COMMUNITY DIRECTIONS

Making diversity 'count'-empowering students through the co-creation of inclusive STEM curricula

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Abstract

STEM disciplines have traditionally been taught as an exercise in memorisation and repetitive application of formulae, with historical aspects often confined to male, Eurocentric contributions of mathematicians, scientists, and engineers. Consequently, this can often alienate students from diverse and under-represented backgrounds, who find it difficult to find inspiring examples of positive role models whom they can relate to when studying STEM disciplines.

This practice paper investigates the impact of diversifying STEM curricula through the development and implementation of student-staff co-created teaching toolkit resources within two first and second-year undergraduate applied mathematics modules to create a more inclusive learning environment for students. Feedback gathered through dissemination of dedicated surveys featured responses from 113 first year and 196 second-year students from multiple engineering disciplines, with 55% and 65% of students strongly or mostly agreeing that the resources inspired them to want to learn more about the contributions of diverse individuals in STEM disciplines.

The insights gained from this implementation will inform future iterations of this project, featuring for example, the expanded use of this toolkit across additional modules and related disciplines as well as inclusion of formative practice quizzes to improve student engagement. Highlighting the contributions of historically underrepresented groups will promote diversity, foster belonging, and inspire future generations among STEM graduates.

Introduction

In recent years there has a been a stark emphasis on the importance of decolonisation in response to students from minority groups feeling alienated with the limited representation of individuals from under-represented backgrounds within traditional STEM curricula in higher education (Iweuno et al., 2024). This stems from the historical and social context of many discoveries (often Eurocentric and male-dominated) being sidelined in favour of memorisation and formulaic learning (Park & Cho, 2022). Consequently, this reinforces the negative perception that STEM is inaccessible or exclusive which could be a contributing factor to increased withdrawal rates of minority students from STEM degree programmes (Archer et al., 2023).

Many higher education institutions have attempted to address this by prioritising embedding equality, diversity and inclusion (EDI) within their STEM curricula (Adewumi, 2024). Hall et al. (2022) also noted that such initiatives must not be tokenistic and performative and need to be reinforced by student opinion and feedback. An effective way of implementing this is through student-staff co-creation partnerships (Cook-Sather et al., 2014), which involves students taking on a leading role in designing and democratising teaching content to the new generation of students.

Changing the perception of STEM subjects by employing inclusive teaching practices can improve student engagement and retention, especially among women and ethnic minority student, foster active participation and help dismantle unconscious bias within the STEM community (Thomas, 2016).

Methodology

The aim of this project is to evaluate the impact of inclusive teaching resources, developed through student-staff co-creation, to showcase diversity, enhance representation, foster belonging, and challenge the hidden curriculum that perpetuates traditional narratives in STEM education (Whitehead, 2025).

This involved the development, implementation, and evaluation of educational resources comprising visually engaging posters compiled from a comprehensive toolkit of biographies (Shah & Belafonte, 2024) that highlighted the contributions of historically marginalised scientists, mathematicians, and engineers, including women, non-Western scholars, and individuals from ethnic minority and LGBTQ+ backgrounds. In accordance with the student-staff co-creation methodology, this was undertaken collaboratively between two undergraduate students and an academic lecturer. These materials were subsequently embedded within two large undergraduate applied mathematics modules comprising a total of 766 first and second-year students in the academic year 2024-25 in the School of Engineering and Materials Science at Queen Mary University of London (QMUL).

Integrating these as asynchronous, formative resources alongside the course content proved to be an effective way to allow for a curated, self-guided learning experience by students, who could learn in a convenient manner at their own pace (Zhang et al., 2020). Dedicated surveys were then used to gather feedback from students to assess engagement, accessibility, and perceived inclusivity of the resources. Based on this, the resources were iteratively refined and digitised into visually engaging posters featuring socially conscious and accessible language.

Phase 1 (EMS412U-Year 1 Mathematics Module)

A set of 6 posters (example shown in Appendix Figure A1) featuring individuals from under-represented backgrounds was introduced as asynchronous content, accompanied by a feedback questionnaire to be completed within a first-year mathematics module (EMS412U) comprising 405 engineering students.

Phase 2 (EMS506U-Year 2 Mathematics Module)

A different set of 6 posters (example shown in Appendix Figure A2) featuring individuals from under-represented backgrounds was introduced as asynchronous content, accompanied by a feedback questionnaire to be completed within a second-year mathematics module (EMS506U) comprising 361 engineering students.

Results

Both groups of students were asked to complete a feedback questionnaire containing the following five questions:

Question 1: Were you aware of any diverse mathematicians, scientists or engineers before coming across these resources?

