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Evaluating UK academics' perspectives of ethics education within computer science degree programmes: a preliminary insight

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Abstract

Emerging systems using artificial intelligence (AI) including the complexities of deep learning leading to decision-making outcomes pose challenge, risk alongside opportunities to revolutionize business sectors and thus, human life. Building AI that impact on critical decision-making must be entwined with ethical questioning from the initial conception of design. As academics educating future technologists, we must lead on embedding the importance of ethical thinking for equitable designed systems. Currently, it is unclear across UK Higher Education how widely ethics is taught across programmes of study within computer science disciplines, their importance within the curriculum plus the confidence of academics for its delivery. This paper carries out a survey analysis to identify gaps, measures of engagement, expertise and knowledgebase of topics through both quantitative and qualitative questioning. The survey was distributed to 15 member universities of the Council for Professors and Heads of Computing (CPHC) randomly selected across the UK for which 32 academics engaged in the study. Results show ethics was noted as being important although one-third reported it was not widely embedded across the curriculum. Just less than half of participants schedule the teaching of ethics regularly either across one or several modules. Interestingly, 91% of respondents stated that they have not received any instruction or training and that 62% felt that they require more training on the subject matter. This paper is inspired by wider research from European studies however, this study provides a specific novel focus on a broad range of UK universities, providing comparative analysis and unique findings from the UK perspective. The significance of these findings suggest academics perspectives vary with specific training needs. This demonstrates that this early-stage research requires further exploration of the wider computer science curriculum, sharing of good practice and collaborative working.

Keywords Artificial intelligence · Computer science education · Ethics · Teaching and learning

Extended author information available on the last page of the article

Introduction

This paper investigates academics' perspective of ethics and its inclusion and delivery within computer science degree programmes. Evaluation and incorporation of ethical design for software systems, particularly artificial intelligence (AI) within industry poses great challenge. The consequences of emerging systems have increasingly come into public view. Take for example, how data harvested illegally from social media platforms was used to influence voters in elections in the US and the UK or how automated decision-making software displayed gender and racial biases when shortlisting applicants for jobs (Stavarakakis et al. 2022). Industry however, demands talent within evolving technologies and as such, universities are clamoring to add technical AI and machine learning (ML) courses into computing curriculum – but how are societal and ethical considerations part of this landscape (Garrett et al. 2020)? English and Hayes (2022) report a need to address graduate attributes (transferable skills) such as 'professional practice', 'global citizenship' (which includes themes such as ethical conscientiousness) and 'critical thinking' (English and Hayes 2022). However, to develop computer science students' ethical thinking, it is important to know how they make decisions when they face ethical issues (Hedayati-Mehdiabadi 2022). Stravarakakis (2022) identifies there are increasing calls for more computer ethics content to be included in Computer Science curricula. One of the outputs from the Ethics4EU project was to identify educators' skillsets and their approaches to its delivery; the aim to bring computer science lecturers and ethics experts together to better support collaborative practice. Interestingly, two key points extracted from their surveys included:

- When Computer Ethics is not taught as part of Computer Science or related programmes the most common reasons given include a lack of staff availability and expertise.
- Most institutions devote a relatively small number of hours to teaching Computer Ethics in their Computer Science or related programmes, 67% of institutions surveyed teach 10 h or less per semester (Ethics4U 2022).

Smith et al. (2023) conducted a survey on instructors' attitudes towards ethics and revealed a generally positive approach to ethics although barriers were identified to its delivery in some computing courses. Three such barriers identified included: 'a desire to leave ethics to other courses'; other topics had more priority' and 'not having enough time or encouragement'. A statistically significant finding noted by Smith et al. (2023) was the importance of cultivating community support, thus having professional collaborative environments to discuss ethics.

As universities train the next generation of technologists, it is critical that we train students to consider all potential ramifications (Garrett et al. 2020). When those building technologies understand that thinking through ethical and social consequences is as an essential part of technical practice, they will inevitably critically consider the technologies they are building (Garrett et al. 2020). Projects funded by the Turing institute's AI for science and government (ASG)

programme aim to deliver best practice in the development of emerging technologies. However, there is a key focus on 'People first' and explainable AI as demonstrated through the ASG-funded ProjectExplAIIn (Bennett 2022; Stravarakakis et al. 2022). While emphasising the remarkable impact that our graduates could be responsible for in the future of emerging technology there is further an importance for them to be able to explain the decisions made by their systems and communicate as such to varying audiences. In order to gain confidence, stakeholders and those that are impacted by these decisions must be provided with detail of the algorithm design and resulting outcome in an explainable manner for discussion. According to Briggs, "there's mutual investment and interest in this idea of explainability" and of placing AI in its wider, social context (Stravarakakis et al. 2022). There is evidently a need to educate students with this developing expertise as more research is poured into its design and context of 'People First'. Such skill will no doubt provide unique opportunities for graduates as industry demands increase in the exploration of AI.

