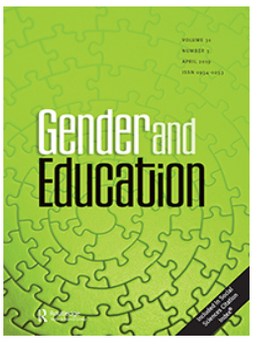

Gender and Education

ISSN: 0954-0253 (Print) 1360-0516 (Online) Journal homepage: https://www.tandfonline.com/loi/cgee20

Networked texts: discourse, power and gender neutrality in Ugandan physics textbooks

Lydia Namatende-Sakwa

To cite this article: Lydia Namatende-Sakwa (2019) Networked texts: discourse, power and gender neutrality in Ugandan physics textbooks, Gender and Education, 31:3, 362-376, DOI: 10.1080/09540253.2018.1543858

To link to this article: https://doi.org/10.1080/09540253.2018.1543858

GENDER AND EDUCATION
2019, VOL. 31, NO. 3, 362–376
https://doi.org/10.1080/09540253.2018.1543858

Routledge
Taylor & Francis Group

Networked texts: discourse, power and gender neutrality in Ugandan physics textbooks

Lydia Namatende-Sakwa

Teachers College, Columbia University, New York, NY, USA

ABSTRACT

Research within science textbooks has dominantly focused on examining explicit representations of women and men using quantitative methodology. The assumption that gendered arrangements are necessarily explicit and therefore visible and count*able*, overlooks how power works explicitly *and* implicitly through discourse to produce specific gendered subjectivities. In taking up feminist post-structuralisms, this study contributes to textbook studies within sciences by illuminating both explicit and implicit representations of gender. Using discourse analysis, 'gender-neutral' and/or disembodied subjects and objects were 'unmasked,' revealing a generic male and/or masculine subject. Gender-neutrality, which is pervasive within the physics textbooks, was thus exposed as a mask for generic maleness/masculinity. I argue that this objectivist science, which remains compatible with a narrow range of student gendered identities, forecloses possibilities for a wide range of scientist subjectivities, to produce a more inclusive physics curriculum, with a greater possibility of developing physics using diverse subjectivities.

ARTICLE HISTORY
Received 26 November 2017
Accepted 14 October 2018

KEYWORDS
Post structural theory; gender; physics; textbooks; Uganda

Introduction

Dominant research within science textbooks has focused on examining the explicit representation of women and men (Elgar 2004; Garcia, Harrison, and Torres 1990; Taylor 1979; Walford 1980). This scholarship has attributed the underrepresentation of women, especially in physics, which is considered the least gender diverse, to its masculine image (Hazari, Tai, and Sadler 2007; Jammula 2015). The findings from these studies are largely based on quantitative methods, indicating the numbers and/or prevalence of male and female in the textbooks. They generally found, as well summarized by Taylor (1979), 'references to females were few, references to active females were even fewer and references to females in scientific activities were virtually nonexistent' (272).

While quantitative methods have been useful in illuminating the invisibility of women in the sciences, some scholars have problematized them, affirming, 'simple ratios reveal only quantities and cannot reveal the way in which male and female are presented' (Porecca 1984, 713). Additionally, the use of quantitative methods is based on the

CONTACT Lydia Namatende-Sakwa lln2109@tc.columbia.edu Teachers College, Columbia University, 525 W 120 Street, New York, NY, USA

assumption that gendered arrangements are necessarily explicit and therefore count*able*, not only essentialising male and female (Hughes 2001) but also overlooking how power works both explicitly and implicitly through discourse, to produce specific gendered subjectivities (Youdell 2006). Such methodology, based on visibility, fails to recognize gender arrangements devoid of explicit mentions of male and female.

This study contributes to textbook research by illuminating how discourses are networked to produce specific gendered subjectivities, even within a gender 'neutral' disciplinary framing. In examining physics textbooks, therefore, I focused on how masculinities and femininities are indexed and/or signaled through culturally available discourses and practices. Indexing 'implies that one particular social meaning is signaled (often linguistically) over another' (Sunderland 2004, 24). Sunderland (2004) explained that 'Language, but also visuals and physical objects, can in different ways index or "point to" social meanings' (25). Masculinities and femininities within this study were indexed through conventional understandings of what are considered appropriate norms for males and females within Uganda society. While such understandings are contingent on local contexts, some of them are more universally recognizable than others.

This approach departs from previous studies that dominantly based their conclusions on numbers and/or explicit representations of male and women (Ansary and Babaii 2003; Barton and Sakwa 2012; Holmvist and Gjorup 2007; Lee and & Collins 2009; Rifkin 1998). Rather than focus on visibility, my study attends to the ways in which discourses are networked in physics textbooks to privilege masculine subjectivities. This not only allowed for unraveling of both explicit and implicit gendered constructions, but also illuminated the gendered truths and/discourses underlying this construction of gender, revealing the common/collective sexist assumptions that inform how gender is constructed within textbooks. This approach promises to tackle deeper gender inequalities, relations and hierarchies in institutions and cultures.

Before proceeding with the analysis, I provide the context of the study, and then describe the textbooks examined. Second, I situate the study of Ugandan physics textbooks within research on physics and gender. Third, I analyze the texts, demonstrating how gender is produced therein. This leads to the conclusion, in which I recap the key findings and provide some implications.

Context of the study

Uganda, located in East Africa, is a developing country with a population of about 43 million (World Population Review, 2018), and an economy based on agriculture (UBOS 2011). The population is multiethnic, with diverse patriarchal cultures (Mirembe and Davies 2001, 402), in which women have traditionally been constructed as subservient to men. This is reflected through practices like bride price, polygamy, and intergenerational marriage which structure gender relations (Bantebya and Keniston 2006; Kaleeba and Willimore 1991; Obbo 1995). These gender discrepancies are reproduced in the pervasive gendered division of labor in homes, work places, and the education system. Subject choice and performance are gendered with girls performing better in subjects like English and social studies, while boys in physics and mathematics (Muhwezi 2003). As such, boys dominate science courses, taking up the biggest percentage of admission and funding in public institutions of higher learning which privilege sciences, inscribing

the status quo, where access to higher education dominantly privileges males (Sakwa and Longman 2013).

