Eliminating Gender Bias from Mathematics Textbooks in Palestinian Schools from Grades 1 to 12: A Proposed Mechanism from Gender-Specific Toward Gender-Neutral Norms

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Eliminating Gender Bias from Mathematics Textbooks in Palestinian Schools from Grades 1 to 12: A Proposed Mechanism from Gender-Specific Toward Gender-Neutral Norms

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Abstract: Eliminating gender bias from mathematics textbooks in Palestinian schools is not an easy task, given that 50% of the names, verbs, actions, professions, or pictures in mathematics' textbooks portray traditionally feminine activities, such as sewing and embroidery. In these textbooks, these feminine activities do not involve males. Eliminating gender bias from mathematics textbooks in Palestinian schools is more challenging than we think because these biases are rooted in culturally based mind-sets. Therefore, upon careful analysis of this important and crucial issue, the researcher suggests a new framework for developing mathematics curricula based on gender balance, which is a gender-neutral approach.

Keywords: Gender bias, Gender balance, School mathematics textbooks, Gender neutral

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Introduction

Mathematics is considered a foundation of national development (Alutu, A. N. G. and Eraikhuemen, L. ,2004), and technology would not exist without mathematics. Moreover, mathematics invented by both males and females (such as the famous female mathematician Hypatia) (Poincaré, H ,2012).

Unfortunately, some educators are deliberately view the role of males in mathematics and neglect the role of females (Sleeter, C. E., & Grant, C. A,2017), although there are many female mathematicians (Coolidge, J. L,1951).

Malala Yousafzai illustrated the importance of gender, teachers, books (such as mathematics and other subjects), and pens in the following piece of wisdom:

"One child, one teacher, one book, one pen can change the world."

-Malala Yousafzai(2019)

First, Malala explicitly described the effect of the teacher and the curriculum in changing students'lives for the better, so the curricula and textbooks are the most important drivers of change, and the acquisition of knowledge and understanding is considered the backbone that empowers people.

Second, Malala implicitly directed us to pay attention to the curriculum to achieve the mission and vision that we seek for advancing humanity and empowering individuals with knowledge, especially given that we are in the digital information era.

Finally, Malala is on a feminist leadership mission and aims to eliminate all means of misogyny, i.e., gender bias, in domains such as school curricula.

Curriculum and gender in mathematics teaching and learning are considered one of the most important trends in equity and equality. Equity in mathematics means eliminating all means of "gender, race, class, special needs, and language that affect our own teaching and our students' learning of mathematics in our classrooms" (NCTM, 2008).

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No one ignores women's shaping history, women have struggled to survive, but also contribute to develop life and solve problems. There are many women who presented very great achievements in various fields of science in general and in the fields of mathematics (194 females, see[1]) in particular, such as the creative mathematician Hypatia (370-415) who formulated the important basic conic concepts such as ellipses, parabolas, and hyperbolas, which are considered the soul of modern mathematics) Osen, L. M,1974, Case, B. A., & Leggett, A. M. (Eds.),2016, Chipman, S. F, 2005)

Hypatia was not the only creative woman in mathematics, many women made great achievements in the field of mathematics, (Henrion, C,1997, Morrow, C., & Perl, T. (Eds.),1998, Taylor, J. E., & Wiegand, S. M,1999, Hewitt, G. C,1978).

Gender equity in mathematics has grabbed the attention of the National Council of Teachers of Mathematics (NCTM) in the United States recently (see, for example, Aguirre, J., Herbel-Eisenmann, B., Celedon-Pattichis, S., Civil, M., Wilkerson, T., Stephan, M., ... & Clements, D. H. (2017); Warburton, T., & Buendia, E. (2016);Reinholz, D. L., & Shah, N. (2018); Kitchen, R., & Berk, S. (2016);Selling, S. K. (2016); and Larnell, G. V. (2016); all these studies recommended gender balance and equity in teaching, learning, evaluation and testing in mathematics' school textbooks).

Additionally, more recent studies have recommended the need to develop mathematics' textbooks to promote greater balance between females and males in the content of mathematics' such as the study of Karama.M.J (2020). To achieve this goal, we can integrate gender balance into the mathematics' curricula taught by school teachers as well as develop the teachers' guidance to achieve the mission, but what is gender balance? How and when should we promote it? We aim to address this complicated issue in this study.

