

# Visual representations of women in a Jamaican science textbook: perpetuating an outdated, sexist ideology

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## ABSTRACT

The gender gap in post-compulsory science education remains a key concern for educators in many countries. Over the last two decades significant effort has been placed in a number of initiatives aimed not only at raising the profile of science in schools, but also at widening female participation. Despite these initiatives, the rate of female participation in science has typically remained below that of males. Although many reasons have been advanced to explain this, visual representations in school science textbooks remain under-researched. Against a background of gender disparity in the Jamaican education system, this article examines the extent to which visual representations in a widely used school science textbook reinforce or ameliorate gender stereotypes. The results indicate that the textbook presents implicit support for gender-biased messages, though in ways that are more subtle than might be supposed. There were a number of ways in which the images did not favour males over females but there were also other ways in which males were more likely to be portrayed as powerful and in high-status 'positions', while females were more likely to be depicted in inferior situations. Such gender representations may affect how students see themselves in relation to science.

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## Introduction

Concerns about equity in science and science-related fields have been a central issue for academic scholarship for decades. These concerns reflect a broad spectrum of perspectives ranging from systematic gender biases (Miller & Wai, 2015) to issues related to the racialisation of science and its implication for minority people (Archer et al., 2015). It is, however, the notion of science as both a repository and a source of gender-based forms of oppression that has dominated critical theory scholarships (Richardson, 2013). The general thrust of these concerns is that the epistemic ideas and discursive practices of science embody a form that is androcentric in origin (see, for example, Charles & Bradley, 2009). Such narratives have been used through

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systematic and unconscious reinforcement to reproduce gender-normative stereotypes, which has marginalised and devalued the contribution of women in science.

At the same time, feminist scholars have also drawn attention to further issues regarding the access, participation, and achievement of females in school science (Cooper & Berry, 2020; Riegler-Crumb et al., 2012). Evidence from a range of international studies seem to justify these concerns. For example, in the UK, research by the Wellcome Trust (2017) found that 48% of females compared to 54% of males were likely to study a science or science-related subject at A Level (the main course for 16–18 year-olds who remain in school after the age of 16). Although this suggests only a modest gap between the sexes when it comes to studying post-compulsory science subjects, we would argue that these sorts of relatively small sex differences accumulate at the various stages in a person's life where they make decisions (or decisions are made) about their study/employment. Indeed, in Canada in 2016 women accounted for less than one third of students in STEM undergraduate programmes of study (Statistic Canada, 2017). Such studies highlight the continuing gender gap in post-compulsory participation of male and female students in science education, the UK data coming from 16–18 year-olds in schools, the Canadian data coming from the next phase of education, namely for undergraduates.

The situation in poorer countries, like those in the Anglophone Caribbean such as Jamaica, is even more worrisome as it lags behind that in wealthier countries. Data from the University of the West Indies indicate that despite a rise in the number of females participating in STEM disciplines, between 2014 and 2017 males accounted for the majority of the cohort (University of the West Indies, n.d.). In terms of school attainment in science, although some progress towards gender parity has been made, males continue to outperform females in the Caribbean Secondary Education Certificate at age 16 in biology (a pass rate of 75% compared to 70% for females), chemistry (61% compared to 57%) and physics (55% compared to 46%) (Caribbean Examination Council, 2016).

Although many factors may play a part in explaining sex-specific findings in attainment and participation, such as those reported above, including student interest in science and broader societal assumptions about what is suitable for girls as opposed to boys (e.g. Davis & Hines, 2020; Metcalfe, 2018), what is not always considered is how students internalise and therefore accept hegemonic visual gender stereotypes in school science textbooks and how this might influence their participation in science subjects once such subjects are no longer compulsory. It is against this background that this article examines the extent to which visual representations in a Jamaican school science textbook reinforce or ameliorate gender stereotypes. It is important to note that the extent to which visual representations in science textbooks influence the construction of students' social realities must remain an open question. However, textbooks must not only be viewed as pedagogical tools but also as systems of representation through which 'latent messages' about the characteristic of members of various social groups are transmitted (cf. Hickman & Portfolio, 2012).