The Ministry of Education and Sports is responsible for training, licensing schools and regulating the curriculum (Jones 2008). Government, in its commitment to quality and inclusive education, in line with the Millennium Development Goals and Education For All, established several strategies (Muhwezi 2003; Omagor et al. 2001) to accelerate girls' participation and retention in schools. Under the policy of Universal Primary Education, for example, the government provides free education for up to four children in each family, and priority is given to girls and children with disabilities. Additionally, the policy on affirmative action gives women an additional 1.5 points, as an incentive to improve access to higher education (Onsango 2009).

While these policies have focused on access to education leading to increased enrollment, they fail to address systems of knowledge that structure how gender relations are (re) produced and sustained inside and outside schools, which in turn inform curriculum and pedagogy. It was within this framework that I investigated the discursive resources that inform how gender is constructed in physics school textbooks. This study disturbs power structures and knowledge systems privileged in schools and in society-at-large in order to inform teacher education. The study fits in with the Ugandan government's political decision towards gender equality, as well articulated in *The Uganda Gender Policy* (2007), 'to take into account gender equality concerns in all policy, program, administrative and financial activities' (34).

Physics textbooks in Ugandan secondary schools

Ugandan schools rely heavily on textbooks, which layout the curriculum. The textbooks analyzed here are recommended by the Ministry of Education and Sports, for teaching physics to lower secondary students, preparing them for the Ugandan Certificate of Education, which is equivalent of GCSE (General Certificate of Secondary Education) in England. Each unit within the textbooks provides lessons, activities and practice exercises that generally model the exam. I reiterate Hartman and Judd's (1978) assertion that 'some of the texts that have unfortunate images of the sexes are pedagogically excellent in other respects' (384). As such, far from investigating the overall quality of these textbooks, I am interested in how they construct gender.

The study focuses on five textbooks, including *Ordinary Level Physics* by Abbott (1977), *Physics for Today and Tomorrow* by Duncan (1990), *Principles of Physics* (Nelkon 1993), *Advanced Physics* by Pople (1996) and *Physics* by Rowell and Herbert (1995). I focused on these because they had been included in the scheme of work/ teachers' work plan for Senior 3 (aged 15-16) during one school term in a Ugandan public secondary school. The teachers' plan shows that they did not use the textbooks in their entirety, but chose the most suitable texts from a range of textbooks. My study focuses on this assemblage of textbook texts/extracts. This was useful in illuminating discourses and practices likely to be encountered by students and teachers from the textbooks during a specific school term. I now situate the study within theorizing around gender and physics and/or science.

Theorizing gender and science: the science question in feminism

Research on gender and science in the 1970s and 1980s was concerned with female underrepresentation, especially in the physical sciences (Hughes 2001), reflected through low participation in elementary and secondary school and low enrollment at tertiary level (Gonsalves 2010). This research, as well articulated by Gonsalves (2010), was based on 'a definition of the problem as one of numbers – women, especially in physics, are under-represented at staggering numbers relative to other academic fields' (24–25). The goal, then, was to tackle the 'woman question in science' in order to achieve parity by eliminating structural obstacles external and internal to women, which shortchanged their opportunities in science (Gonsalves 2010; Hughes 2001). This goal has been problematized because it perpetuates 'discourses of female deficiency, whilst not tackling deeper gender inequalities and hierarchies in the institutions and cultures of science that regulate so-called choices' (Hughes 2001, 277). Based on this, Harding proposed a shift from the lack of women in a supposedly gender-neutral science to the epistemology of science itself – in what Harding (1986) referred to as a shift from the woman question in science to the science question in feminism.

This redirection meant less focus on getting more women into science to more focus on making science itself the object of scrutiny, by interrogating what was inherent within the culture of science that is/was prohibitive for women. This generated a plethora of feminist research critiquing the ideologies inherent in science, as well as its masculine, elitist, Eurocentric discourses, practices, texts, and products. Keller's (1982) important work, for example, criticized the very assumptions of objectivity and rationality that underpin modern Western science. Keller (1992) also emphasized that the foundations of science rest on the mind/body, subject/object, and mind/nature dualisms, which have meant a valorization of 'detachment, objectivity, and rationality in science, and a devaluing of intuition, feeling, and connectedness' (Gonsalves 2010, 21). The former, viewed as 'scientific' characteristics, are pervasively associated with masculinity and maleness, while the latter, viewed as 'non-scientific' are associated with femininity and femaleness. Feminist appeals for science curriculum that is contextual, cooperative, student-centered, accessible, philosophically informed and socially relevant (Hazari and Potvin 2005; Hazari, Tai, and Sadler 2007; Jammula 2015), illuminate the discourses of *lack/deficiency* within science, and specifically physical science curricula.

In taking up this feminist turn, Harding (1991)'s feminist standpoint theory problematized the uncritical push for a simple injection of women into science, explaining that such an approach is not critical of science itself. Instead, science, in and of itself, should be interrogated to expose the common/collective (racist, sexist, classist) assumptions of that community (Gonsalves 2010; Harding 1986; Harding 1991; Rolin 2008). Additionally, Harding (1991) draws attention to the disparity between 'those who believe that the task of feminist analysis is to object to "bad science" from those who think that "science-as-usual" – the whole scientific enterprise, its purposes, practices, and functions – should be the target of feminist criticism' (54). She critiqued the latter for attempts to alienate women from embracing the sciences, for which they have worked so hard, in order to end their exclusion by patriarchal structures. Moreover, as she affirmed, 'we live in a scientific culture; to become scientifically illiterate is simply to be illiterate … should feminists join science-as-usual in fostering scientific illiteracy among women?