Feedback from student responses:

"No, as science and engineering teaching in the UK is very western-centred and often gives little information about global scientific and engineering development" (Year 1 student).

"Examples of diverse mathematicians, scientists or engineers before are not mentioned enough in the public sphere, which is why these posters are great at individually highlighting achievements" (Year 2 student).

Question 2: What did you find most enjoyable or interesting about these resources?

Feedback from student responses:

"Realising that all the pioneers of respective STEM fields had to go through struggle, hardships and challenges. This perspective helps me push myself further through the difficulties I often face with studying STEM" (Year 1 student).

"I am often bombarded with mathematical formulas or concepts but was never taught about the people behind any of those ideas. My love for maths is almost equal to my love for history, so these resources killed two birds with one stone for me" (Year 1 Student),

"It was inspiring to see how these individuals overcame barriers in STEM and paved the way for future generations" (Year 2 Student).

"The blend of technical excellence and personal resilience makes these stories deeply inspiring and serves as a powerful reminder that diversity in STEM enriches the entire field" (Year 2 Student).

Question 3: What suggestions, if any, do you have for improving these resources?

Feedback from student responses:

"I suggest incorporating elements such as discussion prompts or quizzes to increase user interaction significantly" (Year 1 Student).

"Dedicating time as part of a session during 'Skills and Employability Week' to discuss these ideas would help gain further traction" (Year 2 Student).

Question 4: Would you like these resources to be introduced in a classroom setting e.g. in lectures or tutorials? Explain why.

Feedback from student responses:

"Yes, as they provide valuable insight into diverse figures in STEM. I also believe this can help challenge and remove any stereotypes and promote inclusivity" (Year 1 Student).

"I would be keen for this, because it gives a background to the theories and formulas that we use. It would explain how these great minds struggled yet still made large contributions to the field of mathematics" (Year 1 Student).

"*I understand that increasing awareness is important, so maybe talking about the significance of learning about these people can be discussed separately, rather than during lectures"* (Year 2 Student).

"Yes, in lectures possibly during reading week to showcase the impact of mathematics in real-world applications and inspire students from various backgrounds to further pursue their careers in STEM" (Year 2 Student).

Question 5: How far do you agree with this statement?

'These resources made me want to learn more about the contributions of diverse individuals to STEM disciplines'

Figures 1 and **2** below document the responses received to Question 5 from 113 and 196 first and second-year students from both the EMS412U and EMS506U modules respectively.

