textbook publishers, editors, and illustration designers should raise their awareness of gender equality and hold some seminars on gender issues; at the same time females should be encouraged to participate in textbook editing and illustration design. Secondly, national textbook examination committee should take gender issue as one of the standards of teaching material examination. Last but not least, teachers play a decisive role in the development of students' gender roles. Therefore, teachers should establish a correct view of gender; Meanwhile teachers should pay attention to the problems of gender stereotyped textbook illustrations, do the teaching reflection in time report gender stereotyped problems to the compilers of textbooks in time and thus doing a good job in supervising the quality of textbooks.

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