Can Decolonising the Curriculum Provide an Enhanced Engineering Education?

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ABSTRACT

Decolonisation is defined and discussed. University College London has several initiatives to decolonise the curriculum and enhance diversity and inclusion. In 2022, a series of online flipped lectures were developed for the postgraduate software engineering module. The aim was to provide a range of perspectives on artificial intelligence (AI) ethics. Teaching was through the decolonisation lens, highlighting historical viewpoints and imbalances in power. Students could reflect on the ethics of AI systems and how these systems perpetuate colonial biases.

Students had previously indicated their interests in AI, environmental and social issues, including climate change. Before lectures, students completed questionnaires, providing an understanding of their prior knowledge of topics.

A qualitative analysis of the reading material using coding within ATLAS.ti provided insight to select schemas to scaffold students' knowledge. The suggested reading was then adapted to ensure a greater diversity of viewpoints. The analysis also indicates that adding these additional perspectives may not increase cognitive load.

Lectures include real-world perspectives from guest speakers from diverse backgrounds, reinforcing the importance of different opinions. Students greatly valued the different perspectives and opportunities to discuss ethical dilemmas. Students' answers, following ethics discussions, indicated an improved understanding of engineering concepts. This study suggests that incorporating a range of views can enhance the topics students want to learn. Providing different perspectives can also

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deliver a more balanced engineering pedagogy. Adopting a decolonisation approach that recognises the past but provides alternative narratives may strengthen opportunities for engagement with other universities: creating new scenarios in engineering education.

1 INTRODUCTION

> *Decolonization involves identifying colonial systems, structures and relationships, and working to challenge those systems. It is not "integration" or simply the token inclusion of the intellectual achievements of non-white cultures. Rather, it involves a paradigm shift from a culture of exclusion and denial to the making of space for other political philosophies and knowledge systems. It's a cultural shift to think more widely about why common knowledge is what it is, and in so doing adjusting cultural perceptions and power relations in real and significant ways.*
>
> Keele Manifesto for decolonising the curriculum [1].

Decolonising the curriculum is about overcoming the structural disadvantages and barriers in education and the lack of representation of black and minority ethnic groups. At its core, it is ensuring that what we teach and how we teach is 'more responsive to the problems of colonial racialised privilege and discrimination' [2].

Over the past few decades, there have been movements to decolonise universities to allow equal access and better educational outcomes for marginalised groups. There are efforts across UK universities by students and staff to dismantle the legacies of colonialism. Shortly following the Rhodes Must Fall campaign led by students and communities within South Africa to remove the Cecil Rhodes statue, several campaigns at University College London (UCL) have renamed buildings linked to racism. Not only to dismantle colonial statues but also to address the domination of structural inequalities and the idea that somehow the Global North is superior intellectually. In response to strong student interest, the SOAS was one of the first UK universities to commit to delivering a decolonising agenda. Their resulting toolkit [3] was one effort to provide suggestions to transform the legacies of colonisation. The toolkit suggestions were the starting point for developing the series of online lectures outlined within this paper.

The decolonisation projects at UCL are just one aspect of broader developments to enhance equality, diversity, and inclusion (EDI) to ensure that the university provides a welcoming environment for students from around the globe. The UCL Department of Computer Science has been recognised for its EDI initiatives. The department was awarded the Athena SWAN Silver award in 2015 and 2019 in recognition of advancing

gender equality. When invited to deliver a series of lectures for the MSc software engineering professional practice module, the author was keen that this should support EDI initiatives and enhance the efforts to decolonise the curriculum.

The author had initially co-developed this module to include a range of guest speakers to provide a leading-edge and alternative perspective to the academic lectures. The speakers represent a diverse range of ethnicities and genders. Developing the new lectures was also an opportunity to tailor these lectures to students' interests in AI ethics. Students in the software engineering programme attend machine learning and software engineering modules and the professional practice module. The last module is focused on project management and ethics to provide students with the necessary knowledge to deliver their industry research projects. Machine learning is covered by theory and practical lab sessions, focusing on technical areas. Developing a series of new lectures provided an opportunity to align with the university's decolonisation initiatives.

This paper covers the development and open-ended approach (allowing for multiple answers) for the three AI lectures for the spring semester of 2022. These were designed as online flipped lectures with pre-lecture reading covering: research papers, reports, and textbook chapters. The emphasis was on discussions of the material before and during the lectures.

2 METHODOLOGY

2.1 Decolonising the reading lists

Reading lists have a role in decolonising our universities [3, 4]. The SOAS toolkit suggests providing a more comprehensive range of source materials, particularly from the Global South. A range of research papers and texts were considered, from geographic regions, particularly where they critiqued the subject matter or provided a different perspective. Where research papers had authors with more than one affiliation, the institution and country origin of their correspondence email was selected. The analysis included all authors for each research paper. The author's identification of gender and geographic/institution affiliation was confirmed by referencing publicly available web pages, the publication, and the journal itself or other research papers the author had published.

A more comprehensive representation of authors and countries [4] is one approach to decolonising the curriculum. The reading material was updated to include authors representing a more comprehensive range of countries, Fig.1.