What could be progressive about that?' (55). Feminist analyses should, therefore, aim to critique bad science for replicating oppressive and/or bourgeois androcentric, racist, imperialist social structures. Using a feminist post-structural approach, this study takes up the critique of bad science, illuminating how discourses are networked to privilege masculine and/or male subjectivities.

Feminist post-structuralisms

The study was informed by feminist post-structuralisms (Baxter 2003; Weedon 1997). The centrality of discourse in constructing gender has been emphasized in feminist post-structural accounts (Butler 1990; Youdell 2006). Discourses function as a 'regime of truth' (Foucault 1980), providing rules, practices, and knowledge(s) that produce a range of historically specific possibilities of inhabiting femininity and masculinity. The textbooks in this study, for example, produce physics using discourses that signal masculine and/male ways of being and/or knowing. Discourses that construct physics as rational for example invoke subtexts of objectivity and are implicated in disavowing emotionality, discursively associated with female/feminine ways of being and knowing (Namatende-Sakwa 2018).

In examining physics textbooks, therefore, I focused on how masculinities and femininities are indexed through culturally available discourses and practices within a specific community. Masculinities and femininities within this study are indexed through conventional understandings maleness/masculinity and femaleness/femininity within Uganda society. I identified discourses invoked, cited, and/or made available in the construction of gender in the textbooks: What kinds of discourses were deployed? How were they produced? How did they function? How are they intertextually linked to other socio-historical discourses? These questions reflect Bove's (1990, as cited in St. Pierre 2000) often-cited post-structural quest *not* for discourses per se, but *how* they have been historically produced. I illuminate the binary discursive structures dominantly used to construct physics using terms which privilege masculinity while disavowing femininity. As Weinereich-Haste (1986) affirmed, such gender dualisms in which the so-called 'feminine' characteristics are perceived as less valuable are reflected in myriad cultures. In taking up the feminist agenda to critique bad science and/or patriarchal ideology inherent in science, I identify five closely related dominant discourses underlying the construction of physics as masculine within Ugandan textbooks.

Re-inscribing the masculine image of physics

I demonstrate that it is through citational chains of discourse (Youdell 2006) which draw on gender hierarchical binaries that physics within the Ugandan texts is constituted as masculine. I turn to the discourses – naming, describing, and then illustrating each using narratives from the physics textbooks.

Concern with the abstract

Physics is characteristically thought of as abstract and/or conceptual (Hughes 2001). This pervasive discourse, which produces physics as decontextualized, intangible, and

immaterial, is reflected within all the texts I examined, which reduce 'reality' to numbers and symbols. In explaining 'Curved Mirrors' for example, *Physics for Today and Tomorrow* (16) uses images with arrows, lines, and points, to show how light acts on and is reflected from surfaces between different points. The working of spherical surfaces of mirrors is explained using abstract linguistic traces like 'principle axis,' 'center of curvature,' and 'radius of curvature.' The language of physics is a specialized discourse which Halliday and Martin (1993; as cited in Kitetu 1998) refer to as a 'discourse technology – a linguistic semiotic practice developed in order to do specialized kinds of theoretical and practical work' (15). The abstract rather than the concrete is foregrounded as readers are expected to imagine the movements of beams. *Absent* in the explanation is 'real' mirrors as we 'know' them – as used, for example, to look at images of ourselves. The text further provides examples of three types of mirrors – shaving, reflector, and driving mirror – illustrated using abstract figures to show reflections afforded by each type of mirror (17) (Figure 1).

The examples of mirrors given, specifically the shaving and driving mirrors, resonate with conventional masculine interests. Absent is the mention of women and/or femininities and their entanglements with physical beauty, which are also likely to be evoked in the mention of mirror (s). Instead, masculine images are inserted as suitable in the context of physics and/or a 'man's world.'

Objective, logical, factual, rule-bound, incontestable body of knowledge

Also cited in the text about mirrors is the discourse of physics as factual when, for example, mention is made regarding 'Facts about the images formed by spherical mirrors' (16). The reference to 'facts' suggests that the knowledge in physics is true, incontestable, and therefore objective rather than subjective. Discourses of truth are tangled up with the idea of 'the' correct and/or one way. The idea of the correct answer implies a distancing from the subjective as well as the idea of multiplicity, suggesting the plausibility of coming to 'the' one objective, provable answer. The texts are replete with equations and/or formulas, considered the roadmap to provable/correct truth in a calculable world. Students must memorize such formulas that they are expected to draw on and which are pervasive within the practice

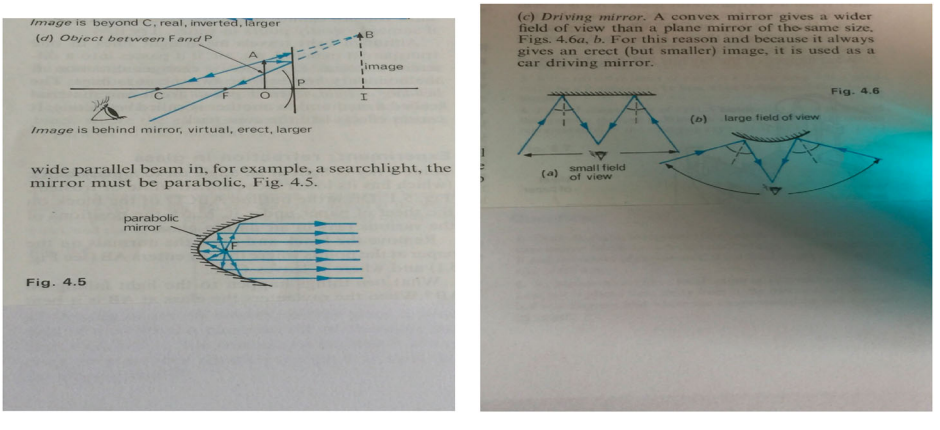

Figure 1. Shaving, reflector mirror and driving mirror respectively From *Physics for Today and Tomorrow* (Duncan 1990, 16).

questions. *Physics: A course from GCSE*, corroborates this in a statement which reads: 'The four equations should be memorized and used to solve problems' (60). Such narratives produce physics as quantitative, imbuing it with methods, which enable the attainment of the correct answer as guaranteed by the application of formula and/or 'gold standard' for correctness. Mathematical formulas have traditionally been associated with the interests of boys (Mitrevski and Treagust 2011). Indeed, Mitrevski and Treagust (2011) explain that girls in their study found physics difficult.

