Ensuring Global Perspectives within Reading Lists to Increase Students' Engagement

G.J. Collins
University College London, Department of Computer Science, London, United Kingdom
g.collins@ucl.ac.uk

***Abstract* - University College London attracts students worldwide and provides students with the latest research opportunities to meet global challenges. The Department of Computer Science within the university has won recognition for its diversity and inclusion initiatives. During 2022 a series of AI ethics lectures were developed for the software engineering professional practice module to help students prepare for their research projects. Teaching was through the viewpoints of power imbalances relating to AI and green technologies, including resource extraction. The AI ethics series was designed as online flipped lectures. Students were encouraged to read research papers beforehand, which were subsequently discussed during the online lecture. Qualitative data analysis of the reading list provided insight to optimize content and reduce cognitive load. During 2022/23, students completed redesigned questionnaires to help the lecturer understand their knowledge of the topics and interests. Students outlined their interests in leading-edge AI concepts and how AI can reduce energy consumption and protect the environment and biodiversity. Analysis of questionnaires and discussions indicates students' increased engagement in sustainability related topics. When perspectives from different regions of the world, reflecting the class's global community, were introduced to the reading list, students were more engaged with the module.**

Keywords - AI ethics, cognitive load, curriculum development, engineering education, reading lists, student engagement

I. INTRODUCTION

This paper advances the approach of diversifying reading lists [1] to engage with students who register for a software engineering course from countries worldwide. It covers the further adaptation of flipped online lectures and the development of questionnaires to establish students' interests and prior knowledge.

University College London (UCL) welcomes students from around the world. UCL recognizes the importance of attracting students worldwide to ensure the right mix of leading research talent. Each department emphasizes the university's equality, inclusion, and diversity (EDI) initiatives. The Department of Computer Science recognizes the importance of supporting females in research and won several awards in recognition. The department won the Athena Scientific Women's Academic Network (SWAN) award in 2015 and 2019 for advancing female career opportunities for students and staff. Within the research-intensive universities in the UK, the department has one of the highest female ratios of students and staff, with over 20% female staff [2]. The postgraduate taught module is no exception. Female students comprise over 30% of the intake.

There is an increasing emphasis on interdisciplinary research to solve some of the most challenging global problems within all departments. Student research is focused on and supported via the UCL Grand Challenges initiative [3], which seeks to bring UCL's academic expertise to address these global problems by integrating knowledge across disciplines. This initiative is a collaborative venture across the university and with industry, research institutes, and associated clinical partners such as University College Hospital. The themes within this initiative address: Global Health, Sustainable Cities, Cultural Understanding, Human Wellbeing, Equality and Justice, and Transformative Technology. These cover the spectrum of the 17 United Nations (UN) Sustainability Development Goals [4]. Students' research projects, therefore, align with both these frameworks.

International conferences such as the 27th Conference of the Parties to the UN Framework Convention on Climate Change 2022 (COP27) and the 2022 UN Biodiversity Conference (COP15) seek to address some of the world's most significant problems. These conferences call for more progress toward addressing climate change and biodiversity loss. The World Economic Forum's (WEF) Global Risks Report 2023 [5] outlines that the most urgent problems faced by humanity relate to climate change and the destruction of the environment. Their report cites biodiversity loss and ecosystem collapse as the fastest-growing risk to the planet over the next ten years. Students are aware of these calls for action and increasingly want to be involved with projects that create a more sustainable future.

Since 2003 the lecturer (author) has, in collaboration with colleagues, developed the postgraduate professional practice module within the Department of Computer Science. From its inception, this module has included industry guest speakers providing an alternative perspective to the academic content taught by research staff at UCL. The initial development of the AI ethics

lectures during 2021/22 [1] provided an opportunity to adapt these lectures to students' interests in bias and creating a fairer society. The lecturer refined this series during 2022/23 based on a more detailed questionnaire to incorporate students' interests and views on leading-edge AI developments and how AI can reduce environmental impact and biodiversity loss and mitigate the climate crisis.

Software engineering students can take machine learning modules which focus on the technical aspects. The technical examples introduced within the AI ethics series during 2023 provide a background for students to discuss the ethical implications of the increasingly complex models: machine learning, neural networks, and foundation models. The lecturer has included these examples to help students understand approaches to interpreting data and how AI can reduce energy consumption. Developing and updating the AI ethics lectures ensured they aligned with students' interests and the university's EDI and sustainability initiatives.