Typically the teaching of ethics is either incorporated as a standalone session or tagged onto the end of a module. It is also apparent that the delivery of ethics education often appears at varying stages of the curriculum, in some cases appearing at the latter stages of the degree programme. At this point, the relevance of this subject matter maybe lost, in which case, too late for students to evaluate its importance and impact. Ethics is very much a part of the computer science journey requiring regular integration and reflection throughout. Agile is a popular methodology for developing software (with familiar design patterns) which encourages user interaction and feedback with various iterations and opportunities for product amendments. Emerging technologies such as AI and data science very often impact on life decision-making and would thus, benefit from an incremental approach to allow for continual reflection on the ethical procedures in place as they arise through the developmental cycle. Complementary research such as, Artificial Intelligence in Education (AIED) endeavours to integrate emerging technologies to support teaching and learning and enhance outcomes. However, the point still remains that no framework has been devised, no guidelines have been agreed, no policies have been developed, and no regulations have been enacted to address the specific ethical issues raised by the use of AI in education (Jarzemsky et al. 2023). The potential impact of AIED designs and methods of deployment on students, teachers and wider society appears yet to be fully worked out (Washington 2020) and limited in relation to pedagogy.

Creating a curriculum that considers the user and thus, ethical thinking from the outset provides a strong grounding to encourage integration at appropriate stages and throughout the academic programme. Not addressing potential ethical issues as they arise in-situ during computational learning risks marginalizing ethics or reinforcing the idea that it is for someone else to worry about rather than a necessary part of the daily practice of a technologist (Fiesler et al. 2020). How do we devise a curriculum content structure logically to address the breadth of computer science ethical thinking? Garrett et al. (2020) explored two pathways for ethics content in specifically AI curriculum across US institutions: (1) standalone AI ethics courses, and (2) integrating ethics into technical AI courses but in each case asking the question, what is being taught? The resulting study provided insight and guidance on

the types of topics for instruction including: topical events, real-life scenarios and examples such as fake news, privacy concerns about Facebooks “people you may know” feature, and how user news feeds are manipulated that may be shifting our perceptions of the world. Another proposed example included making these issues more tangible by including them as part of the technical practice of building AI. Similarly, Fiesler et al. (2021) focused on replacing existing assignments with new assignments contextualized with ethical dilemmas and concepts.

Who should teach computer science ethics and what is the perception of academic staff and their relation to the subject matter? There are arguments for both specialist ethics educators to lead on this provision but also for computer scientists to take ownership and demonstrate their social impact specific to computing disciplines (DuBois and Burkemper 2002). Although both have value and importance due to departmental workloads and acquiring specialist expertise, this may not be a viable choice. Further, Holmes et al. (2022) recognises from their study on AIED ethics that most academics are not well-trained to tackle emerging ethical questions (Washington 2020). There are still many questions about how to best accomplish the goals of ethics education, and further, the ways that different universities and programs teach in both content and extensiveness (Leslie and Burkemper 2021).

A Harvard-based program ‘Embedded EthiCS’ examined the integration of ethical reasoning into courses throughout its computer science curriculum (Holmes et al. 2022). Importantly, students should learn to think not only about what technology they could create, but also whether they should create that technology (Holmes et al. 2022). Grosz (2019) states that embedding ethical reasoning throughout the entire computer science curriculum has the potential to habituate students to thinking ethically as they develop algorithms and build systems, both in their studies and as they pursue technical work in their careers Holmes et al. 2022). Interestingly, the embedded EthiCS programme addresses the short-comings of stand-alone ethics teaching in that students’ lose sight of ethical considerations when working through technical modules. As suggested, if the focus of ethics is included and continually revisited across the curriculum, we are better placed to ensure that students do not lose this vision and continue to consider these themes.

Stavarakakis et al. (2022) developed a survey that polled faculty from Computer Science and related departments from universities across multiple European countries (Holmes et al. 2018). Key findings noted that most institutions devote small numbers of teaching time to ethics and that certain topics such as AI and data science were considered more important for ethics. Ethics is apparently important so why is still so little time devoted to its teaching? What can be inferred from academics’ availability, engagement and expertise when teaching across Computer Science programmes? Building an ethical curriculum is challenging. However, using an interdisciplinary approach would provide a different perspective but would not be without conflict due to the nature of staff expertise and alignment of learning outcomes. There are limited examples on the specific challenges within the UK as opposed to European and international studies however, it is an increasing area for development. This has been addressed by the Turing Institute (The Alan Turing Institute 2024) by their measures to provide guidelines, resources and calls for submissions on collaborative working to address themes of ethical education within emerging fields such as AI and data science.