Also pervasive are laws for example about acceleration, motion – suggestive of a universalism, as the laws are constructed *not* as context-bound and/or partial, but as applicable and *always* true in all situations. The idea that physics problems are solv*able* through applying the 'right' equation and/or law to come to 'the' correct answer overlooks possibilities of contingency in knowledge production. The masculine commitment to 'objectivity' and quantitative approaches to guarantee 'truth,' entangled with the detachment and/or disregard for the personal has 'carried from its beginning an essential hostility to the body, the feminine and the natural environment' (Easlea 1986, 148). This displaced subjectivity, personhood, and emotions, traditionally been associated with feminist epistemologies (Harding 1986; Harding 1991).

The use of a myriad of graphs and calculations further highlights the importance of numbers as a means of representing reality – masculine ways of perception. The measurement of accuracy in terms of distance, length, width, and so on focuses on ideas that hold male and/or masculine interest such as the *imagined* speed on runaways, rather than, for example, the concrete distance from home to work, or, say, the time taken to cook a meal, take a shower and so on, which are practical routines of everyday living. These constructions produce physics as removed from 'reality,' disassociating it from a concern with living things (a discourse extended in the next section), and firmly locating it within discourses that link it to non-living things like machines, conventionally associated with males.

Remoteness from concern with living beings

This discourse constructs physics as vested in machines/non-living things rather than the human and/or living. Lexical traces like 'a mass,' 'a body,' 'an object' in the subject position of sentences are evidence of their importance. Some typical example, sentences from *Advanced Physics* include: 'A **body** falls from a cliff 125 m high … How far did the body fall in half this time?' 'An **object** is dropped from a helicopter at a height of 45 m above the ground. If the helicopter is at rest, how long does the object to reach the ground?'

Additionally, the use of the impersonal passive voice is another way that textually backgrounds living and/or human beings in order to bring non-living things, machines, and objects to the forefront. This is demonstrated in *Principles of Physics* for example: 'When there is air in the vessel and the battery is connected to the leads of the suspended bell, the bell is heard ringing' (368). Another example from the same text reads: 'A narrow tube B is placed inside a vessel A … the tube is then slowly raised to increase the length of the air column' (380). These examples illuminate the silencing of the subject who connects the battery to the lead or places the narrow tube B inside vessel A. As Kitetu (1998) explained, 'People tend to disappear as actors and agents. Colloquial

language, personifications, figurative language, irony, humor and exaggeration are avoided. Fiction and fantasy give way to talk of "facts"' (16), accentuating the disembodiedness of this masculine space.

The *absences* of human beings as well as contextual information highlight the privileging of decontextualized knowledge over knowledge situated in everyday practices, traditionally associated with femininity and/or femaleness (Hazari and Potvin 2005). While this disembodiedness might be aimed towards gender neutrality, the irony is that when the non-living things are named, they are almost always male and/or approximate conventional interests associated with masculinity. An example is the object 'car,' which is the most commonly named object in all the textbooks. Other examples include 'train,' 'iron ball,' 'cannon ball,' 'helicopter,' 'gun,' and 'bullet.'

The use of synecdoche – defined by the online *Oxford Dictionary* as a 'A figure of speech in which a part is made to represent the whole or vice versa' – is an example of how physics texts draw attention away from human beings to focus on objects. Rather than show a picture of a whole human being operating a machine, for example, only the *fingers* are shown as illustrated in Figure 2.

These fingers (which stand for human beings) are represented in relation to the machines they operate. This attempt at gender neutrality, however, has slippages in which 'gender-neutral' objects are 'unmasked,' only to find a male and/or masculine subject! This affirms Keller's (1985) assertion that gender 'neutrality' and 'objectivity' have both come under suspicion as androcentric. I extend this idea in the next section where I illustrate how the slippages in the so-called disembodied subject always turn out to be a male, suggesting that the 'gender neutrality' is but a mask.

Attention to boys and 'boy stuff'

Closely linked to a discourse of physics as remotely concerned with living things is the discourse that constructs it as vested in the mechanical and/or 'boy stuff' (Connell 2008). The narratives within the texts cite materials like 'discs,' 'spade,' 'bottle opener,' and 'fish rods,' which hold interest for masculinities. Additionally, almost all the objects named (e.g. cars, guns, balls, bullets) as well as activities described (e.g. helicopter at rest, throwing a ball, a gun pointing, and a bullet returning) have traditionally been associated with maleness. Indeed, Henwood (1998) affirms 'technology and technological work are synonymous with masculinity' which collocates with 'the propensity to control and manipulate nature; the celebration of muscle and machine in action … the tolerance of, even pleasure in dirt, viz., grease, swarf, and metal shavings' (38).

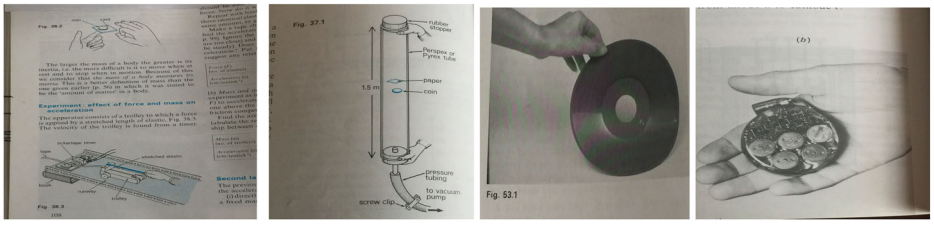

Figure 2. Assemblage of images showing fingers. From *Physics for Today and Tomorrow* (Duncan 1990).