Data collected 2020/21 via a departmental questionnaire indicated the highest number of students logged on from the UK and the second-highest number of students from China.

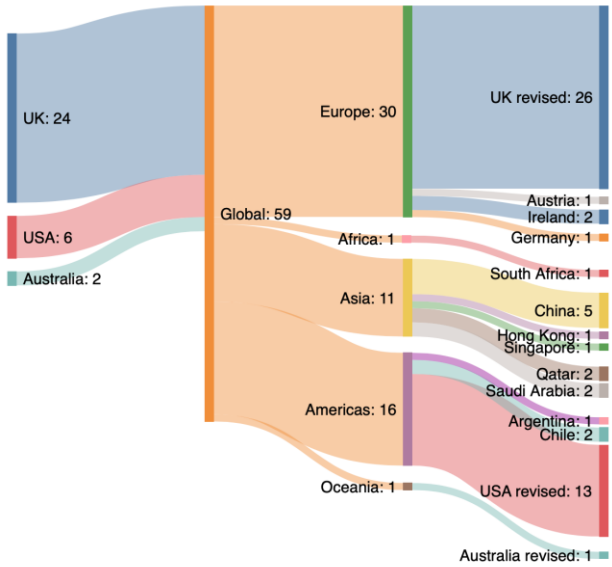

Figure 1. Geographic distribution of author locations for reading list and research papers cited. The left-hand side represents the initial documents selected for the lectures. The right-hand side indicates documents after analysis and review. The recommended reading now better reflects the many countries UCL computer science students are from during 2021/22.

UCL Postgraduate computer science students during the academic year 2021/22 registered from many countries, including Austria, Ireland, Germany, South Africa, China, Hong Kong, Singapore, Saudi Arabia, and the UK. An analysis of the reading list now shows a broader range of perspectives, including the Global South, Fig.1.

2.2 Use of questionnaires to understand student's prior knowledge

Questioning is a powerful tool to unlock learning and new ideas. Asking students what they already know does not create a defensive response. Students frame their replies as part of their perspective and view of the world. Understanding what students know can be used to tailor the lecture content, which avoids the repetition of well-understood concepts. Once each student had answered each question, more detailed information and resources were provided automatically according to their answers, ensuring that time during the flipped lecture was devoted to developing a deeper understanding of the topic.

Students had previously shown an interest in health and sustainability, including climate change, when answering questionnaires. Analysing questionnaires and incorporating data from online posts, Table 1., helped determine the three main AI

topics delivered during 2022: AI and bias, AI emotion recognition software, and AI and sustainability.

Lecture topic	Year and Student Registrations	
	2019/20 N=39	***2020/21 N=42***
Sustainability	10	18
Inclusion and Diversity	18	20

Table 1. The two topics with the highest level of interest as indicated by online posts for lectures during the last two years. For 2021/22, 36 students registered for the module.

An analysis of student's answers to the questionnaires indicated the level of understanding of each topic. Students demonstrated a high level of understanding of most machine learning concepts. However, one question regarding receiver operator characteristic (ROC) curves was less understood. 66% of students (N=24) provided option (c) as the correct answer for this question.

> What does the area under the curve (AUC) for a receiver operator characteristic (ROC) curve tell us?
>
> (a) How well the model works at its optimum decision threshold
> (b) Indicates which is the optimum decision threshold
> (c) Provides a summary of how well the model works across a variety of thresholds

The information from the questionnaires provided an opportunity to adapt the lecture material accordingly, with a threshold example within cancer diagnosis. It was optional for students to retake the questionnaire. After class explanations, every student who retook the questionnaire selected the correct answer. The teaching highlights a research paper that indicates medical professionals often have difficulty interpreting threshold data [5]. This research suggests an alternative approach to independently examine the ROC curve's axes of sensitivity and specificity by encapsulating the data as one metric: net benefit to the patient.

2.3 Using computer-aided software to develop the schema

ATLAS.ti version 22 [6] was used for quantitative analysis of the reading list. Segments of the text of the intended reading list had codes attached (or tags) representing social phenomena, such as colonisation, bias, and perpetuation of bias. Analysis of the data within the software tool provided a way to integrate the data in numerous ways. The data querying also provided a visual impression of the interrelated concepts, helping

formulate ideas to refine the schema. Visualising the codes, for example, as a heat map, also provided information to ensure there was adequate coverage of concepts.

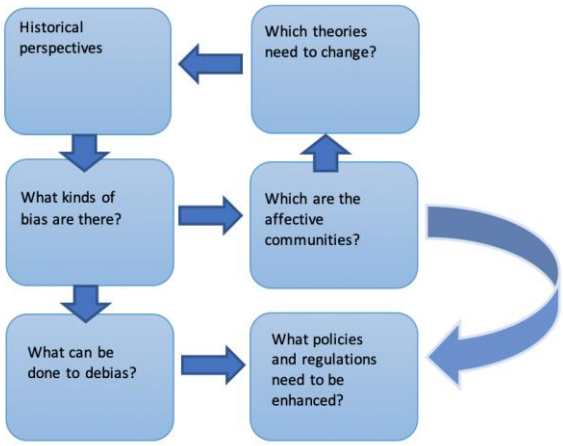

Figure 2. The schema developed for the lectures focuses on historical perspectives, the categories of bias, and which communities are affected. Discussions also encompassed techniques to debias and if underlying theories need to change.