Such messages are shaped and disseminated by an androcentric and patriarchal hegemonic society whose cultural norms and attitudes are prejudiced against women (Reddock, 2016). Thus, the visual representation of women in Jamaican science textbooks should be a consideration in a study of this nature since the social identities

and roles of women in Jamaica differs in many ways from those in wealthier nations. Jamaica is still, for the most part, a conservative country, with a long history of colonialism, and the traditional roles of men and women still exist and operate (Reddock, 2016). Thus, despite considerable reconfiguration in gender equality in some aspects of the Jamaican workforce and education system, a feeling of unease still persists regarding the dearth of women in science, when compared with so-called first world countries (Elliott, 2013).

## Gender ideology in Jamaica

Over the last three decades there has been heightening awareness in Jamaica about the need to bring gender issues into the mainstream and a renewed interest in the relationship between ideology and gender realities within Jamaican society (Reddock, 2016). Research led by the Centre of Gender and Development Studies at the University of the West Indies has shifted the argument from the established dyadic logic of gender ideologies – dominance versus subjugation, oppression versus privilege, master versus subject – to a more holistic understanding of the intersecting social categories which affect the experiences of women in Jamaica and which are seen as impediments to upward mobility. Intersectional paradigms recognise that gender issues are not the result of monolithic categories but are influenced by a complex interconnectivity of multiple social factors, such as sexuality, ethnicity and class, that have significant consequences for social outcomes (Carpenter, 2017).

At the same time, the academic space in Jamaica has also been broadened by scholarly work conceptualised within a social constructivist approach examining the discursive construction of masculinity. Among the most influential of these works are Errol Miller's *The Marginalisation of the Black Male: Insights from Development of the Teaching Profession* (1986) and *Men at Risk* (1991). In both these publications, Miller grounded his analysis in postcolonial theories and offers a counter-narrative to the notion that male domination has resulted in the subjugation of Jamaican women. Instead, he argues that the liberation of women in Jamaica has been as a direct result of the colonial establishment decision intentionally to impose restrictions on indigenous male access to economic opportunities that could increase their social mobility. The unintended consequence of such actions, Miller argued, was that black women enjoyed greater upward mobility than men as they took advantage of educational opportunities, so that their enrolment in secondary and tertiary institutions increased. Miller's marginalisation concept was greeted with scepticism and resentment by a range of scholars; for example, Figueroa (2004, p. 138) argued that Jamaican men had 'access to a broader social space and greater control over a wider range of resources'. Nevertheless, Miller's arguments resonated with those who had long lamented the various arguments directed against men. This debate highlights some of the complexities of gender in Jamaica. Figueroa (2004) noted that gender issues in Jamaica often display a texture that is distinct from those identified by scholars in other countries, resulting in what LaFont (2000) described as a 'gender war'.

Perhaps unsurprisingly, in spite of considerable academic achievement, very few women occupy decision-making positions within the Jamaican society. Indeed,

according to the United Nations Development Programme (2015) report on the status of women in Jamaica, women hold less than a quarter of the seats in both the Senate and the House of Representatives. Moreover, since the island gained independence in 1962, only one woman has held the post of Prime Minister compared to six males and none has ever been appointed to post of Governor General, the ceremonial head of the parliament. Science and technology in Jamaica have not been exempt from this 'glass ceiling'. Although, women have progressively moved into middle-management positions in science and science-related fields, very few have been elevated to top positions (Hernandez, 2021).