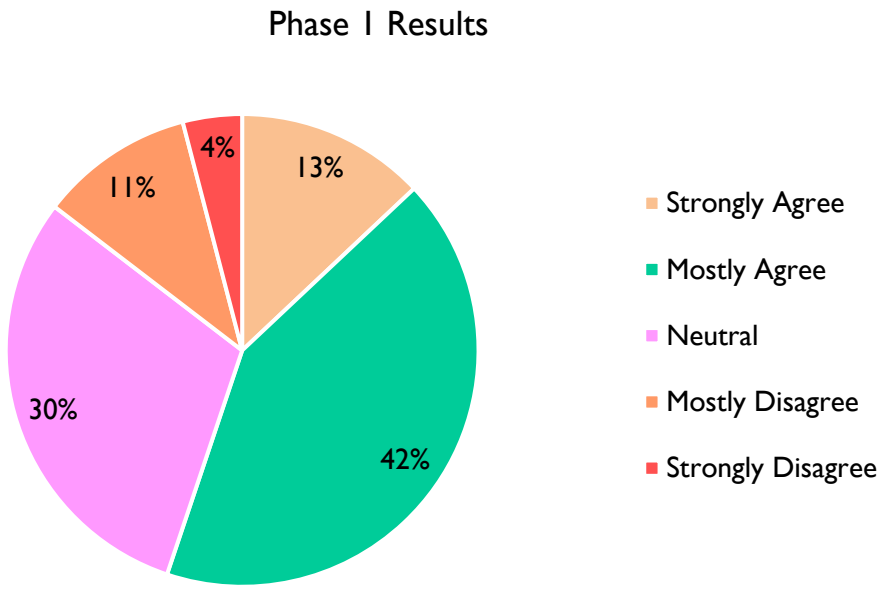

Figure 1 Pie-chart displaying EMS412U student responses (n = 113) to Question 5

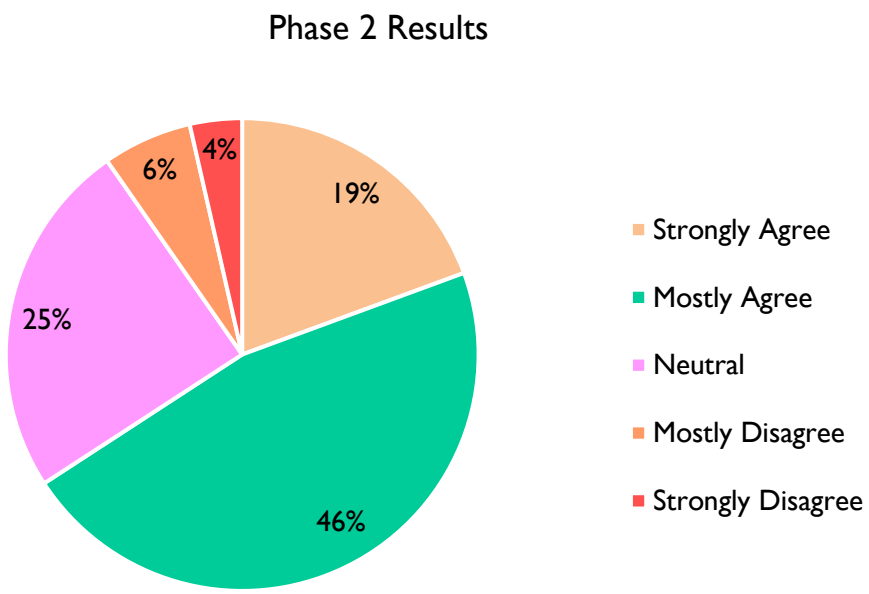

Figure 2 Pie-chart displaying EMS506U student responses (n = 196) to Question 5.

Discussion

Overall, the integration of these resources across the two undergraduate mathematics modules produced largely positive outcomes in terms of student engagement to increase diverse representation within current STEM curricula. The feedback received indicated that most students had not previously been aware of the featured individuals from minority backgrounds, thereby reinforcing the western-centric and male-dominated attitudes prevalent within STEM disciplines. This substantiates the idea that despite an increase in emphasis in recent years on creating a more representative academic community, core teaching materials and content are yet to catch up and have not been able to successfully include a more representative narrative.

The survey results, depicted in **Figures 1** and **2**, revealed that 55% of Year 1 student respondents from Phase 1 and 65% of Year 2 student respondents from Phase 2 strongly or mostly agreed that the resources encouraged and sparked a desire within them to learn more about diverse contributors and their work within STEM. In addition to this, students' comments suggested that they saw value in connecting technical concepts with the stories that led to their discovery, which they described as 'motivational' and 'refreshing'.

The results to Question 5 indicated that 12-15% of students from both respondent groups expressed concern regarding these resources causing potential deviation from the compulsory mathematics content that needed to be taught, which is reflective of the overarching challenge that the creation of an inclusive curriculum is often faced with. This also resonates with the view among several academic staff within the community who perceive such interventions to be supplementary or secondary to the primary teaching content.

Nonetheless, majority of the students agreed that the inclusion of these resources within the curriculum was valuable particularly to those from similar backgrounds who could directly relate to the individuals shown. This consensus highlights that students not only recognise the educational value of inclusivity, but also its ability to provide a more well-rounded and holistic view of the discipline.

While the findings shed light on the potential issues surrounding the embedding of EDI in STEM, the positive reception from students suggests that inclusive pedagogical materials do help foster

emotional engagement by humanising the discoveries and contributions made within these disciplines. At the same time, the slight resistance amongst students also highlights how inclusive pedagogy must be framed within clear academic objectives and fully aligned with module content to 'earn its place' in the curriculum. Co-creation can be a useful tool in tackling this, as both student and staff voices are equally heard in developmental stages, making these efforts less tokenistic and more feedback oriented.

Conclusion

The implementation of inclusive resources has demonstrated how co-creation can be used as an effective model for embedding EDI within STEM curricula, with the comparative analysis of student feedback responses over different year group cohorts highlighting the increased awareness, satisfaction, and sense of belonging among students, particularly those from underrepresented groups.

This project has shown that inclusivity within STEM curricula is indeed desired and of value to the current student body and has made clear how continued iterative development is vital to ensure that diverse representation can promote more successful outcomes for underrepresented groups. The study has also formed the basis for wider ongoing work in this area by providing a transferable co-creation framework for other HE institutions aiming to normalise representation and inclusivity in STEM disciplines.