This paper builds on the development of the online flipped learning AI lectures for the spring term of 2022 [1] and outlines further refinement based on student questionnaires and student feedback. The reading list mainly consisted of research papers. During 2023 the lecturer diversified the pre-reading to include sections of textbook chapters, industry blogs, and online articles from NGOs and Indigenous peoples. The module emphasizes different perspectives for each topic and allows adequate time for discussions before, during, and after lectures so that students can reflect on various perspectives.

II. Curriculum Development

A. *Diversifying the Reading Lists*

During the lecturer's previous classes, students have often commented on projects within their own experience or projects that have affected their communities. Where there has been coverage of associated topics in previous years, students have shown greater engagement, as indicated by the number of discussions and questions raised in class and online within Moodle, their online module resource. As the postgraduate students within the computer science department register from over 50 countries worldwide, students were asked through questionnaires whether teaching should cover a range of projects from around the world. The majority, 86%, of the students[1] during the academic year 2022/23 participating in these optional questionnaires either "strongly agreed" or "agreed" that projects covered within these lectures should include examples from different world regions. The reading list, to support the AI ethics online lectures, was diversified to represent a range of authors with different perspectives from around the world.

Reading lists can contribute to making universities more equitable. Reading lists can also provide a voice to marginalized authors. Students are increasingly demanding that there are more diverse sources of knowledge [6]. One way of achieving this is via the reading list: ensuring there are perspectives from around the world. Encouraging students to contribute to these resources is another way to collaborate and engage in the process.

All students benefit from a plurality of views. By diversifying reading lists, students from minority groups see that their opinions and communities are represented [7]. The lecturer followed the suggestion of the SOAS, the School of Oriental and African Studies (University of London) toolkit [8], to widen sources within the reading list to be more representative of the Global South. In addition to recommended sources from around the globe, the lecturer considered the perspectives of each source. The lecturer recorded each author's university or institution and location. Gender was also recorded by reference to personal pronouns within biographical notes at the end of the paper or other articles they had written.

The initial design of the lectures only included research papers from the United Kingdom, the United States of America, and Australia. These resources were not representative of the students' registrations. Postgraduate students in the department 2021/22 registered from many countries, including Austria, Germany, South Africa, China, Hong Kong, the Islamic Republic of Iran, Japan, Saudi Arabia, Singapore, South Africa, and the United Kingdom. Following students' opinions recorded within the 2022/23 questionnaire, the lecturer has widened the reading list further by ensuring different perspectives for each topic and including research papers from other world regions, Fig. 1. The

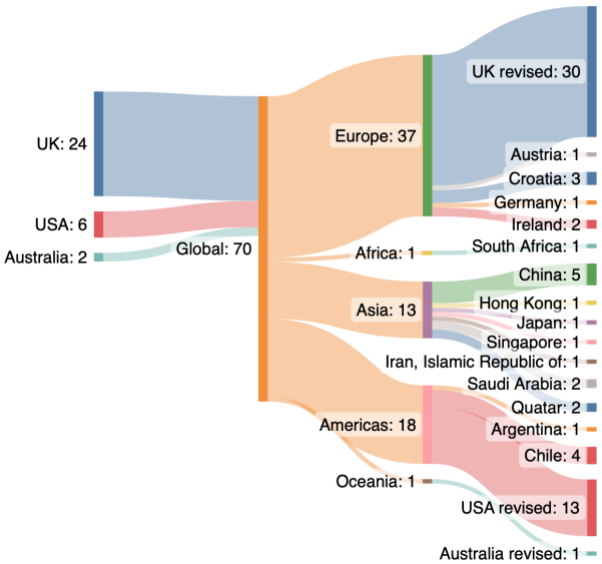

Figure 1. Geographic distribution of authors' locations for the AI ethics reading list. The left-hand side represents the authors' locations for the documents initially selected in 2021. The right-hand side indicates the authors' locations for the academic year 2022/23. Adapted and updated from G.J. Collins [1].

[1] Questionnaires were anonymous. Class size (*N*) 2022/23 =*32*.

reading list better reflects the diversity of UCL software engineering student registrations.

B. Questions to Understand Students' Prior Knowledge

The pre-lecture questionnaire is in two parts; the first section is designed to understand students' knowledge of machine learning and AI ethics. The second part is designed to understand students' interests (Section C).