Also interesting are the kinds of 'gadgets' in the texts. I refer to them as gadgets because of their complexity both in terms of technicality and physical appearance. An example is the tickertape timer with its 'vibrating steel strip,' 'carbon paper disc,' 'drawing pin,' 'coil,' 'magnet,' '6–12 V a.c.,' and 'ticker tape' (see Figure 5). The ticker tape timer is used to measure speeds and accelerations by paying attention to detail to ensure accuracy. It is interesting that while women's attention to detail has been the subject of myriad jokes that construct them as trivial, the attention given to detail in physics, where measurements like speed/distance per second are calculated, is valorized as critical for 'accuracy.'

Consistent in these texts are slippages in which what initially appeared as a gender-neutral object is eventually unmasked to reveal a male, signaling male as the norm and/or generic in physics. For example, while Figure 5 in *Physics for Today and Tomorrow* shows a 'gender neutral' ticker tape, the adjacent image used to explain the tickertape reveals a male subject 'manning' it (100) (Figure 3).

In another example, from *Ordinary Level Physics,* an image of a bicycle might have been associated with gender neutrality. However, the use of the masculine pronoun 'he,' and possessive pronoun 'his' in reference to the cyclist in a follow-up question, confirms that males linger as norm regardless of fronting gender neutrality. Such slippages *always* signal masculinity, and *never* femininity. Gender 'neutrality,' is thus exposed as a mask for generic masculinity.

Interestingly, whenever the texts allude to sex, it always male. Some examples include Bernoulli, Galileo and Newton who developed concepts of fluid dynamics, inertia and Newton's Laws of motion respectively. Indeed, even the writers of the physics textbooks analyzed are all White males. Cited here is a discourse that produces scientists as always already male – a discourse, which Finston (2002, 341; as cited in Elgar 2004) affirms, 'has largely endured' (890). Indeed, Obura (1991; as cited in Kitetu 1998) reiterated this, asserting that his research on physics textbooks demonstrated that 'Most textbooks thus portray scientists as men' (14). The few photos of human beings explicitly represent male bodies. The textual *absences* of femininity in text and illustration illuminate the privileging of masculine epistemologies.

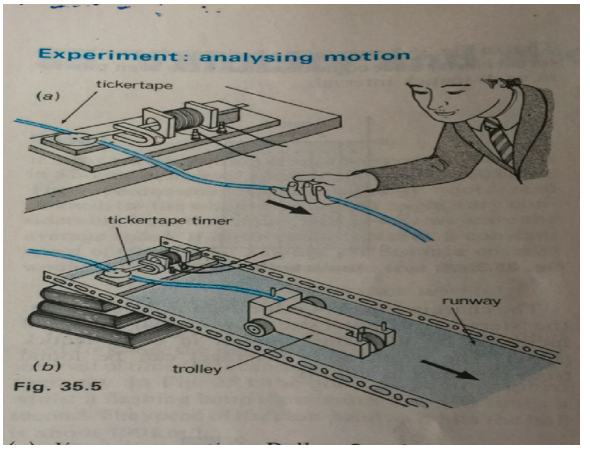

Figure 3. A man 'manning' the ticker tape. From *Physics for Today and Tomorrow* (Duncan 1990, 100).

Indeed, an examination of *Physics for Today and Tomorrow* as well as *Ordinary Level Physics*, the most dominantly used textbooks, illuminated not only the paucity of women but also their construction as specific gendered subjects. Both *Physics for Today and Tomorrow* as well as *Ordinary Level Physics* shows only four images of women in their entirety, amidst myriad images of men.

Similarly, the textbook *Ordinary Level Physics* shows four images of women in the entire book.

The invisibility of women is accentuated by their juxtaposition with active males, invoking active male-vis-à-vis-passive female discourses (Namatende-Sakwa 2018; Weinereich-Haste 1986). This is illuminated in active roles such as a tightrope man *walking* while the ballet women *stood* (Figure 4), or in a woman lying down while an ultrasound is performed by a male (Figure 5). The men are produced as taking on the 'real' core and/or technical physics in manipulating machines, while the women take on more supporting roles. Interestingly, only White women are represented in the images. As Harding argues, 'race supremacy, economic overprivilege and Eurocentricism are problems that the sciences have helped to advance' (Harding 1991, 36). Physics, therefore, as constructed in these texts is implicated in imperialistic projects of the West.

In the lab vs. in the everyday

This discourse produces physics as experimental rather than lived. It is constructed as investigational and involving apparatus, taking the form of tools, machines, devices, and gadgets rather than 'real' things used routinely in daily-lived experiences. Apparatus such as 'gas jar,' 'U-tube,' 'beaker,' 'porous pot,' give the impression of remoteness from reality, evoking the idea of a set-up, which in this sense is artificial, fake, crafted, synthetic. This displaces femininity traditionally associated with nature, the everyday, and the real (Weinereich-Haste 1986).

