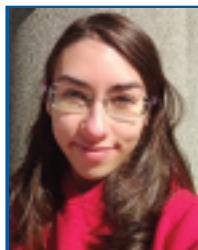


# WHO GETS THE PICTURE? DIVERSITY IN CANADIAN SCIENCE AND PHYSICS TEXTBOOKS

BY TATIANA ZANON, MELISSA MENDES, ANICK JASMIN, GITA GHIASI, AND TANJA TAJMEL



Textbook content is considered to have a significant impact on the knowledge construction and transmission process, providing and constructing a specific ‘reality’ of society [1]. Science textbooks highlight the historical work of influential scholars who have shaped the field, hence embodying students’ imaginations of who scientists are, have been and can be. Thus, the lack of representation within these materials can potentially negatively impact their identification with science [2]. Likewise, images in science textbooks communicate critical information about the society and its values [3].

Studies have shown that school textbooks, in general, are filled with stereotypes and implicit messages of female inferiority [4,5]. If present at all, Indigenous people are likely to be depicted inferior to Europeans [6], and Black people are depicted in the context of a subordinate position, e.g., performing manual labour [7]. Diverse role models are paramount for underrepresented groups since they usually do not have access to mentors that share “salient elements of their identity” [2].

There exists no study so far that reveals how Canadian science and physics textbooks are representing women and minorities. With our study, we aim to close this gap.

## SUMMARY

**In this study, we investigate the representation of women, Black and non-Black People of Color (NBPoC) in Canadian science and physics textbooks. First outcomes reveal a huge gender gap in undergraduate physics textbooks (twice as many men as women) and a particular underrepresentation of Black people in scientific contexts. No images of famous or historically known Black or non-Black PoC scientists could be identified, all famous and highlighted scientists across the textbooks are white.**

## PHYSICS AND SCIENCE TEXTBOOKS: STATUS QUO REPRODUCERS?

In our ongoing research, we are investigating the representation of women, visible minorities, Indigenous peoples and persons with disabilities in Canadian elementary and secondary school science textbooks and undergraduate physics textbooks used at Canadian universities and colleges, compared to their representation in Canadian society. Here, we present preliminary results of our ongoing study regarding the representation of women and visible minorities.

Our research questions are:

- Do Canadian science (elementary/secondary school) and physics (colleges/university) textbooks represent the demography of the people living in Canada?
- How are members of different groups portrayed?
- Who is portrayed as a scientist?

For the image analysis, we applied a deductive coding method and developed a coding scheme consisting of categories, definitions, examples and coding rules as an instrument. The categories defined were *gender*<sup>1</sup> (feminine/woman (F), masculine/man (M)), *race/racialization* (White (W), Black (B), Non-Black People of Color (NBPoC)<sup>2</sup>), *role/activity* (scientific activity (Sc), famous or historically known scientist (HSc), athlete/sports (Ath))<sup>3</sup>, *visible disability*, and *age*<sup>4</sup>. Each category considered the subcategory ‘not identifiable’ (NI). The calculation of

Tatiana Zanon  
<tatiana.g.zanon@gmail.com> Centre for Engineering in Society, Concordia University, Montreal, Quebec

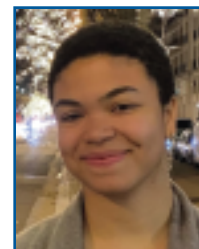
Melissa Mendes  
<melissa.mendessilva@mail.mcgill.ca> Department of Physics, McGill University, Montreal, Quebec

1. We considered a nonbinary gender category in the pilot study but the interrater reliability for this category was too low to include this option in the coding scheme for the main sample.
2. Our pilot study revealed that it was not possible to reliably identify Indigenous peoples on basis of any visible characteristics. Therefore, Indigenous people have not been considered as category in the image analysis. However, in our ongoing study, we are also analyzing text through a decolonial lens, and how Indigenous peoples are constructed as ‘Others’.
3. We considered athletes/sports (Ath) as category because sports is commonly used in physics textbooks to illustrate concepts of physics (particularly in Mechanics). Additionally, previous research showed that Black people tend to be represented as athletes [14].
4. We also included ‘visible disability’ and ‘age’ in our analysis. Here we are only presenting preliminary results for the categories ‘gender’, ‘race’ and ‘role/activity’.