Connell's (1987) account of hegemonic masculinity and how this works to construct and legitimise men's privileged space in society while justifying the subjugation of women offers a means of making sense of the 'politics of representation' at issue here. In his interpretation of Gramsci's (1971) theory of hegemony, Connell (2005, p. 34) discusses hegemonic masculinity in terms of 'the configuration of gender practice which embodies the currently accepted answer to the problem of the legitimacy of patriarchy, which guarantees the dominant position of men and the subordination of women'. At its foundation, this concept denotes an oppressive relationship between men and women. This casts women in the narrative role of home makers, reinforcing a value system that discriminates against females while, at the same time, presenting males as independent and in control (Lamont, 2015). Such a regime of representation depicts a 'gender hierarchy' which is considered an accepted ideological form of social organisation, and this may influence girls' academic and career interests (Elgar, 2004).

Simone de Beauvoir's (1949) conception of the 'other' provides a fruitful perspective from which to examine gender relations in the Jamaican context. In the introduction to her ground-breaking work *The Second Sex*, she argued that women have occupied an inferior position to men. She writes 'she is defined and differentiated with reference to man and not he with reference to her; she is the incidental, the inessential as opposed to the essential. He is the Subject, he is the Absolute – she is the Other' (p. xxii). This argument – between man as 'subject' and woman as the 'other' – has been used by several scholars to critique the roles of women and girls in Jamaican society, in particular focusing on how these intersect with other aspects of subordination, such as race and class, to reinforce dominant gender ideologies (see, for example, Rowley, 2010).

In her assessments of 'gender realities in Jamaica', Bailey (2002) argues that woman as the 'other' is embedded in relations of power which should be understood in terms of dyadic relations of domination/subordination. Under such conditions, power is usually directed against women, who do not have the power to define the terms of their situation. Although this claim is contested, most feminist scholars seem to have sided with it. For example, MacKinnon (1987) argues that gender relation is itself a function of domination/subordination and, as she puts it, 'the social relation between the sexes is organised so that men may dominate and women must submit' (p. 3). The implication here is that men are powerful and women powerless. As MacKinnon further articulates, 'women/men is a distinction not just of difference, but of power and powerlessness' (p. 123).

## Gender representation in science textbooks

Previous research findings emanating from a range of countries suggest that science textbooks have long supported a sexist presentation of the natural sciences. In an analysis of 80 science textbooks from both primary and secondary schools, Powell and Garcia (1985) found that men were shown more than women and that over 85% of the occupations pictured were represented by men. Bazler and Simonis (2006) examination of seven secondary chemistry textbooks found that only one achieved gender parity in image representation; the other books overwhelmingly pictured more men than women. Elgar (2004) reported the following patterns in text illustrations: (1) in all chapters there were more male images than female images; (2) males were portrayed more as role models and ranked more prominently than females; and (3) there were relatively low level of integration of achievements of women scientists. The findings of Elgar's (2004) study are also consistent with those of more recent research (Baker, 2016; Parkin & Mackenzie, 2017).

Although some writers have reported some moves towards gender equity with respect to the visual images in modern science textbooks (Baker, 2016), there is still considerable evidence that females are typically portrayed in stereotypical ways that reflect and sustain socially endorsed views of gender. Parkin and Mackenzie's (2017) examination of the 'genderness' within key stage 3 science textbooks (for 11–14 year-olds) in the UK revealed that males were significantly more likely to be depicted as active (altering the situations around them) than were females, who were more likely to be represented as passive (merely reacting to their environments). In the images examined by these researchers, females were depicted in roles that epitomise 'traditional' women's roles – namely, cooking, cleaning, and childcare. These stereotypical representations of females reinforce at least two harmful beliefs. First, they may suggest that females are, first and foremost, helpmates and supporters of men and families, thus reinforcing the traditional dominant-subordinate pattern of male-female relationships. Secondly, they may imply that women inherently have different interests and are better at some things compared to men (gender essentialism), for example, that women are better at domestic tasks than are men.

