The representation of women in Irish Leaving Certificate Physics textbooks

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Abstract

This paper examines the representation of women in Irish Leaving Certificate Physics textbooks. Findings show that women are significantly underrepresented, both in terms of scientific characters (historic and current) described within the textbooks, and also in terms of more general non-scientific characters within the books. Furthermore, analysis suggests that the language used to describe characters mentioned in the books may compound gender inequalities. Relevant policies (curricular, governmental, etc) are examined and suggestions are made to improve gender balance in future textbooks.

Keywords: gender, textbooks, leaving certificate

1. Introduction

Despite the talent they bring, women and girls are under-represented in virtually all physics communities (Smith 2011). In 2019, of the 7942 students who sat the physics exam for the Irish Leaving Certificate, 26% of them were female (Mcloughlin et al 2020). Similar inequalities are seen in England, Scotland, Wales and Northern Ireland (Francis et al 2017). In recent years, various campaigns have been launched in the UK and Ireland to address gender inequality in physics, with particular focus on numbers of women studying physics in second-level education. The Improving Gender Balance Ireland (Mcloughlin et al 2020) programme sought to grow the number of women studying Physics at Leaving Certificate by focusing on (a) deepening teachers’ confidence and content knowledge; (b) adopting a whole school approach to addressing gender biases that exist in physics, and improving the confidence of women taking Physics; and (c) increasing awareness of science, technology, engineering and mathematics (STEM) and careers therein. Among the study’s findings was the need to raise awareness of unconscious gender bias.
This focus on improving awareness of gender bias and gender stereotypes in physics is supported by several key findings from the literature. Stereotypes relating to ‘traditional’ understandings of gender roles continue to persist and influence our classrooms. Examples of such stereotypes include notions such as ‘boys are better at mathematics and science than girls’, that ‘girls just do not have the same interest in physics as boys’, and ‘science and engineering careers are masculine areas’ (Hill et al 2010, Francis et al 2017). Such stereotypes affect teachers’ mindsets and practice; parental influence and expectations; and consequently students’ self-efficacy, decisions, actions, and achievement (OECD 2015, Copur-gencturk et al 2021).

One everyday item that deserves particular attention in this area is the physics textbook that students use over their two-year Leaving Certificate cycle. Good et al (2010) have shown that when female students used chemistry textbooks containing pictures of female scientists, they demonstrated deeper understanding of the chemistry topics and performed better in assessments in comparison to female students who used chemistry textbooks containing only pictures of men.

While examining pronoun use and illustrations in British physics texts, Taylor (1979) and Walford (1981) found that while personal pronoun usage in science texts may be of some limited importance, the pictures seem much more likely to have an impact on students’ views. Therefore, if our science textbooks lack images of women involved in science, female students may view science as an activity that excludes them (Bazler and Simonis 1991). Science Foundation Ireland commissioned a study (Kennedy and O’Dwyer-Duggan 2014) on the career choices of young people in Ireland. Looking at a representative sample of students in the first year of their undergraduate third level course, the study examined the key influencing factors affecting course selection. The study found that ‘fitting in’ is the most important consideration for young people when making qualification choices. If the physics textbooks at Leaving Certificate level leave girls feeling that they will not ‘fit in’ with the physics community, it is possible that these textbooks could be playing a role in deterring students from their desired field of study at third level.

This paper reviews the representation of women and girls in four physics textbooks used in Ireland. It does this in the context of relevant policy documents around improving gender diversity and inclusion in physics.

2. Policy perspectives

While there are a number of significant international policies that aim to improve gender equality within education (UNESCO 2004), the majority of policies relevant to gender equality in physics, or science more generally, that are acted upon are those published at a national level.

Mindful of poor gender balance in students taking many Leaving Certificate STEM subjects and the knock-on consequences, as indicated by the MacCraith report on STEM Education (MacCraith 2016), the Irish government’s Department of Education 2021–2026 Policy on STEM Education (2017) stressed the need for STEM curricula (in subjects like Physics, Chemistry, Applied Mathematics and Engineering) to be reformed such that more women study them. More recently, a Department of Education literature review (Goos et al 2020)—completed to identify effective interventions for addressing gender balance in STEM subjects—recognised that ‘there is no single barrier or level of influence that can be identified as the overriding factor in achieving gender equity in STEM education’ (p 6). The review identified the need to focus on intervention within four categories: the learner; their family; their school; and society in general. Within the third category ‘school’, the review stated that ‘the science curriculum is implicated in contributing to gender imbalances in participation’ (p 29). Within this context, it is important to recognise the Department of Education (and its subsidiary organisations) have not issued specific gender-related guidelines for those producing the various STEM curricula or for those writing associated STEM textbooks.