TABLE 1

Canadian demography retrieved from Canadian census 2016 [13] compared to data obtained from our analysis. The lower part of the table shows the textbooks' representation of women (F), men (M), Black and Non-Black Persons of Color (NBPoC) as famous/highlighted scientists (HSc) or involved in science activities (Sc).

	DEMOGRAPHY CANADA (%)	SCTex (%)	PTEX (%)
<b>F (overall)</b>	50.75	43.30	30.41
<b>M (overall)</b>	49.25	49.04	61.21
<b>Black (overall)</b>	3.48	10.00	14.82
<b>NBPoC (overall)</b>	18.80	16.60	15.58
<b>F/ Sc</b>		24.76	0.76
<b>F/ HSc</b>		3.33	0.38
<b>M/ Sc</b>		22.38	1.14
<b>M/ HSc</b>		6.67	3.04
<b>Black/ Sc</b>		4.29	0.00
<b>Black/ HSc</b>		0.00	0.00
<b>NBPoC/ Sc</b>		11.11	0.00
<b>NBPoC/ HSc</b>		0.00	0.00



Cohen's kappa coefficients<sup>5</sup>, a statistical quantity that measures the agreement between two independent raters and controls random agreement [8], yielded a minimum of 0.81 for each category. The inter-rater reliability can thus be considered as almost perfect.

The data presented here results from our analysis of two science textbooks (SCTex; grade 8 [9] and grade 9 [10]) and two physics textbooks [11,12] (PTex; undergraduate level). For the analysis, we selected the most widely used textbooks across Canada<sup>6</sup>. For SCTex, all images (210 depicted individuals)<sup>7</sup> were analyzed; for PTex, we selected one topic, Mechanics, and analyzed all images (263 depicted individuals). In total, 473 depicted individuals were coded.

## FIRST OUTCOMES

Table 1 gives an overview of our gained data compared to Canadian demographic data. In both textbook categories, feminine individuals (50.9% of the Canadian population) are underrepresented. The gender gap between masculine

and feminine representation is 5.7% for SCTex and 30.8% for PTex. Individuals coded as Black are in both textbook categories overrepresented (SCTex 10.0%, PTex 14.8%) compared to their representation in society (3.5%). NBPoC (visible minorities without the category Black) are slightly underrepresented (18.9% in Canada versus 16.6% in SCTex and 15.6% in PTex).

The ratio of White, NBPoC and Black is different when considering the role/activity of the depicted person. In SCTex, in the subcategory scientific activity/famous scientist, 4.3% of the individuals are Black and 11.1% NBPoC. In the same category in PTex, no Black and no NBPoC individual could be identified, whereas the representation of Black individuals in the category Athletes/Sports increased.

In SCTex (Fig. 1), there is a small difference between masculine and feminine persons depicted in science-related activities (22.38% masculine versus 24.76% feminine). However, regarding highlighted or famous scientists, men appear precisely twice compared to women (6.67% men versus 3.33% women). Regarding race, in science-related activities, NBPoC are depicted in 11.9%, Black in 4.28% and White in 30.96%, whereas only white persons are depicted as famous or highlighted scientists.

Anick Jasmin  
<m\_jas@live.concordia.ca> Gina Cody School of Engineering and Computer science, Concordia University, Montreal, Quebec