## Social semiotics

The framework used in this article draws heavily on the ideas of social semiotics described in Kress and van Leeuwen's *Reading Images: The Grammar of Visual Design* (2006). This highly cited book (17,245 citations on Google Scholar at the time of writing) helped usher in an entire new way of understanding visual imagery, in a way very different from that employed by art historians (cf. Hatt & Klonk, 2007). Kress and van Leeuwen take as their starting point that all signs and messages are carriers of cultural values and significance, and therefore should be positioned within a social, cultural and historical context. In so doing, their approach not only builds on the social functional perspective of language (Halliday, 1978) but moves beyond written and spoken language to include the full repertoire of semiotic modes. It is these modes, Kress and van Leeuwen argue, that are constitutive of the material means, and which have been socially and culturally moulded by different communities into semiotic

resources. In this sense, social semiotics replaces the principle of 'arbitrariness' to one of 'motivation' in all instances of sign making, for any kind of signs (Hodge & Kress, 1988). This position is captured in Kress (2011, p. 209, italics in original) in which he describes signs used in social semiotics as '*motivated* conjunctions of form and meaning, the product of the sign-maker's agency, and as representing her or his *interest* at the moment of the making of the sign'.

Kress and van Leeuwen's (2006) framework for analysing the 'grammar of visual designs' draws on the metafunctional elements of Halliday's (1978) Systemic Functional Linguistics. The functional components are discussed at length elsewhere (Halliday & Hasan, 1989) but can be summarised as follows: ideational (the function for engaging human experience); interpersonal (the function of establishing social interactions) and textual (the function for text cohesion). These three metafunctions are closely interrelated and interdependent and by applying them to other semiotic modes an underlying assumption is that visual images also draw upon the same semantic systems as language in realising meaning potential. Moreover, as Kress and van Leeuwen (2006, p. 44) noted, while visual modes differ in terms of the ways in which choices from the social semantic system are realised, 'the semiotic code of language and the semiotic codes of pictures [and other visuals] each have their own quite particular means of realising what in the end are perhaps quite similar semantic relations'. The metafunctions in Systemic Functional Linguistics were renamed in *Reading Images* as *representational meaning*, *interactive meaning* and *compositional meaning*.

### **Representational meaning**

Central to Kress and van Leeuwen's understanding of representational meaning is the notion that 'any semiotic mode must be able to represent aspects of the world as it is experienced by humans' (2006, p. 42). Thus, representational meaning deals with the expression of experiences. Kress and van Leeuwen noted two types of participants that one must consider when analysing images: interactive participants and represented participants. Interactive participants are those persons who interact with each other in the act of reading a visual image while represented participants are those elements that are present in the image. These two types of participants are connected through 'vectors' (lines of direction), which often, though not always, take the form of sight lines between represented participants.

Kress and van Leeuwen (2006) posited two major processes that embody the relationship between individuals, places and things in visual images: narrative processes and conceptual processes. A narrative process represents 'unfolding actions and events process of change, transitory spatial arrangements' whilst a conceptual process 'represents participants in terms of their more generalised and more or less stable and timeless essence' (p. 79). Narrative structures are realised by using vectors. Thus, depending on which vectors are used and the participants' involvement, narrative processes can either be action or reactional. Action processes are realised by vectors originating from one participant and directed at another whilst reactional processes are concerned with vectors produced in the direction of the participants' glance.

As for conceptual structures, three dimensions were identified by Kress and van Leeuwen (2006): analytical (involving a carrier and parts that give possessive attributes to the whole); symbolic processes (depicting what a participant is or means) and classificational processes (relating participants to each other). Symbolic processes are broken down into two further categories: symbolic attributive and symbolic suggestive. Symbolic attributive processes depict the association between the carrier and the symbolic attributive; in other words, a participant comes to represent something other than the participant itself. In contrast, symbolic suggestive processes only deal with the carrier.