3. Methodology and data analysis

To investigate how women and girls are represented in Leaving Certificate physics textbooks,
The representation of women in Irish Leaving Certificate Physics textbooks

the contents of four mainstream textbooks (all published since 2000) were assessed in two ways. Firstly, we looked at images of people within each textbook. Secondly, we examined the characters referred to in the books’ text, along with terms used to describe them. This methodology was chosen, to align with work carried out by Brugeilles and Cromer (2009a) in analysing gender representations in school textbooks.

Mindful that most physics students primarily work with a single physics textbook over the two-year Senior Cycle that leads to the Leaving Certificate, our analysis focused on ‘mainstream’ books. We excluded exam-focused texts, such as exam revision books.

When examining the textbooks, it was sometimes difficult to attribute a gender to unnamed characters in textbook images. It is important to note that our analysis did not set out to explicitly determine biological sex or gender identity of characters (Becker and Nilsson 2021). Rather, characters in pictures were recorded as male or female based on what the reader would likely perceive as the gender of a person in an image. The people in images were analysed based on physical attributes, hairstyles, clothes, etc, as these items are highly stereotyped within a cultural context and often act as a basis for classification (Brugeilles and Cromer 2009a).

If a character was depicted more than once within a textbook chapter or section, their occurrence was recorded only once. We reasoned that the character’s name was repeated to remind the reader of whom the author was referring and thus all references to them were within the same scientific context. Comparatively, when a particular character was mentioned multiple times in different sections or chapters, this was noted each time (with each referring to a distinct scientific area). When names such as ‘Celsius’, ‘Kelvin’, ‘Joule’, ‘Watt’, etc were used as SI units, their details were not recorded.

When analysing the language used to describe characters, data was recorded for named characters only (e.g. Marie Curie or Isaac Newton). This excluded unnamed characters such as men and women who might have been mentioned in end-of-chapter questions.

4. Findings and discussion

Analysis of how women and men are represented in four mainstream Leaving Certificate physics textbooks showed that women are significantly underrepresented, both in terms of scientific characters (historic and current) and also in terms of more general non-scientific characters included within the books. Furthermore, analysis suggests the language used to describe characters mentioned in the books may compound gender inequalities.

4.1. Unequal representation of women in textbooks

Characters presented across each of the four physics textbooks examined are predominantly male. Figure 1(a) shows the gender breakdown for images and text for each of the four books. Women account for 13%–28% of the characters depicted as images and 0%–3% of the characters mentioned in text, depending on the book. Figures 1(b) and (c) give a more thorough breakdown, presenting the gender breakdown of ‘science characters’ (i.e. those who are clearly scientists) and of ‘general characters’ (i.e. generic people who are not scientists). Female science characters are shown in 0%–6% of the images and 0%–3% of the text, across the textbooks. Finally, of the general, non-science, characters shown in textbook images, 28%–31% of them show women or girls.

Given the historic underrepresentation of women in science, some readers may not be too surprised at the percentage of science characters who are women in physics textbooks. Some might argue that physics textbooks presenting the central ideas of physics will inexorably be linked to the people who are associated with the relevant work—most of them being men. However, presenting physics in this way tends to overlook the historic barriers that have excluded women from physics and the many incidents of women’s contributions to physics being overlooked or attributed to male colleagues. Rossiter (1993) explains that women in science who were unrecognised in their own time have generally remained so, but others who ‘were well-known in their day have since been obliterated from history’.

March 2022 3 Phys. Educ. 57 (2022) 025017
Female Character Representation, %

Figure 1. The gender breakdown of characters (depicted as images or within text) within four Leaving Certificate Physics textbooks. (a) All characters represented in each of the four books, (b) ‘Science characters’—i.e. those people described in the books, who are clearly scientists, (c) ‘Non-science characters’—i.e. general characters presented in the books.

It is harder, perhaps, to easily explain why so few of the general characters presented in images across all four textbooks analysed in this study are women.

While reading through these books, that do not represent men and women equally, students are being exposed to an implicit bias suggesting that physics is not really for girls. The imagery and text in the books analysed gives the impression that physics is an area for boys and men, and that any women in the field are an exception or an outlier to this. Messages such as this, conveyed through gender-biased textbooks result in disproportionate levels of participation amongst boys and girls (Brotman and Moore 2008).