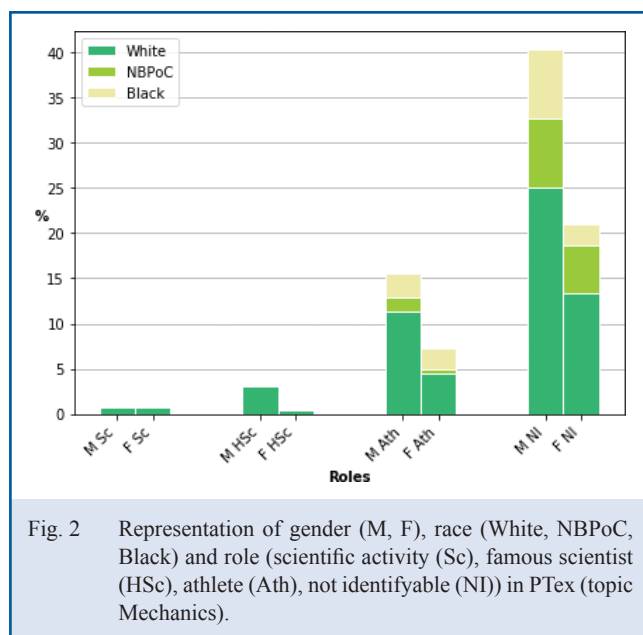
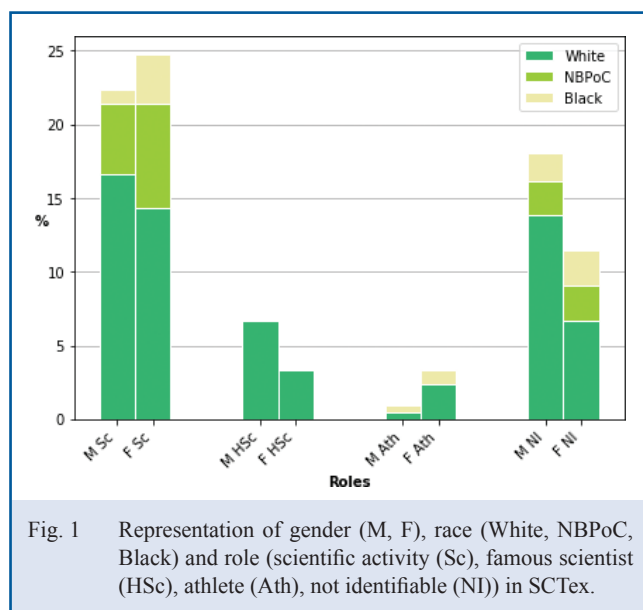
Gita Ghiasi  
<gita.ghiasi.hafezi@umontreal.ca> École de bibliothéconomie et des sciences de l'information, Université de Montréal and the Institute for Data Valorisation (IVADO), Montreal, Quebec

Tanja Tajmel  
<tanja.tajmel@concordia.ca> Associate Professor, Centre for Engineering in Society, Gina Cody School of Engineering and Computer Science, Concordia University, Montreal, Quebec

5. Values for Cohen's kappa coefficients range from 0 to 1, where 1 is closest to complete agreement.

6. Information was retrieved from the Ministry of Education of each Canadian province.

7. Images with more than one person were analyzed by coding each person individually.



In PTex (Fig. 2), in the topic analyzed, there was a small difference between the representation of masculine and feminine individuals in science-related activities (1.14% masculine versus 0.76% feminine). 3.04% men versus 0.38% women are depicted as famous or historically known scientists. Black and NBPoC persons are depicted as athletes; however, no Black and NBPoC person could be identified in science-related activities nor as famous/highlighted scientists.

## CONCLUSION

Our preliminary results, although limited, reveal that Canadian elementary/secondary school science textbooks (SCTex) and undergraduate physics textbooks (PTex) may represent women and minorities differently. The overrepresentation of visible minorities in SCTex indicates the intention to represent minorities and the diversity of society. However, in science (performing a scientific activity or being a famous/highlighted scientist), marginalization becomes conspicuous. At the undergraduate level, in PTex, visible minorities are marginalized even in non-scientific activities, particularly women. In undergraduate Physics textbooks, Black or non-Black persons of color are neither represented as scientists nor performing a scientific activity. Across all textbooks all famous scientists are white.

Our results demonstrate the necessity of an intersectional lens in studying marginalization and underrepresentation, including the individual's role in a specific field. Furthermore, the findings call for a critical approach regarding the representations of minorities to showcase 'diversity'. Overrepresenting racialized people or visible minorities in non-scientific contexts by simultaneously underrepresenting them as scientists does not contribute to an equitable representation, but rather reinforces and centers whiteness in the STEM fields.

## ACKNOWLEDGEMENTS

The authors Tatiana Zanon, Anick Jasmin and Tanja Tajmel kindly acknowledge the support of the Government of Canada's New Frontiers in Research Fund (NFRF), [NFRFE-2018-00725], the Fonds de recherche société et culture Québec, [2021-NP-282549], and Concordia University. Work by Melissa Mendes was supported by the Schlumberger Foundation in the Faculty for the Future Fellows program.

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