### ***Interactive meaning***

Interactive is the second of Kress and van Leeuwen's metafunctions and may provide an explanation for the power relationships and attitudes that are constructed between the makers and the viewers of the image. Here, three kinds of relations are identified: the relationship that connects represented participants; the relationship that is categorised by the interactive and represented participants; and the relationship that is categorised by interactions amongst the interactive participants.

These various relationships are realised through contact, social distance, attitudes and modality. Contact is established through the represented participants' gaze and can be of two types: demand (a participant's gaze is directed at the viewer) and offer (a participant's gaze is directed away from the viewer). Social distance describes the kinds of social relations between participants, whether they be long-term or short-term relationships, and are realised by different sizes of the frame. Attitudes are established by degree of involvement or detachment between participants. Modality refers to the representation of people as though they were real or as though they did not actually exist and can be indicated by means of visual markers such as colour saturation and contextualisation.

### ***Compositional meaning***

The composition and organisation, elements that connect the representational and the interactive metafunctions into a purposeful whole, represent the third metafunction of Kress and van Leeuwen's (2006) analysis. Here, meanings are depicted in terms of three interconnected systems: information value, salience, and framing. Informational value is correlated with the location of specific elements of the image in relation to each other. For example, Kress and van Leeuwen demonstrate that when images are viewed horizontally, the value of an element on the left zone may be seen as 'familiar' while an element on the right zone may be considered as 'unfamiliar'. Conversely, when elements are observed vertically, those in the top zone are interpreted as 'ideal' whilst those in the bottom zone focus on the 'factual'. Salience refers to the method by which the elements in the composition are positioned to attract attention to various degrees. For instance, a foregrounded image is more salient than one placed in the background. Salience can be determined by considering factors such as tone, size, contrast, colour, focus, perspective, and overlap.

## Methodology

### Research question

Do visual representations in a widely used Jamaican science textbook reinforce or ameliorate gender stereotypes?

### Methods of analysis

The textbook analysed in this article is Mitchelmore's (2009) *Investigating Science for Jamaica, Book 1*. This textbook was selected as it is amongst the most widely used (very possibly the best-selling, though we were unable to obtain data on sales) in the first form (for 12 year-olds) in Jamaican secondary schools. Content analysis and semiotic analysis (as outlined above) were used to address the research question. Content analysis of textbooks has the benefit of producing numerical data and allows for statistical analysis and pragmatic conclusions to be made in a reliable and efficient way. Semiotic analysis allows the 'systematic, comprehensive and coherent study of communications phenomena' (Hodge & Kress, 1988, p. 1) by exploring the affordance of the meaning-making potential of signs. In this sense, semiotic analysis is well adapted for alerting us to the varied ideological meanings constructed through visual images by dominant groups in Jamaican society.

Some have argued that semiotic analysis can lack validity since it relies on assertions (Sonesson, 2010), i.e. on subjective interpretations. Combining content analysis and semiotic analysis should not only provide quantification but also strengthen the semiotic claims made in the study. This approach has been effectively utilised by researchers such as Bell and Milic (2002), who, following on from Goffman's (1976) examination of images in US magazines, analysed gender stereotypes in 827 advertisements from a representative sample of popular Australian 'men's' and 'women's' magazines as well as magazines aimed at a general readership.

### Content analysis

With respect to gender, females and males appearing in drawings and photographs were counted both by the number of individual people illustrated and by the total number of illustrations for each gender. In most of the drawings, the gender (gender defined as a dichotomous form of cultural categorisation signified by means of standard attributes such as clothes, hairstyles and facial features) of individuals was clearly identifiable. However, there were ten illustrations that were genderless (stick figures or otherwise depicted as genderless). Categorisation by gender in photographs was also mostly straightforward. However, in five photographs it was not possible to verify the gender of individuals (they appear as indistinguishable figures in the background or not facing the camera).