[1] https://www.agnesscott.edu/lriddle/women/chronol.htm

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Before answering these questions, it is important to present the structure of the mathematics curriculum from kindergarten to 12th grade, which consists of the content and operations identified by the National Council of Teachers of Mathematics in the United States (NCTM in 2000) and is followed by the content of core mathematics, also by NCTM (2006). In summary, the mathematical content consists of numbers and operations, algebra, statistics, probabilities, and measurement. There is mathematical knowledge in such content as facts, concepts, procedures, and problems. It is useful that each element of content in mathematics has different teaching methods.

Mathematical facts are the basic bricks of mathematical content, such as symbols of numbers and geometrical shapes (such as squares). While concepts in mathematics are based on facts that making sense of symbols, shapes, terms, and procedures or generalizations, the elements form a relationship between two or more concepts, such as the calculation of the area of a square. On the other hand, the problems in mathematics reflect the integration of all elements of mathematical content into a new and confusing situation for the student, such as finding the length of the diagonal of a square.

In summary, the relationship between mathematical content and its knowledge matrix can be clarified in a simpler way (see below; adapted from NCTM, 2000, and developed by the author of this article).

Table (1): Interaction among gender context, mathematical content and its knowledge

Knowledge Content	Facts	Concepts	Producers	Problems
Number and operations	Gender Context			
Algebra				
Geometry				
Data analysis and probability				
Problem solving				
Reasoning and proof				
Communication				
Connection				
Representation				

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To clarify how to address Table (1), it is useful to provide more explanation in how it works. There are three dimensions: content to be taught by teachers to their students, i.e., knowledge; ways of mathematical thinking to be learned by students; and the medium among teachers, students, and content, which is the human context, such as gender issues. Thus, this medium is one of the most important pillars in transforming mathematics from the abstract form into something has a meaning of our daily life.

To be more precise, we can give examples in how this matrix works. If we use numbers and operations, we need actual numbers and operations in a human context, such as counting processes; e.g., one is related to my mother, two is related to my parents, and three is related to me and my parents.

In the same manner, we can use every day issues in mathematical concepts. For example, if we need to teach our students the concept of the number two, we need to connect it with our body (we have two eyes, ears, hands, and so on).

Mathematical procedures also need a human context, so if you teach your students how to subtract, you need to put it in an everyday context, such as "Lila has five red flowers, but she lost two of them; how many flowers are left?"

Meanwhile, problem solving in mathematics fully dependent on the human context, so if you take a close look at any problem, you must determine the everyday context. For example, if we teach our students about the Pythagorean theorem, we can use any application related to students' daily lives: "If Jean's house is 40 meters farther than Jon's house, and Jon's house is 30 meters farther from Julia's house with a right angle, determine the distance between Jean's house and Julia's house."

In conclusion, it is very difficult to consider teaching and learning mathematics without a human context because mathematics used to solve our everyday problems, and it invented by the human brains of both females and males. Thus, there is no preference for any specific gender because they are equal partners.

Gender trends in mathematics textbooks

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The researcher conducted a survey of previous studies that addressed gender trends in mathematics' textbooks, in which he reached a set of conclusions and classifications for these studies. Then he developed the theoretical framework that is believed to be effective in integrating the concepts of gender in mathematics textbooks in Palestinian schools.

The first trend (which is popular worldwide) is the formulation of the mathematics' curriculum so that it is biased in favour of males at the expense of females, such as the studies of Kenway, J., Willis, S., & Junor, A. (1994), Karama. M. J. (2020), Hodes, C. L. (1995), Burton, L. (1990), and Leder, G. C., Forgasz, H. J, & Solar, C. (1996).

As this approach does not take into account females and requires females to adapt to the methods of mathematical thinking and study, as is the case for males, any reminder of females led to the superiority of males in achievement and the frustration of women, which affected their self-confidence.

The second trend is to develop the mathematics' curriculum so that it becomes more compatible with feminine culture and knowledge and includes activities and themes in mathematics that are predominantly female, such as female pictures and female athletes, as well as sewing, embroidery, symmetry, mosaic, ceramic, weaving, cooking, sweets and fashion. In short, mathematics should be more tailored to females, which may require males to adapt more in the learning of mathematics. This type of curriculum raises the morale and achievement of females, but reduces morale and the achievement of males, as observed in studies in this area, such as the study of VI.RIH. (1990) and the study of DowiINC, P. (1991).