As Easlea (1986) convincingly affirms,

> To the extent that culture associates men (and not women) with competence in the design and control of apparatus and machines, and associates women (and not men) with competence in professions demanding the capacity to care and nurture, it is not surprising that the practice of physics is associated with masculine ability to manipulate and control inanimate matter rather than with feminine ability to empathize, communicate and care. (135–136)

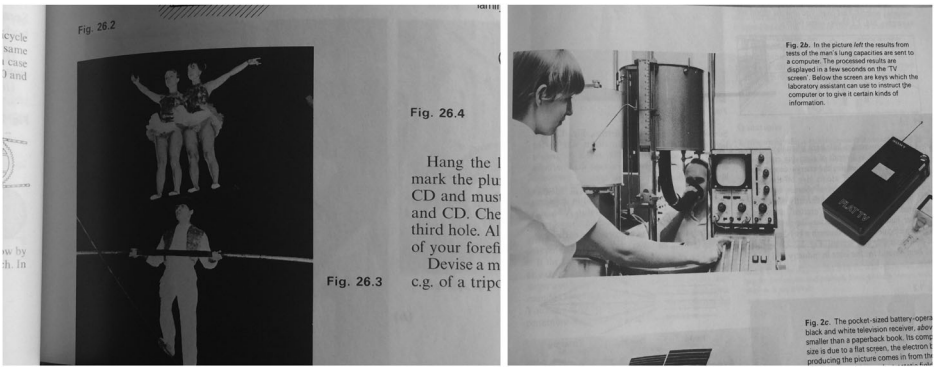

Figure 4. Some images of women in *Physics for Today and Tomorrow* (Duncan 1990).

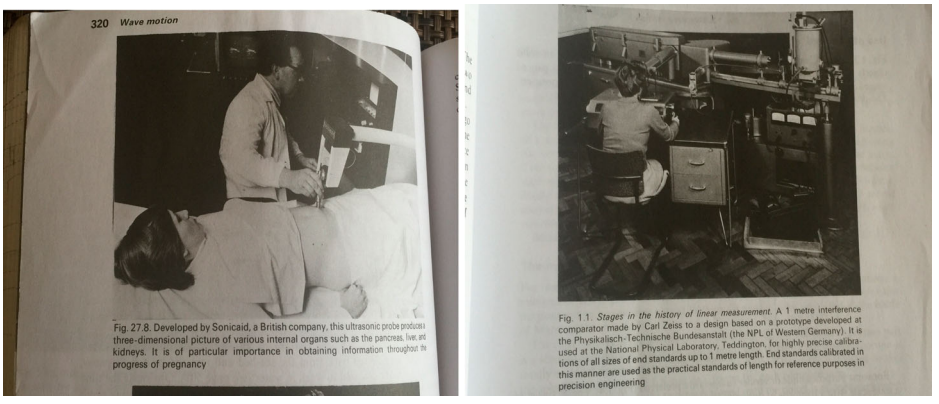

Figure 5. Some images of women in from *Ordinary Level Physics* (1995).

In explaining 'Properties of matter' for example, *Advanced Physics* illustrates the idea of 'diffusion,' affirming that it involves smells, pleasant or otherwise, that travel quickly as a result of rapidly moving molecules. The text then uses examples such as the diffusion of brown nitrogen-dioxide gas with air molecules. In the second example, the text uses a set of apparatus, showing the diffusion of Copper Sulfate and water to illustrate diffusion in liquids. While it is permissible to use these gases and liquids, it would also have been feasible and useful to start with the familiar – the smells that we can identify with: perfume, aroma of food, and so on.

Nonetheless, a marginal discourse in which physics is constructed as applicable to daily living is illustrated in the same topic on 'Properties of matter' under the subtopic 'Capillarity.' The text first explains capillarity using the ways in which water rises in a capillary tube, stating that the narrower the tube, the greater the rise in the water. The use of other familiar examples such as the rise of oil up a lamp wick as well as the idea that the non-porous materials in the walls prevent water rising up in the bricks of a building by the capillary action made sense to me. This is mostly because I have used a lamp and have also spent time at a building site during the construction of my family house in Uganda. This way of illustrating physics concepts, using items with which we are familiar, is a possibility, and yet, it hardly features in the physics texts examined.

Physics as such creates what Lemke (1990; as cited in Kitetu 1998) has referred to as a 'mystique of science' that 'sets up a pervasive and false opposition between the world of science – objective, authoritative, impersonal – and the ordinary world of human uncertainties, judgments, values and interests' (16). Easlea (1986) added, 'apparent remoteness from concern with living beings is one important aspect of the masculine image of physics which is missing in the images of supposedly less masculine sciences such as biology, medicine and sociology' (136). He suggested that because of its attention to living things, biology, unlike physics, is seemingly more personal, active, and relevant to the everyday world of values and emotion, apparently inhabited by women. Indeed, Mitrevski and Treagust (2011) explained that 'the top four most interesting topics chosen by students were from biology … students want physics to be relevant to them and the world they live in' (37). Therefore, the disassociation of physics from the everyday separates it from the traditionally feminine realm of relating empathetically and caringly. It drives a

wedge between physicists and 'all extraneous factors, particularly intrusions of an emotional kind, and so allow themselves to be guided by logic and facts alone in order to arrive at their (assumed) goal of genuine knowledge and truth about nature' (Easlea 1986, 136).

Conclusion

This study is based on an investigation of how gender is constructed in Ugandan physics textbooks. The textbooks predominantly avoid explicit mention and/or gender marking of both objects and subjects. While this might be aimed towards gender neutrality, the texts are rife with slippages in which the 'genderless' subjects and objects are eventually – albeit inadvertently – marked for gender. This is reflected through the use of masculine nouns like 'boy' and pronouns like 'his' in reference to subjects and/or objects whose gender had previously been unmarked. Additionally, while the texts have minimal illustrations of human beings, the images either explicitly show White males or implicitly invoke masculinity and/or maleness. Also prevalent is the use of objects and activities conventionally associated with masculinity such as 'cars,' 'trains,' and 'guns.' As such, my study corroborates previous scholarship, highlighting the privileging of masculine epistemologies, and reputing physics for its masculine image.