Analysis of the selected documents helped refine the schema to emphasise adversely affected communities Fig.2. Discussions focused on what developers need to do and how regulations must adapt. It also helped students consider how communities can be empowered to have a voice in the deployment of AI systems.

Research indicates that providing appropriate schemas of related information can reduce cognitive load and improve learning [7]. Building on what one already knows with schemas helps retain information. Adopting appropriate schemas aids the rapid assimilation of new concepts and information. Although the reading list now has a broader range of references, the specific pages for suggested reading are limited to ensure an overall reduced cognitive load.

2.4 Flipped lecture examples

The focus during the first lecture was on machine learning: selecting data, bias, and how to debias. The pre-reading [8] includes Amazon's failed attempt to use AI to recruit staff, resulting in the AI system training on the predominantly male workforce data, perpetuating gender bias. Students readily identified solutions such as removing gender or words used by a specific gender. As students had mentioned an interest in health-related topics, lectures covered medical examples, including how medical data is often biased. The material also covered how a proxy of healthcare spending per person determines future healthcare spending for communities within the United States. Research shows that monetary spending per patient is less for black and

ethnic minorities; this perpetuates inequality of healthcare provision for these communities. The students recognised that if the data is biased, this will exacerbate the problem. Historically clinical data has been collected predominantly from white non-Hispanic populations. Using AI algorithms with these records provides poorer identification of illness for other ethnicities. Discussions covered approaches to mitigating these situations, such as oversampling. An outline of how synthetic data could compensate for the lack of data for ethnic minorities and help reduce the bias in clinical data was also introduced [9].

Several students had previously outlined their interest in advanced AI techniques. Therefore, the background reading and slides included the use of adversarial techniques [10], illustrating how using AI, new data sets for under-surface ice profiles can be created to determine ice melt and better understand climate change. The students recognised the importance of these measurements and the threat to global communities at risk of sea level rises, often in the Global South.

The class pre-reading also includes using AI systems to identify cancers during surgery [8]. These critical decisions with a high risk have a human-in-the-loop approach. In this case, the surgeon makes an informed decision based on the AI system prediction combined with their expert knowledge. Students appreciated that the EU recommends this approach as oversight for many AI systems that affect individuals and society.

3 DISCUSSION

Although there are numerous papers covering AI ethics, there is a paucity of research papers on how AI ethics should be taught [11]. Also, the canon of AI ethics does not necessarily prioritise students' interests; students' environmental and climate change concerns are often a sub-category of AI ethics [12]. Students have recognised the importance of alternative perspectives and have suggested alternative sources during their discussions. Accepting the value of students' suggestions is one step toward co-creating the curriculum.

Tailoring content can have a positive impact on cognitive load. Linking knowledge to well-understood schemas can decrease the cognitive load. These schemas then act as a scaffold to learning new information. The questionnaires also provide a chance to learn from smaller units of information. Students can steadily build their knowledge via the automated feedback within the questionnaires. Ensuring well-understood concepts are not repeated during class allows for more challenging problems to be discussed. Evidence from answers to questionnaires suggests that considering ethical and moral dilemmas can improve technical understanding.

Providing questionnaires in quiz form with an assessment also provides students with an indication of their progress. Detailed explanations after each choice also help students prepare for the lecture, provide time to assimilate this knowledge into a schema, and embed information into long-term memory.

The discussions helped students appreciate the relevance of ethics; how we can balance choices. The discussion regarding interpreting the ROC curve highlighted the need to lower the threshold to improve cancer diagnosis. However, it raised potential resource problems associated with the increased number and ratio of false positives. The discussion also raised further questions, such as the availability of medical testing and whether tests should be free of charge, a particularly relevant societal issue in the UK. The discussions also reinforced that persons affected by AI should be empowered to participate in its regulation, a key recommendation of the Ada Lovelace Institute's Policy Briefing 2022 [13] to strengthen the EU AI Act.

4 CONCLUSIONS

The interests and knowledge of students should be considered when designing modules. Incorporating the perspectives of countries where students come from acknowledges the importance of their communities. Ensuring all students see themselves and their cultural backgrounds reflected in the curriculum helps ensure all students feel welcomed and engaged.

These preliminary studies have indicated that decolonising the curriculum can support the development of engineering skills. However, these studies have focused on AI ethics and bias, and future research is required to confirm the validity and efficacy of this approach for other teaching contexts and other engineering fields.

Diversification of the reading list has an essential contribution to the decolonisation process. Encouraging students to suggest additional research which critiques the reading or has a different perspective is one way to co-develop and decolonise the curricula. Decolonisation provides an opportunity for staff and students to collaborate. This approach may be one starting point for comparative studies across universities.

Viewing the curriculum through the decolonisation lens helps us consider that not all students have equal chances in education. Considering perspectives from around the world, examining the histories that have led to injustices, and sharing our decolonisation practices, we can hopefully break down some of the barriers in engineering education.

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