This paper will examine various perspectives by asking the following research question: How do academics perceive the teaching of computer science ethics? Perception will include consideration of their skillset, current participation, and methods to teaching the subject matter? Further, this study will propose an opportunity to review a list of topics currently covered by academics, clarify gaps in the curriculum and propose intervention strategies for future research. In addition, future aims of this work will be to develop content to better serve lecturing staff, students and wider educational settings thus, sharing good practice.

Method

An online survey was created to better understand the perspectives of a range of academics in an easy and accessible manner. The survey consisted of both quantitative and qualitative questions. This data mining exercise was used to identify gaps, source topics of importance, potential academic professional development opportunities, and curriculum review. The data collected will take the form of mostly qualitative data in order to gain rich insights of curriculum content and to elicit staff expertise. Two separate sections were used to identify those staff that are engaged with the teaching of ethics and those that are not or don't anticipate any involvement over the coming year.

The survey was distributed to 15 university members of the Council of Professors and Heads of Computing (CPHC) including the University of Central Lancashire. The study received funding from the CPHC to conduct the survey along with a second proposed study based on student perspectives. The randomly selected universities were broadly chosen based on an equal spread of north, west, east and south divides including a mixture of post-90, Red Brick and Russell group institutions. The 15 selected participant universities were initially informed via email of the study with details of the study and invitation to participate over six weeks. Academics did not receive any incentives or remuneration to complete the survey. The survey was anonymous in both participant detail and the institution to which they belonged. This was important so as to encourage uptake and participation with the study from the institutional perspective enabling anonymity of the findings. This was noted by several universities, which would have prevented their participation following assessment from associated ethical clearance panels. The survey was also shared on the CPHC website forum.

This study aimed to present exploratory findings using a select sample size. No hypothesis testing will be carried out rather the research will be explored using qualitative and quantitative questioning. The analysis will consist of descriptive statistics and comparisons of distributions. These findings will serve to promote further, wider work in this area. The survey was created and analysed using Qualtrics.

The survey design and some of the associated questions were influenced by an EU study of university academics across Europe by Stravrakakis et al. (2022). The questionnaire was adapted to enable its completion within 10 to 15 min but developed to include more qualitative feedback. This survey further was designed as a preliminary investigation with the anticipation of a follow-up study.

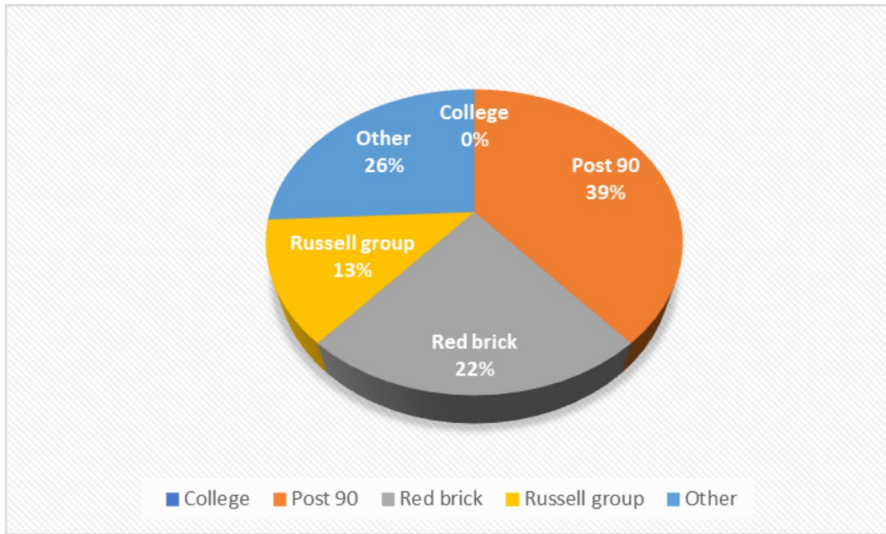


Fig. 1 Description of university

Table 1 Academic role within institution

Tutor (teaching-focused role)	3.13%
Post Graduate (with part-time teaching)	0.00%
Lecturer (Assistant Professor)	28.13%
Senior Lecturer (Associate Professor)	53.13%
Professor (Reader)	9.38%
Head / leadership role	6.25%

Findings/Results

The results of the survey are presented herein. The survey was shared with 15 universities of which 32 replies from academic staff were received. The survey questions and responses now follow:

How would you best describe the university at which you teach?