The data were coded by three coders, two of whom had not been involved in any previous aspect of the research process. After some discussion of the criteria for each category, the coders were each given a copy of the textbook and asked to independently classify the images based on the characteristics belonging to each gender. Interrater reliability was determined by using Cohen's kappa in SPSS. There was good agreement amongst the coders at .80, above the minimum acceptable level of 0.70 suggested by

Peat (2001). One shortcoming of using content analysis to analyse visual images is the problem of classifying gender based on visual markers on the body. Gendered identities are complex constructs with changeable and capricious social meanings. Thus, a person's self-identification might not be aligned with the description ascribed to them based on physical characteristics (Cameron & Lalonde, 2001). It is therefore quite possible that the coders might have misrepresented the self-identification of the represented participants by only using their physical markers.

### ***Social semiotics analysis***

Specific attention was given to Kress and van Leeuwen's (2006) three metafunctions for interpreting visual images: representational (focussing on the patterns of experiences (as configurations of processes, participants, and circumstances) and the logic-semantic relations between them), interactive (the interactions between image producers and the viewers) and compositional meanings (the compositional arrangement of visual elements in the text).

Four dimensions encapsulated the narrative representation of the participants:

- 'Actors' (participants doing something to another participant);
- 'Reactors' (participants who react to the actions of another participant)
- 'Goals' (those who are the target of the actions of other participants)
- 'Expressors' (participants who perform non-transitive actions).

As for conceptual structures, participants were portrayed in an analytical way when they emphasised part-whole relationships. Participants were depicted in symbolic ways by emphasising one of the attributes for display and in comparison to something else. Images were categorised as 'non-conceptual' if there were no relationships illustrated.

With respect to the patterns of interaction between the participants, Kress and van Leeuwen identified four dimensions: gaze direction, social distance (visual techniques), vertical angle and horizontal angle. Two kinds of gaze were coded: demand and offer. In addition, two levels of social distance (visual technique) were distinguished: intimate (magnified or 'close up' view of the participant) and impersonal (participant is captured from a 'public distance' or 'long shot').

The angle of interaction is represented by both the horizontal and vertical planes. Participants shot from a high angle were coded as high, those shot from below were coded as low and those at the same height as the assumed viewer as medium. In addition, with respect to the horizontal plane, participants shot from a frontal angle appear near or in front of the vanishing points while those shot at an oblique angle are positioned to the left or right of the vanishing points.

In terms of compositional criteria two dimensions were coded: information value and salience.

### **Findings**

There were 170 individuals illustrated; of these, 69 could not be identified in terms of their gender, leaving 101 who could (Table 1). There appears to be a tendency for more males than females to be represented in the illustrations, but this does not reach

**Table 1.** Distribution of identified male and female illustrations in the textbook.

Number of individuals illustrated	Number of individuals where gender could be identified	Number of males	Number of females
170	101	58 (57%)	43 (43%)

statistical significance ( $\chi^2 = 2.23$ , 1 df,  $p > 0.05$ ). Initially, therefore, it might be thought that the illustrations in this popular school science textbook do a good job of representing males and females equally. However, there is still substantive evidence that images depicting females seem to reinforce traditional sex-role stereotypes, such as passivity and occupational limitations. Of the 31 illustrations of adult females in the textbook, only three were depicted in high-status occupational roles – two as scientists and the other as a doctor.

### **Representational meaning**

The data in Table 2 suggest possible differences between the participants' gender and their narrative role. There is no evidence that males are shown more frequently in active roles (as 'actors') than females ( $\chi^2 = 0.35$ , 1 df,  $p > 0.05$ ). However, males were depicted as 'goals' of other participants' actions much more often than were females and this difference is statistically significant ( $\chi^2 = 9.86$ , 1 df,  $p < 0.01$ ). Further scrutiny of the data shows statistically significant differences between participants depicted as 'expressor' in terms of their gender ( $\chi^2 = 15.5$ , 1 df,  $p < 0.01$ ), with women being much more likely than men to express emotions. Only seven 'reactor' images were found and these were as likely to be displayed by males as by females. These findings are consistent with stereotyped assumptions in which males are more likely to be the centre of attention and females are more likely to be emotional.