Questioning can provide an enhanced understanding of a subject and can be a valuable teaching tool [9]. The lecturer can ascertain the student's knowledge by asking what a student already knows within a questionnaire. By asking via a questionnaire prior to the lecture, the lecturer can develop the module so that concepts that are well understood by students do not have to be repeated. This information can then be used to ensure the time is not spent on repeating concepts but on new areas of interest to students.

The lecturer developed the student questionnaire using Microsoft Forms. The anonymous questionnaire provides an automated answer to the student, with a constructive comment on the validity of the response and a pointer to further resources. These additional resources are highlighted with specific page numbers within the reading list. The questionnaire is integral to the learning process by outlining the student's progress before lectures and as a learning resource to develop a fuller appreciation of the topic.

Previous research by the author [1] has shown that students sometimes need help understanding receiver operator characteristic (ROC) curves. Most students, 66% correctly identified that the area under the curve (AUC) for a ROC curve "provides a summary of how well the model works across a range of thresholds" [1]. Students' anonymous answers were used to examine this issue more thoroughly. In 2022, the lecturer needed significant time within the online lecture to explain the example. The lecturer provided further guidance before the class in 2023. The lecturer also shortened the introduction to the problem during the online lecture with a worked example, which allowed more time for an extended discussion and adequate time to discuss the ethical implications of interpreting the data.

The lecture material was based on a hypothetical example of cancer diagnosis to identify patients for treatment based on Halligan, Altman, and Mallet [10]. The worked example was adapted for 2023 to provide an additional model for students to calculate the relevant figures for sensitivity and specificity. During the online discussion, the lecturer explained the reference diagnosis scale using Table I. The lecturer also explained the graph's axes and plotted the ROC curve, Fig. 2. A worked example for threshold 5 was outlined, assuming this is the highest accuracy of a cancer diagnosis. At this threshold, 17 patients are correctly identified with cancer (34% sensitivity), and only 1 with a false positive diagnosis (98% specificity). The lecturer then used threshold 3 as a further example. The lecturer reminded students this would include all patients for threshold 3 and above. Students calculated the total of patients diagnosed with cancer and percentage sensitivity. Students also provided the answer for the relevant specificity.

TABLE I. REFERENCE DIAGNOSIS

REFERENCE DIAGNOSIS/THRESHOLD	1	2	3	4	5	TOTAL
PATIENTS WITH CANCER (TRUE POSITIVES)	1	3	8	21	17	50
PATIENTS CLEAR OF CANCER (FALSE POSITIVES)	17	21	8	3	1	50

Adapted from S. Halligan, D.G. Altman, and S. Mallet [10]. Adapted with Permission

Students discussed which threshold to select. Students noticed that lowering the threshold would correctly identify more cancer patients, with a consequent increase in the rate of false positives. However, students also appreciated that lowering a threshold may create a moral dilemma if there are limited resources to cope with additional tests and procedures. Students recognized that many communities do not have the same access to healthcare as others. Students suggested that accuracy in diagnosis, whether in this example or AI systems in surgery [11] within their recommended reading, is essential, and this will often need the medical professional's expertise to interpret the AI systems' recommendations.

Guided instruction for students unfamiliar with topics rather than allowing students to explore unguided has shown to be effective [12], [13]. Although optional, students who retook the questionnaire achieved the

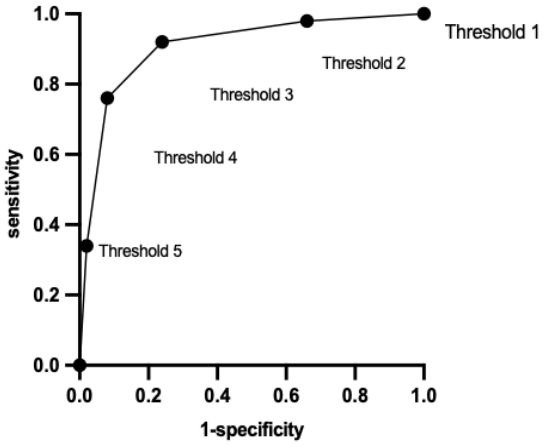

Figure 2. The ROC curve drawn during the lecture. Adapted from S. Halligan, D.G. Altman, and S. Mallett [10]. Adapted with Permission.

correct answer for the related questions. The responses suggest the guidance contributed to a better technical understanding. Students noted that the pre-reading [10] highlights that medical professionals often find it challenging to interpret these ROC curves. Many students found the discussion helpful, as they realized that professional experience is still required to make an informed decision.