Textbooks play a central role in any classroom. Apple (1989) suggested ‘textbooks become the “real curriculum” that is filtered through the lived culture of teachers and students’. Pienta and Smith (2012) outline how ‘textbook images reflect a hidden curriculum that works to deter girls and women from academic and
The representation of women in Irish Leaving Certificate Physics textbooks

career interests in the fields of science’. This suggests that gender biases evident in the four textbooks analysed in this study, are likely to filter down to the everyday experience of many physics classrooms in Ireland.

While it is acknowledged that improving the representation of female scientists in physics textbooks will require some thought, a simple strategy that authors could adopt would be to extend general core physics concepts to more modern research topics, which would easily allow for the integration of both historic and current women in science (Becker and Nilsson 2021).

In recent years, significant efforts have been made to celebrate the work of female physicists, while acknowledging the structural and cultural barriers they face(d) while doing their research. Projects such as Inspirefest, and work by academics within professional bodies (e.g. the IOP Women in Physics group) are rich resources to learn more about female physicists that are worthy of inclusion in any Leaving Certificate physics curriculum or textbook. Physicists who have made significant contributions in the past might include women like: Lise Meitner (for her work on nuclear fission); Joycelyn Bell-Burnell (for her work on radio pulsars); Kathleen Lonsdale (X-ray crystallographer); Sheila Tinney (for her work in quantum physics); Barbara A Williams (radio astronomy); and Ruby Payne-Scott (radio physics). Contemporary physicists should also be considered. These might include: Andrea Ghez (2020 winner of the Nobel Prize in Physics for her discoveries relating to black holes); Donna Strickland (optical physicist and recipient of the 2018 Nobel Prize in Physics); Vera Rubin (astrophysicist); Fabiola Gianotti (particle physicist); and Margaret Murnane (optical physicist).

Addressing gender inequalities of non-science characters in physics textbooks is also important. If the physics community (textbook authors, policy makers, researchers, etc) is to meaningfully address the idea put forward by Francis et al (2017), who argue that science is ‘socially constructed as a high status, masculine domain that is appropriate for, and populated by, middle class men’ (p 157), far more care must be given to gender diversity in textbooks.

4.2. Language used to describe characters compounds gender inequality

Only two female scientists were included in the four textbooks examined—Irène Joliot-Curie and Marie Curie. This compares with a total of 91 male scientists.

Twenty-two high-profile professions (e.g. scientist, physicist, professor) were used to describe the many male characters, while none were used to describe women. The only descriptions provided of these women in the text were as follows: Irène Joliot-Curie was named ‘daughter of Marie Curie’ and ‘Marie Curie’s daughter’. Marie Curie was mentioned as having ‘won a Nobel in Chemistry’, ‘won a Nobel in Physics’, being the ‘first person to win two Nobel prizes’ and as being part of the ‘husband and wife team of Pierre and Marie’. These women were not specifically identified as being scientists, chemists, or physicists. Thus, while implied across all of the texts that they were scientists, this is different from how the men are described in the text.

Furthermore, across all textbooks there were six references to male scientists as the ‘father of’ a scientific topic (‘father of classical physics’, ‘father of the atomic bomb’, ‘father of big science’ and ‘one of the founding-fathers of the USA’). While each of the associated individuals associated with the respective areas of science did incredible work, the use of such paternalistic language reinforces traditional stereotypes. Such language is also a distortion of how science actually works—a collective enterprise wherein knowledge is created through consensus rather than through the work of ‘great men’ working in isolation. Other terms used to describe the male characters presented in the four textbooks tended to resonate with this image of physics. Phrases such as ‘changed the world forever’ and ‘revolutionary’ are used to describe the men and not the science they contributed to. Descriptions of many also use terms like ‘lacking communication skill’, ‘erratic student’, ‘notoriously clumsy’ and ‘difficult character’. We would suggest that such language presents physics as something not just done by men but by rather estranged characters working on their own.
4.3. Curricular context

The current Leaving Certificate Physics Syllabus (NCCA 1999) consists mostly of physics concepts, and activities which might be thought of as gender blind. However, the list of personalities included in the curriculum is gendered—25 male and 0 female scientists are mentioned by name. With this in mind, our paper does not suggest that the authors of the four physics textbooks purposely set out to have such an unbalanced proportion of male to female scientists. However, there are 91 distinct male scientists mentioned across all four books and two women. While the inclusion of 25 male characters may be attributed to the curriculum, there appears to be no required curricular context for the additional 66 male characters referenced.

Whatever the cause, any explicit or implicit gender stereotypes, communicating the perception that physics and careers are male dominated have been shown to have a negative impact on girls’, engagement, interest and achievement in physics (Hill et al. 2010, Guo et al. 2015, UNESCO 2017).