Table 3 presents the results for the types of conceptual representation and the gender of represented participants. There is no statistically significant relationship between the type of conceptual representation and the gender of the participant ( $\chi^2 = 1.12$ , 2 df,  $p > 0.05$ ).

### **Interactive meaning**

Table 4 presents the results for the angle of eye direction (gaze) in the images for each gender in the textbook. As is evident, there were sex-specific differences in the direction of gaze ( $\chi^2 = 17.6$ , 2 df,  $p < 0.001$ ). In particular, females looked away from the assumed viewer more frequently than males, with only 23% of females looked at the viewer in comparison to 62% of males. Interestingly, these findings contradict Lutz and Collins (1991, p. 370) assertion that 'those who are culturally defined by the West as weak –

**Table 2.** Narrative role and gender of represented participant.

	Narrative				
	Absent	Actor	Goal	Expressor	Reactor
Male	0 (0%)	23 (42%)	25 (46%)	5 (9%)	2 (4%)
Female	1 (2%)	17 (38%)	6 (13%)	18 (40%)	3 (7%)

**Table 3.** Conceptual representation and gender of represented participant.

	Type of conceptual representation		
	Non-conceptual	Analytic	Symbolic
Male	17 (29%)	11 (19%)	30 (52%)
Female	11 (26%)	12 (28%)	20 (47%)

**Table 4.** Gaze and gender of represented participant.

	Direction of gaze		
	Demand	Offer	No Gaze
Male	34 (62%)	14 (26%)	7 (13%)
Female	10 (22%)	29 (64%)	6 (13%)

women, children, people of colour ... are more likely to face the camera, the powerful to be represented looking elsewhere'. These data also contrast with those reported by Bell and Milic (2002) who found that women were less likely to be depicted at a 'public' distance. The findings also seem to refute Dyer's (1982) assertion that men do not tend to gaze at the viewer because they see this action as an indicator of being weak and passive. Such assertions and findings may be culturally specific. Jamaican males are strongly encouraged to gaze in the direction of the viewer and demand something from them (Parry, 2004). Bailey (2002) sees this as an expression of hegemonic masculinity.

With respect to the horizontal angle of interaction, Table 5 shows an absence of sex differences with the majority of the images being shown from the front for both males and females. This indicates that the represented participants had a high level of involvement (according to Kress and van Leeuwen (2006), an oblique angle represent detachment from the viewer). These findings suggest that there were no links between the represented participants' gender and the frontal/oblique dimensions.

Table 6 presents the data for the participants' gender and the vertical angle. The relationship is statistically significant ( $\chi^2 = 8.38$ , 2 df,  $p < 0.05$ ), with females being *more* likely than males to be portrayed at a low angle in which the represented participants are depicted from below, towering over the viewer. This is surprising as, following Kress and van Leeuwen (2006), and in line with what common sense suggests, this suggests women are more likely than men to be depicted as having symbolic power

**Table 5.** Horizontal angle and gender of represented participant.

	Horizontal angle	
	Frontal	Oblique
Male	39 (71%)	16 (29%)
Female	32 (73%)	12 (27%)

**Table 6.** Vertical angle and gender of represented participant.

	Vertical angle		
	High	Medium	Low
Male	6 (11%)	33 (60%)	16 (29%)
Female	0 (0%)	25 (56%)	20 (44%)

**Table 7.** Social distance and gender of represented participant.

	Social distance	
	Intimate	Impersonal
Male	19 (35%)	36 (66%)
Female	27 (60%)	18 (40%)

over the viewer. Table 6 shows for both sexes, the most frequent depiction was for individuals to be photographed from a medium angle (i.e. eye level). This suggests that some attempt has been made by the those responsible for the textbook to promote gender equality at least insofar as this criterion of depiction is concerned.