C. *Questions to Understand Students' Interests*

The second section of the pre-lecture questionnaire aims to understand students' interests [2]. Within this section, one of the questions asked their views regarding the extraction of resources using a Likert scale: strongly agree, agree, neither agree nor disagree, disagree, strongly disagree.

Question: The extraction of resources (such as cobalt and lithium) for green technologies should consider the following statements:

1. The carbon emissions of the resources
2. The impact on the environment and biodiversity
3. That technological advances in the Global North should not be at the expense of the Global South

Most students, 86%, answering this question either "strongly agreed" or "agreed" that impact on the environment and biodiversity should be considered. Many students, 71%, agreed that carbon emissions should be taken into consideration. Although there was less consensus on the last statement, whether "…advances should not be at the expense of the Global South", most students answering this statement agreed.

As students frequently mentioned healthcare bias in their online discussions, the lecturer selected bias as the introductory topic. Analyzing discussions and questionnaires determined two additional AI topics, "emotion recognition software, and AI and sustainability" [1], which were updated for 2022/23.

D. *Refinement of the Schema*

The lecturer used ATLAS.ti version 22 [14] for qualitative analysis of the reading list. The visualization helped to rapidly identify the frequency of the coverage of projects, countries, and perspectives [1]. This information helped identify repeated instances of concepts and enabled a reduction in the content for students to study, lessening the overall cognitive load. Analysis of the reading material helped develop the schema to emphasize various phenomena such as bias, "affective communities" [1], and policies or regulations that need to change, Fig. 3.

Kirschner, Sweller, and Clark [13] outline that learners must acquire the necessary schemas to scaffold their knowledge to develop expertise. The learning process is accelerated if pieces of information are processed simultaneously as a schema. Schemas can be considered akin to "patterns in our heads" [15]. Using schemas makes the learning and recall process more effective as it places less demand on working memory. According to Cognitive Load Theory [16], processing novel information causes a load on the learner's working memory. Additional working memory resources are then required to construct schemas to store in long-term memory [17]. The schema provides a framework for both the lecturer and student to explore each schema segment, helping to scaffold information and reduce the load on working memory [18].

Students have referred to the schema Fig. 3 to identify the affected communities and whether people have a say in regulations or how their resources, including data, are used. When students discussed Microsoft's research [19] to find more sustainable energy solutions for data centers by placing them on the seabed, they raised questions regarding the environmental impact on marine ecosystems, potential sea temperature increase, and the consequences to local marine ecosystems. In response to these student discussions, the relevant schema element, relating to "affective communities" Fig. 3, now encompasses the environment and ecosystems. This elaboration of the schema supports both students' learning and the lecturer to deliver the lecture content.

E. *Increased Range of Perspectives for Topics*

During 2022/23, the class discussed energy efficiency in more detail. This encompassed power usage effectiveness (PUE) measurements: the efficiency of the data center via the ratio of energy use overall compared with that used for computation. Discussions covered the industry perspective on using PUE as a standard measure and the flaws of this approach. Students readily

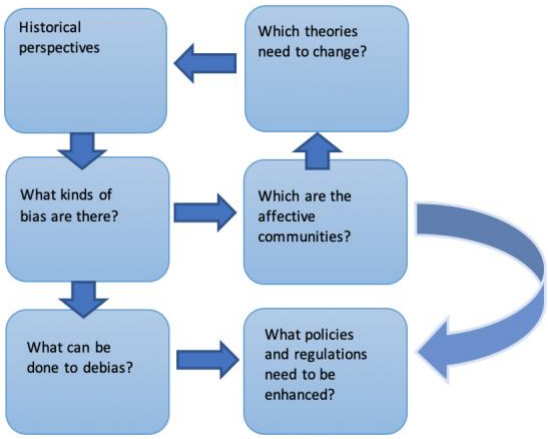

Figure 3. The schema developed for the lectures focuses on the affective communities, which theories need to change, bias, and what may have given rise to bias. The schema examines what can be done to reduce bias and what theories, policies, and regulations need to change. From G.J. Collins [1]

[2] The percentage of female students within the department for postgraduate taught modules was 32% for the year 2020/21.

appreciated that the data center would typically have a more efficient PUE value if relocated to a cooler climate. They also recognized that reliance on PUE values could hide inefficient scheduling within the data center. Students also exchanged ideas on how environmentally friendly different approaches to cooling were, such as the use of solar energy or the use of seawater.