Recently, a study carried out in the United Kingdom and Ireland (Accenture 2017) found that 57% of teachers held subconscious gender stereotypes in relation to STEM. Carlone (2004) urges that teachers should talk about the innate scientific talent of women and men; refer to scientists as smart women and men; use language that is gender neutral and give examples of women in science. This will relay the message that science is for everyone and will not create classroom hierarchies that place boys above girls. A problem arises, however, when teachers and textbook authors are following the prescribed syllabus and assessment model that is itself innately gender biased.

In preparation for new Leaving Certificate STEM specifications, the Irish National Council for Curriculum and Assessment (NCCA) produced a, a ‘background paper and brief’ for consultation and publication (NCCA 2019). It suggested new STEM specifications should aim to ‘increase participation of females in STEM education and careers’. A 2020 report (NCCA 2020b) describing the outcomes of the consultation, showed teachers felt gender equity to be an important aspect of a contemporary Leaving Certificate STEM specification.

Despite clear policy and teacher support for gender equity in STEM specifications, the Physics Draft Specification (NCCA 2020a) makes no effort to improve on the underrepresentation of women in the previous syllabus—naming ten male and no female physicists. While the draft specification refers to ethical and societal issues associated with physics, no mention has been made to the importance of a diverse community of physicists and ongoing issues of gender inequality. While there are fewer men named within the proposed draft specification when compared to the older one, there are still no women named. If references to women are not explicitly made in the specification, the findings of this study suggest that it is unlikely that they will be included in future textbooks, as the specification sets the scene for the books.

Research has shown that designing curricula that take girls’ interests into account, by linking abstract concepts with real-life situations can help increase girls’ interest in STEM (UNESCO 2017). However, research from Baker (2013) and Good et al. (2010) shows that in order to work towards balancing gender uptake, including female physicists in the specification and in textbooks is equally important as linking concepts with real-life situations. This is supported by the findings of the study by UNESCO (2004), which recommends that curricula should include women from history.

Correspondence with the NCCA confirmed that there are no specific guidelines for subject development groups or textbook publishers to address the concept of gender equality or equity. It was suggested that textbooks should follow the curriculum in that regard.

The findings in this paper are broadly in line with similar analyses of commonly used undergraduate physics textbooks by Lawlor and Niiler (2020) who’ve shown how the percentage of images in books that show women has only moderately improved since the 1960s. Research from Bungum (2013) has shown most physics textbooks contain the same canon of images, suggesting their inclusion is rarely questioned by authors or publishers. In the absence of explicit national policies around diversity and inclusion
The representation of women in Irish Leaving Certificate Physics textbooks within curricula, school textbooks publishers may not require authors to address the underlying issue of representation and inclusion.

In November 2016, the Department of Education and Skills (2016, p 9) noted ‘ambitious targets and a sustained, multifaceted action plan to address the gender imbalance in specific STEM disciplines should be established and implemented as a matter of urgency’. However, the principal area of focus with regard to the curriculum, is to create a syllabus that is more engaging. While this should make the subject more appealing to all students, it does not specifically address gender representation within the syllabus. There are excellent guidelines available (Brugéilles and Cromer 2009b) for textbook authors to produce textbooks that are sensitive to gender: publishers could use these if there were sufficient imperatives to do so.

5. Conclusion

This study has highlighted the stark underrepresentation of women and girls within Irish physics textbooks, both in images and in-text references. This underrepresentation is consistent across all textbooks examined and also extends beyond scientist characters. This study also shows that when women are referenced in-text, the language used to describe them is different from the language used to describe men. Francis et al (2017) argue that such imbalance contributes to the ‘continued prevalence of the discourse of physics as quintessentially masculine’, where ‘the lack of representation of women in physics simply becomes further evidence to support the “naturalness” of men’s domination of physics’ (p 170).

It is clear from the analysis of physics textbooks that their content is influenced by the physics curriculum. Any scientist that is named in the existing curriculum is included in the textbooks. The current curriculum contains no female representation. Although perhaps unintentional, one may see this as an indicator that the curriculum does not recognise female contributions of physics to society, which appears to have filtered down into the textbooks. Despite the promise to make addressing the gender disparity a priority within the new physics curriculum, there is still no reference to any female scientists. Unless the curriculum sets an example of what gender balance looks like, it seems likely that the textbooks will continue to be gender biased.

Data availability statement

All data that support the findings of this study are included within the article (and any supplementary files).

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March 2022 7 Phys. Educ. 57 (2022) 025017
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