Kress and van Leeuwen (2006) argued that the distance between the participants in the frame and the situation of the image can affect the social distance between the viewer and the participants seen in the image. The data in Table 7 show that females were more likely than males to be portrayed in ‘intimate’ or close up shots ( $\chi^2 = 6.46$ , 1 df,  $p < 0.05$ ).

### Compositional meaning

Finally, with respect to the informational value, the left-right structure of the display was not sensitive to the participants’ gender in all but two images. In in these two instances, there is a clear left/right system. The females are presented in the left visual field and the males in the right. In such a situation, the compositional meaning of the females represents the given (what is known) and the males represent the ‘new’. Thus, from the perspective of the informational value element, males have superiority over females. With respect to the salience element, the compositional meaning is activated through the size of the represented participants. In all cases the represented participants were positioned in the foreground, without any notable difference in the precision of the outline. This suggests that this aspect of the textbook imagery promoted gender equality.

### Discussion

There is a growing awareness of the importance of science textbooks in conveying important messages about what science is, how it is undertaken and who undertakes it (Abd-El-Khalick et al., 2017; Chen, 2017; Hickman & Portfolio, 2012; Kim, 2021; Ragusa, 2013). The present study sought to determine the extent to which visual representations in a widely used Jamaican lower secondary school science textbook reinforce or ameliorate gender stereotypes, employing both content analysis and the social semiotic analysis of Kress and van Leeuwen (2006).

In a number of respects, the empirical evidence reveals an encouraging absence of gender stereotypes. However, more nuanced analysis indicates that the textbook showed an implicit support of gender-biased messages. Compared to males, females were more likely to be represented in the textbook’s images in ways that presented them as inferior. These findings support Parker et al.’s (2017) assertion that science textbooks promote unequal power relations in favour of men. Narrating males and females in this fashion generates certain ontological effects not only at the micro level of everyday science classroom interaction but also at the macro level where the institutions of science

control and regulate the practice of gender. It gives an account, a singular account, about men having more of an innate talent to succeed in science-related careers in comparison to women, and thus reflects what Walford (1980) described long ago as the ‘masculine face of science’. These narratives are socially constructed and mirror the masculine hegemonic ideologies in the social organisation of the broader Jamaican society (Figueroa, 2004). The result is that they may distort how science students (whatever their gender) see themselves and what they perceive as normal and desirable for males and females.

Females were more likely to be portrayed in ways that reproduced gender-normative stereotypes such as being in domestic or care-giving roles. In contrast, males were more likely to be depicted as agentic, competent, and powerful, and in a wide range of professional roles such as scientists, astronauts and doctors. Sadly, these data are therefore consonant with the patterns found in numerous studies that have examined textbooks within a variety of disciplines, reporting gender inequality not only through analysis of the frequency of images depicting males and females but with consideration of the nature of those images and the ways that language is used within textbooks (e.g. Asriyama et al., 2020; Bataineh, 2020; Elgar, 2004; Parkin & Mackenzie, 2017). Such patterns reflect a (partially outdated) social structure in which Jamaican males are afforded privileged positions of power and authority, not just in cultural and social affairs but also in science and science-related fields. Although some writers (notably Miller, 1990) have challenged this perspective for its inability to account for the way in which Jamaican society operates, there is a danger that representing males in this way can give the false impression that women are deficient in attributes considered essential to the institution of science.

The extent to which the gender-biased images considered in this study deter girls from pursuing science careers in Jamaica remains a question for further research. However, the findings have important implications. For a start, those responsible for Jamaican school science textbooks must challenge the ways that gender is framed in these textbooks, ensuring that there is a greater balance between males and females both numerically and in terms of representation. However, we cannot simply wait for textbooks to improve. There is much to be said for teachers helping their students to read critically and with resistance so that they notice, challenge and reject the biased representations in their textbooks and elsewhere too.

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