The five dominant discourses identified in examining the construction of physics include concern with the abstract, objective-logical-rule-bound incontestable knowledge, remoteness of concern with living things, attention to boys and 'boy stuff,' and in the lab vs. in the everyday life. These discourses illuminate a privileging of masculine epistemologies. I demonstrate that entangled herein is a web of discourses that cite and implicate each other in constructing what physics *is* and what it is *not*. The remoteness of concern with the everyday is suggestive of a remoteness of concern with living things, which intersects with the attention to the mechanical/technical/ boy stuff, evoking the idea of detachment, which is bound up with objectivity. These discourses, located in the idea of rationality, work to displace femininity that is associated with emotionality, subjectiveness and nurturance. This citational chain in which discourses are intricately linked (Baxter 2003) then functions to construct physics as oppositional to femininity.

While the work of feminist critics of science recommends a more 'feminine' – accessible and socially relevant physics that favors females, this essentialist stance has been problematized using feminist poststructuralism. Underlying gender-hierarchical binaries that associate females with feminine and males with masculine models of science is an essentialist one-dimensional male/female divide, which disregards gendered and/or power relations based on race, ethnicity and class, that also inform how gender is taken up. Essentialist curriculum reforms as such, not only ignore the complexity of gender relations, but are also complicit in re-inscribing male/female binaries.

Therefore, in pushing back against an essentialist and positivist curriculum framing, which as Hughes (2001) argues, is only compatible with a narrow range of student gender and ethnic identities, I recommend a more constructivist framing of physics curriculum materials. This promises to create the possibility for a wide range of scientist subjectivities, enabling a more inclusive physics curriculum. Additionally, physics is likely to benefit and grow as a discipline if it is informed by a spectrum of diverse subjectivities within a female/feminine and male/masculine continuum.

Overall, the construction of physics as inherently masculine is not unique to Ugandan textbooks, as demonstrated by studies in Western nations such as the United States (Hazari and Potvin 2005; Hazari, Tai, and Sadler 2007; Jammula 2015; Wilson, Wilson, and Low 2017). Indeed, White male scientists wrote the textbooks analyzed in this study during a historical moment, which illuminated the women's rights movement. This period was marked by three related conferences – in Mexico City (1975); Copenhagen (1980); and Nairobi, Kenya (1985) and Beijing 1995, which hosted the United Nations Fourth World Conference on Women. The conferences endorsed a Platform for Action, which would serve as a blueprint for promoting women's rights in the twenty-first century. This notwithstanding, normative (hyper) masculinities continued, and, circulate through globalization and (neo-) colonialism. As well articulated by Harding (1991), 'The dominant conceptual schemes of the natural and social sciences fit the experiences that Western men of the elite classes and races have of themselves and the world around them' (48). Despite the pervasiveness of these masculinizing discourses within physics textbooks, however, we cannot assume that teachers and students necessarily passively take them up, given they have the agency to disturb and/or trouble these gendered discourses. I recommend, therefore, that researchers conduct more classroom studies to show how teachers and students actually engage with gendered texts in the classroom. This is likely to give nuance to the study of school textbooks, meaningfully informing education.

Disclosure statement

No potential conflict of interest was reported by the author.

Notes on contributor

Lydia Namatende-Sakwa is a teacher educator in Uganda. She completed an EdD in Curriculum and Teaching at Teachers College Columbia University in the USA. She also has a PhD in Gender and Diversity from Gent University in Belgium. She has published widely in the area of gender and textbooks in disciplines like English, Physics and History, illuminating gender constructions as well as teacher and students' enactments of gendered textbooks. She has worked largely within a post-structural framework with research interests in gender, feminism, sexuality and teacher education.

ORCID

Lydia Namatende-Sakwa http://orcid.org/0000-0003-3550-4869

References

Abbott, A. F. 1977. *Ordinary Physics*. 3rd ed. London: Heinman Educational.

Ansary, H., and E. Babaii. 2003. "Subliminal Sexism in Current ESL/EFL Textbooks." *Asian EFL Journal* 5: 200–241.

Bantebya, K. G., and M. M. Keniston. 2006. *Women, Work and Domestic Virtue in Uganda*. Oxford: James Currey.

Barton, A., and N. L. Sakwa. 2012. "The Representation of Gender in English Textbooks in Uganda." *Pedagogy, Culture and Society* 20 (2): 173–190.

Baxter, J. A. 2003. *Positioning Gender in Discourse*. New York: Palgrave Macmillan.