At QMUL for instance, this has already motivated work across multiple STEM disciplines (mathematics (Garetto, 2023), chemistry (Sheriff, 2021), computer science (Alam, 2024) and biology (Faulker & Fumagalli, 2024)) through related co-creation initiatives dedicated to highlighting minoritised and diverse pioneers under an established umbrella of the faculty-wide Centre for Academic Inclusion in Science and Engineering. The resources from this project have also formed part of external collaborations with other universities through open-access repositories e.g. 'MathsHist4EDI' by the UK History for Inclusion and Diversity in Mathematics Network (2025) and 'Diverse Computing Pioneers' by the Open University (2025). Future work of this kind can be extremely helpful in fixing the 'leaky pipeline' by empowering students to pave the way in the future for more diverse top-level decision makers across STEM disciplines.

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Appendix

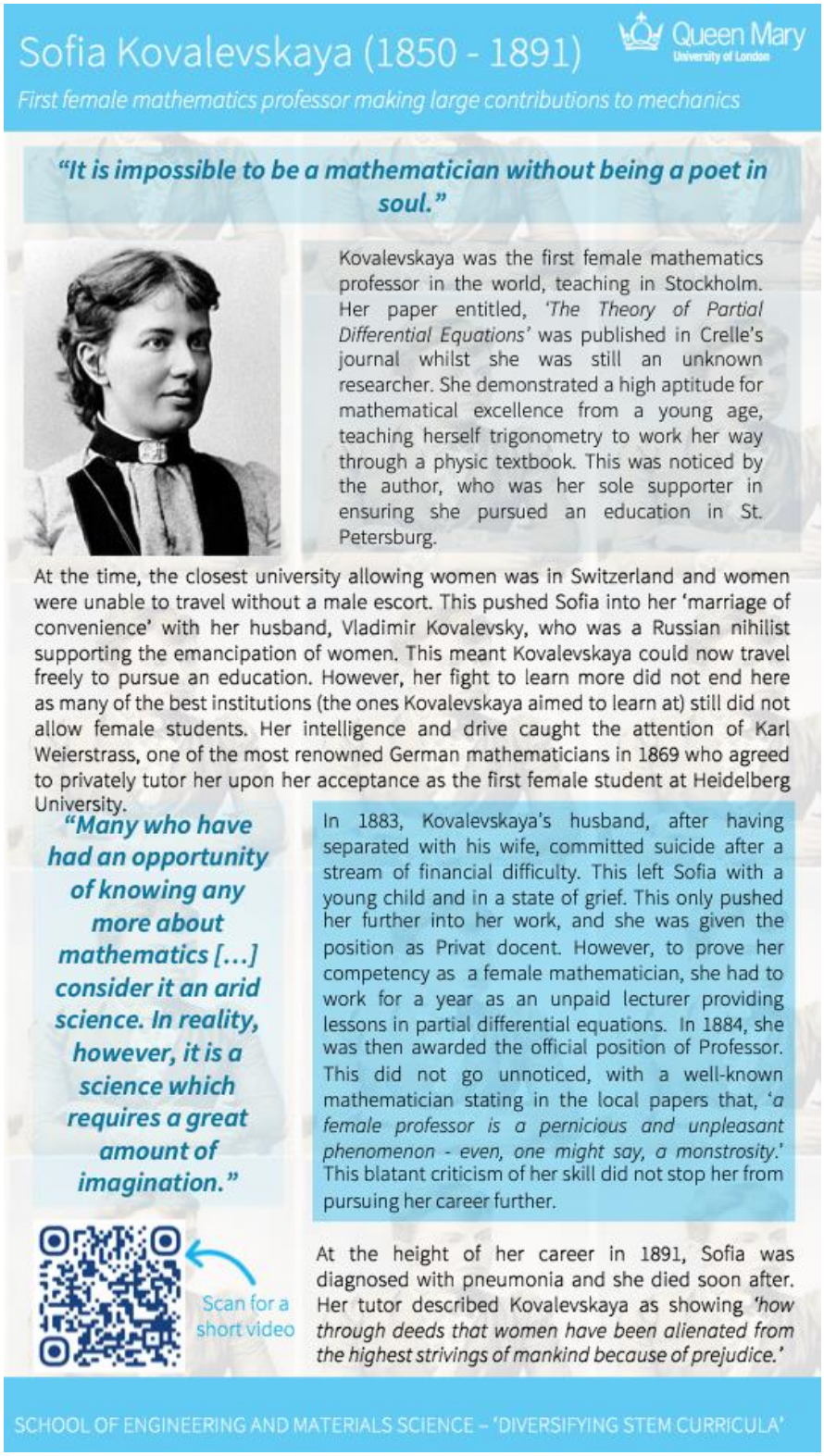

Figure A1 Example of co-created biography poster resource used in EMS412U (Phase 1).

Figure A2 Example of co-created biography poster resource used in EMS506U (Phase 2).