The reading list now includes resource exploitation, particularly lithium mining in South America, from the perspective of the Indigenous Colla community and NGOs [20]. The online discussion covers the water used for lithium processing, reducing the water levels in the hypersaline lakes, and polluting water supplies for the local population. The pre-reading has also been updated to include research highlighting the impact on ecosystems [21]. Students discuss the detrimental effect on the fragile ecosystem, reducing the shrimp population within the lakes, the critical food source for flamingoes. The online lecture uses the schema Fig. 3 to discuss whether the Indigenous community has a say in what happens to these resources and whether this exploitation of resources in the Global South is ethically acceptable.

Students have expressed an interest in protecting ecosystems and climate change. A research paper within their reading outlines the use of generative adversarial networks [22] to accurately measure polar ice profiles. This research was covered in more detail during 2023 as students were interested in the effect of ice-melt on biodiversity within polar regions and climate change. As the department's research students use the university's HPC infrastructure, many are interested in the energy and mineral resources required to build and run these facilities and how AI can reduce energy consumption. The lecturer enhanced the reading list for 2023 with research papers covering AI scheduling within data centers and research outlining the application of AI to reduce energy consumption in smart cities [23].

With the increasing adoption of foundation models, such as ChatGPT, students were concerned that models would perpetuate bias across domains. Students recognized that the model being studied [24] would disproportionally affect under-represented populations in South America and Africa if used more widely. Students also explore how small training sets can improve efficacy: energy consumption, time training models, and reducing bias.

F. Key Outcomes for Online-Lectures

The reading list is now more diverse in representing authors and perspectives from across the world, Fig.1. It also includes a broader range of opinions from academics, industry, research institutes, NGOs and Indigenous communities. The AI ethics lectures have been adapted to cover topics in which students have expressed an interest: advances in AI, bias, diversity and inclusion, health, sustainability, biodiversity, and climate change.

More time was allocated to class discussions during the spring term of 2023 than compared to the previous academic year. Student discussions continued beyond the scheduled lecture time, suggesting increased engagement. The lecturer used the schema to introduce topics and refined this for future lectures emphasizing areas discussed with students, particularly bias and coverage of the environment and biodiversity.

III. DISCUSSION

Numerous research papers cover AI ethics; however, there needs to be more research conducted on how this subject should be taught [25]. Students' priorities, particularly in the environment and climate change, are not always prioritized in the suggested models of AI ethics education [26]. Including the areas of students' interests has increased engagement, as measured by the number of online posts and discussions. Although this number may not be valid, it indicates to what extent students interact with the reading lists and online lectures. Additionally, all online posts and discussions recorded were directly relevant to exploring the topics more deeply.

Providing resources before the lectures can reduce the students' cognitive load [27]. Using questionnaires to establish students' prior knowledge allows the design of the content to build on their knowledge. Having an appropriate schema aids the assimilation of new knowledge [28]. The automated feedback within the questionnaires provides further guidance and resources available. Within a crowded curriculum, it is impossible to cover every aspect of a topic; giving feedback and optional resources is one way to enhance the module.

It is essential that students are equipped to understand the societal impact of these technologies and proposed changes to the regulation of AI. Based on the schema, the discussions emphasized that communities affected by AI should have a say in AI deployment, which is a recommendation of the Ada Lovelace Institute's Policy Briefing [29]. The online lectures also provide an opportunity to discuss that researchers should have rigorous and ongoing review processes when they develop AI systems.

Although students study machine learning options, these are from a predominantly technical perspective. The AI ethics series focuses on enhancing the ethics coverage within the module and considers some examples that students have specifically mentioned they are interested in. In teaching, it is essential to provide a balance of different opinions. Students have recognized the importance of alternative perspectives and have suggested additional sources during their discussions. Including students' research paper suggestions for the reading list can increase engagement and co-create the curriculum. Within the 2022/23 questionnaire, students have indicated that there should be a more comprehensive representation of projects from different regions of the

globe. Although there is still a bias within the reading list towards authors within the Global North, the number of authors and countries represented by the Global South has substantially increased.

IV. CONCLUSION

Diversifying the reading list to include sources from students' home countries can build engagement, help students feel welcome, and create a sense of belonging. Understanding what students are interested in and including their suggestions for the reading matter helps students feel that they also have a voice in their studies. Covering topics within the curriculum that students are concerned with, health, environment, biodiversity, and climate change, demonstrates their opinions are valued.

Diversifying perspectives within engineering education instills the value of considering a more comprehensive range of opinions and technological solutions. This diversification of views enables students to realize that AI can be used to develop a greener technological future that is not dependent on exploiting the resources of the Global South.

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