There is a third gender-related trend in mathematics' curricula through the inclusion of male- and female-centred content in mathematics' books, but the results of the application of these approaches were not fair for females and males which was proved by a study of Kenway, J., & Willis, S. (1993).

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From the previous presentation of the international trends in addressing the issue of gender in the mathematics' curriculum, we find a large gap in these trends, either predominantly female or predominantly male, and this makes us suggest creative and innovative ways to address the gender issue in mathematics' curricula. The following describes a creative solution to this dilemma.

Research Methodology

After the researcher conducted a literature review for studies that addressed the elimination of gender bias from school mathematics' textbooks and explored different trends in this very important issue, no studies were found in Palestine aimed at resolving this problematic situation. Thus, the researcher determined the theoretical framework of this study.

Then, we designed a proposed mechanism based on the theoretical framework, that was explored in the previous step, to bridge the gap in samples of Palestinian mathematics textbooks that were analyzed by the researcher and showed the need for gender balance or gender-neutral content.

The Theoretical Framework

Before presenting the solution, I have to mention the conversation that occurred between me and my daughter. She said, "Dad, we know human is hu-MAN and not hu-WOMEN." In fact, I shocked by the statement of a girl of only 10 years old, and I said to myself, I did not have a response to her.

Hence, the response simply begins for the above statement from this little girl, as females reject male linguistic dominance and vice versa. The origin is gender neutrality (zero gender content based or ZGCB) in mathematics curricula. In other words, when females read mathematics texts, it should be considered neutral, and when males read the same text, they should have the same reaction. Thus, all words and terms that differentiate males and females must be replaced by words and terms that address unity, including the following: the use of pronouns and nouns such as you, I, we, they, person, people, and individual; the use of verbs such as drawing and solving; and the use of images that combine male and female actions to achieve gender-based justice.

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Thus, our ZGCB framework will be very simple, as follows:

Gender components	Names	Verbs	Pictures	Pronouns	Professions
Suggestion mechanism	Try to use names related to females and males at the same time, such as (these names in Arabic culture have the same meaning for females and males): Afnan, Rewah, Wisam, and Anan. In the English language, we can use the following: people, persons, individuals, and living souls.	Try to use verbs related to females and males at the same time, such as drawing, dived, and computed.	Try to use pictures related to females and males at the same time, such as family pictures and a team of teachers.	Try to use pronouns related to females and males at the same time; for example, instead of her and him, consider using me, you, and us. Also, please use Ms. and Mrs. properly.	Try to use professions that involve both females and males, such as a team of doctors or engineers.

The most important mission of the above ZGCB framework is to eliminate all means of differentiation between female and male and to achieve zero effects of the gender issue on the mentality of all partners (female and male). According to this vision, we can build mutual respect and neutralize gender-related clutter, resulting in equity, equality, and a mind-set that no one better than another.

Applying the ZGCB framework in the Palestinian case

Based on the gender analysis conducted by the researcher in selecting the 1st, 4th, 7th, and 11th grades for the interval sampling method, the following results were found when the data were treated by the ZGCB framework.

1) Among students in the 1^{st}, 4^{th}, 7^{th}, and 11^{th} grades, respectively,37%,36%,39%, and11% of the names in mathematics textbooks in Palestinian schools (MTPSs)were specific to females (average of 29% across grades), while 63%,64%,61%, and 89%of names were specific to males (the average of 71% across grades). According to our framework, names for females and males should be replaced by gender-neutral names, such as Alex, Annan, Rewash,

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Bay, Wismar, Anan, and others. The following links have many gender neutral, unisex, non-binary names[2], and the link[3]

2) Among students in the 1st, 4th, 7th, and 11th grades, respectively, 31%, 17%, 28%, and 0% of verbs in MTPSs were specific to females (average of 17% across grades), while69%, 83%,72%, and 100% of verbs were specific to males (average of 83%across grades). Thus, our solution is not to make 50% of verbs specific to females and males, but rather to replace all of these verbs with more gender-neutral terms, yielding the following verbs:

Add, subtract, multiply, divide, draw, compute, figure out, evaluate, estimate, and calculate, among others. The purpose of this suggestion is to remove the initial trigger of gender differentiation, which is the verb; therefore, this approach de-emphasizes gender parity and promotes greater focus on the mathematical problems themselves, rather than on self-assertiveness, frustration, and depression.