Butler, J. 1990. *Gender Trouble: Feminism and the Subversion of Identity*. New York: Routledge.
Connell, R. W. 2008. *Gender*. Cambridge: Polity Press.
Duncan, T. 1990. *Physics for Today and Tomorrow*. London: Hodder Education.
Easlea, B. 1986. "The Masculine Image of Science: Does Gender Really Matter?" In *Perspectives on Gender and Science*, edited by J. Harding, 132–158. Philadelphia, PA: The Falmer Press, Taylor and Francis.
Elgar, A. G. 2004. "Science Textbooks for Lower Secondary Schools in Brunei: Issues of Gender Equity." *International Journal of Science Education* 26 (7): 875–894.
Foucault, M. 1980. *Power/Knowledge: Selected Interviews and other Writings (1972–1977)*. New York: Vintage Books.
Garcia, J., N. R. Harrison, and J. L. Torres. 1990. "The Portrayal of Females and Minorities in Selected Elementary Mathematics Series." *School Science and Mathematics* 90 (1): 2–12.
Gonsalves, A. J. 2010. "Discourses and Gender in Doctoral Physics: A Hard Look Inside a Hard Science." PhD, McGill University, Montreal.
Harding, S. 1986. *The Science Question in Feminism*. Milton Keynes: Open University Press.
Harding, S. G. 1991. *Whose Science? Whose Knowledge? Thinking From Women's Lives*. Ithaca, NY: Cornell University Press.
Hartman, P. L., and E. L. Judd. 1978. "Sexism and TESOL Materials." *TESOL Quarterly* 12: 383–393.
Hazari, Z., and G. Potvin. 2005. "Views on Female Under-Representation in Physics: Retraining Women or Reinventing Physics?" *Electronic Journal of Science Education* 10 (1): 1–33.
Hazari, Z., R. Tai, and P. Sadler. 2007. "Gender Differences in Introductory University Physics Performance: The Influence of High School Physics Preparation and Affective Factors." *Science Education* 91: 847–876.
Henwood, F. 1998. "Engineering Difference: Discourses on Gender, Sexuality and Work in a College of Technology." *Gender & Education* 10 (1): 35–49.
Holmvist, P., and L. Gjorup. 2007. "The Representation of Gender and Gender Roles in English Textbooks." Masters, Lararutbildningen, Malo Hogskola.
Hughes, G. 2001. "Exploring the Availability of Student Scientist Identities Within Curriculum Discourse: An Antiessentialist Approach to Gender-Inclusive Science." *Gender & Education* 13 (3): 275–290.
Jammula, D. C. 2015. "Feminist Physics Education: Deconstructed Physics and Students' Multiple Subjectivities." Doctor of Philosophy, Columbia University.
Jones, S. K. 2008. "Secondary Schooling for Girls in RURAL UGANDA: Challenges, Opportunities and Emerging Identities." PhD, University of British Columbia, University of British Columbia Library.
Kaleeba, N., S. Ray, and B. Willimore. 1991. *We Miss you all: AIDS in the Family*. Harare: Harare Women and AIDS Support Network.
Keller, E. F. 1982. "Feminism and Science." *Signs: Journal of Women in Culture and Society* 7: 589–602.
Keller, E. F. 1985. *Reflections on Gender and Science*. New Haven, CT: Yale University Press.
Keller, E. F. 1992. "How Gender Matters, or, Why It's So Hard for Us to Count Past Two." In *Inventing Women: Science, Technology and Gender*, edited by G. Kirkup, and L. S. Keller, 42–56. Cambridge: Open University Press.
Kitetu, C. 1998. *An Examination of Physics Classroom Practices and the Construction of Gendered Identities in a Kenyan Secondary School*. PhD, Lancaster University.
Lee, J., and F. Collins. 2009. "Australian English Language Textbooks: The Gender Issues." *Gender and Education* 21: 353–370.
Mirembe, R., and L. Davies. 2001. "Is Schooling a Risk? Gender, Power Relations and School Culture in Uganda." *Gender and Education* 13: 401–416.
Mitrevski, J., and D. Treagust. 2011. "Girls and Upper School Physics: Some Optimism and Opportunity." *Teaching Science* 57 (1): 35–40.
Muhwezi, K. M. 2003. *Gender Sensitive Educational Policy and Practice, Uganda Case Study*. Paris: International Bureau of Education, UNESCO.
Namatende-Sakwa, L. 2018. "The Construction of Gender in Ugandan English Textbooks: A Focus on Gendered Discourses." *Pedagogy, Culture & Society* 26 (4): 609–629.
Nelkon, N. 1993. *The Principles of Physics*. London: Longman Group Limited.

Obbo, C. 1995. *Gender, Age and Class: Discourses on HIV Transmission and Control in Uganda*. London: Gordon and Breach.
Omagor, M., M. Atim, D. Okot, K. Kiryahika, and L. Eron. 2001. *Including the Excluded: Meeting Diversity in Education: Example From Uganda*. Paris: UNESCO.
Onsango, J. 2009. "Affirmative Action, Gender Equity and University Admissions – Kenya, Uganda and Tanzania." *London Review of Education* 7: 71–81.
Pople, S. 1996. *Advanced Physics*. Oxford: Oxford University Press.
Porecca, K. L. 1984. "Sexism in Current ESL Textbooks." *TESOL Quarterly* 18: 705–724.
Rifkin, B. 1998. "Gender Representation in Foreign Language Textbooks: Case Study of Textbooks of Russian." *The Modern Language Journal* 82: 217–236.
Rolin, K. 2008. "Gender and Physics: Feminist Philosophy and Science Education." *Science & Education* 17: 1111–1125.
Rowell, G., and S. Herbert. 1995. *Physics*. Cambridge: Cambridge University Press.
Sakwa, L., and C. Longman. 2013. "Government Policy on Science Education in Uganda: A Glass Ceiling to Women's Access to Higher Education." In *Gender Practices and Challenges: A Call for Accountability*, edited by W. J. Khamasi, C. Longman, and M. vanHaegendoren, 20–29. Eldoret: Moi University Press.
St. Pierre, E. 2000. "Poststructural Feminism in Education: An Overview." *Qualitative Studies in Education* 13 (5): 477–515.
Sunderland, J. 2004. *Gendered Discourses*. New York: Palgrave Macmillan.
Taylor, J. 1979. "Sexist Bias in Physics Textbooks." *Physics Education* 14: 277–280.
UBOS. 2011. "Population." http://www.ubos.org/?st=pagerelations2&id=17&p=related pages 2: population
Uganda, G. o.. 2007. *The Uganda Gender Policy*. Kampala: Ministry of Gender, Labor and Social Development, Uganda. http://www.mglsd.go.ug/wp-content/uploads/2013/07/policies/Uganda-Gender-Policy.pdf
Walford, G. 1980. "The Masculine Face of Science." *Education* 8 (1): 51–53.
Weedon, C. 1997. *Feminist Practice and Poststructural Theory*. 2nd ed. Malden, MA: Blackwell Publishing.
Weinereich-Haste, H. 1986. "Brother Sun, Sister Moon: Does Rationality Overcome a Dualistic Word View." In *Perspectives on Gender and Science*, edited by J. Harding, 113–131. Philadelphia, PA: The Falmer Press, Taylor and Francis.
Wilson, A., K. Wilson, and D. Low. 2017, 15th September 2018. "Taking the Pee Out of Physics: How Boys Are Getting a Leg Up." *School News International Magazine*.
Youdell, D. 2006. *Impossible Bodies, Impossible Selves: Exclusions and Student Subjectivities*. Dordrecht: Springer.