3) Similar to verbs, among students in the 1st, 4th, 7th, and 11th grades, respectively, 27%, 27%, 40%, and 0%of pictures in MTPSs were specific to females (the average of 25% across grades), while73%, 73%,60%, and 100% of pictures were specific to males (average of 75% across grades). Therefore, these pictures will be replaced by neutral pictures that convey equity and equality. This does not equate to the use of pictures that have 50% of both genders represented, i.e., equality in terms of quantity. Rather, the solution pertains to the quality and depth of meaning of these pictures. Thus, the following ideas are proposed for such pictures:

[2] : https://www.babycenter.co.uk/a1026121/unisex-baby-names

[3] http://hayatouki.com/baby-names/content/2179945-%D9%84%D9%87-%D9%88%D9%84%D9%87%D8%A7-%D8%A3%D8%B3%D9%85%D8%A7%D8%A1-%D9%85%D8%B4%D8%AA%D8%B1%D9%83%D8%A9-%D8%AA%D8%B5%D9%84%D8%AD-%D8%A7%D9%84%D8%A5%D9%86%D8%A7%D8%AB-%D9%88%D8%A7%D9%84%D8%B0%D9%83%D9%88%D8%B1-%D9%85%D8%B9%D8%A7%D9%8B.

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Families having a picnic, parents, a team of scientists demonstrating gender parity, a family in the kitchen, and a team of teachers. As mentioned earlier, the aim is to let our students learn in a safe social environment that promotes mathematical thinking and does not increase the social gap between parties. Another suggestion is to use pictures of cartoons and comics, such as those found in the following link[4]

4) Among students in the 1st, 4th, 7th, and 11th grades, respectively, 45%, 45%, 0%, and 8% of pronouns in MTPSs were specific to females (the average of 28% across grades), while 65%, 65%, 100%, and 92% of pronouns were specific to males (the average of 72% across grades). In this case, we can use as much gender-neutral pronouns. For example, she and he (same as her/his) may be replaced by it, one, them, there, and us. Therefore, our objective is to use gender-inclusive pronouns for all students. The following link has comprehensive information on gender-neutral pronouns[5]

5) Among students in the 1st, 4th, 7th, and 11th grades, respectively, 0%, 33%, 33%, and 0% of careers and professions were specific to females (average of 14% across grades), while100%, 77%,7%, and 100% of careers and professions were specific to males (average of 86% across grades). Therefore, we need to replace the term for each profession with a gender-neutral term, such as replacing the term "policemen" with "officers", "fireman" with "fire-fighter", "weatherman" with "meteorologist/weathercaster", "cameraman" with "photographer", "salesman" with "salesperson", "landlord" and "landlady" with "owner", and "bellboy" with "bell service", among others. The following link has many useful suggestions for this issue[6]

[4] :https://www.cartoonstock.com/directory/g/gender_neutral.asp
[5] :https://ok2bme.ca/gender-neutra-pronouns/
[6] : https://en.wikipedia.org/wiki/Gender-neutral_language#cite_note-23

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Closing and recommendation

This study has shown how to treat gender representation in a scientific manner; thus, we can replace any gender-related verb, name, picture, and pronoun with a gender neutral, unisex, or non-binary version. This approach may reduce the differentiation between gender and encourage a culture of homogeneity, tolerance, and creativity, because no gender type is better than another. In fact, gender subtypes complement one another, such as a flower and bee: there is no honey if one of them is missing.

The application of gender neutrality in school mathematics textbooks is psychologically comforting to all and encourages students think about math and problem solving rather than engage in thought processes that disrupt their scientific thinking. For example, if a math problem has a male-dominant theme, then a female may consider issues such as “Why the person in this problem is male? “As a result, their focus may have distracted by this social issue, which is not necessary in any textbook.

However, there are questions that need to be answered including: Does gender neutrality solve the problem of balance in school math books? Is neutrality a more appropriate term than bilateral? Is gender the result of bickering between two parties? How can gender truly be established in math books and stem from human instinct rather than from pressure placed by one party upon another?

I suggest these questions to be the core of future studies and investigations.

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