Responses included: - Post 90: 39%; Red Brick: 23%; Russell group: 13% and Other: 26%. The 'Other' option resulted in responses including: distance learning, university alliance group and pre-92 learning as shown in Fig 1. This question is used purely to show the representation of institutions although individuals and their institutions are non-identifiable in subsequent questions.

What is your role within the institution.

Over 80% of respondents identify as a Senior lecturer or Lecturer with little representation of Professor or leadership (Table 1).

How many years of experience do you have of teaching computer science at degree level?

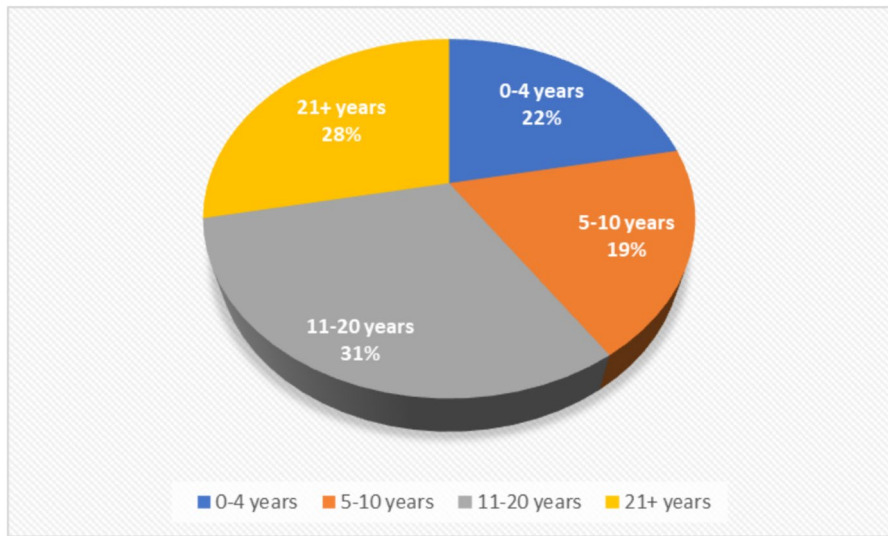


Fig. 2 Academic years of experience

Around 50% of academics have between 5 and 20 years of experience with 28% having over 21 years demonstrating a broad range of expertise as detailed in Fig 2.

What is your age?

65% of respondents were 40+ years with around 9% below 29 years of age. A quarter of respondents were 30–39 years demonstrating a broad range and representative scope (Table 2).

Does your institution teach ethics as part of any Computer Science and/or Computer Science related programmes?

75% of respondents answered yes stating that their institution does teach ethics as part of their computer science programmes. However, 25% answered no that ethics is not taught as part of their computer science programmes. A question appearing later within this survey (ref page 9) requests details on the frequency of delivery of ethics education in which 50% do deliver ethics education across one or more modules across their programme. This is encouraging although there is no clarification as to which year groups or whether this is consistent across an entire programme from foundation year / first year to final year of study. Further, there is no reference to how many hours this equates although the purpose of this question was to identify whether ethics education was taught and then how widely across a programme.

Table 2 Age of academic

20–25 years	3.13%
26–29 years	6.25%
30–39 years	25.00%
40–49 years	21.88%
50+ years	43.75%

Table 3 Perception of ethics importance within computer science curriculum

1- Not at all important	0.00%
2	12.50%
3	0.00%
4	25.00%
5- Very important	62.50%

Table 4 Reasons for not teaching ethics within computer science programmes

Question	1	2	3	4	5
Ethics isn't that important (isn't a key part of CS)	62.5%	12.5%	12.5%	12.5%	0%
We have a lack of staff expertise	0%	12.5%	0%	75%	25%
We have a lack of staff availability	0%	12.5%	25%	25%	37.5%
We have a lack of time (there's too many other things to teach)	0%	0%	37.5%	25%	37.5%
The content we teach is too far away from ethics	37.5%	12.5%	12.5%	25%	12.5%

How important do you think it is that ethics is taught in a Computer Science and/or Computer Science related programme?

Over 85% of respondents stated that ethics was either important or very important to be taught in a computer science programme (Table 3). This question was extended further to seek out why the above question was answered in such a way. Responses included the following:

It's essential for CS. From hackers, activists and cybersecurity staff to casual internet users and programmers, ethics play a significant role in all of them and need to be considered, so that we can browse the web by supporting those who need support and protecting ourselves and others.

If we claim to be educating professionals, we need to equip them to make professional, ethical decisions. Otherwise, we are educating technicians.

I don't have a clear idea of what ethics involves in relation to computing. We may cover some aspects under different headlines, such as sustainability, social impact, decolonisation, etc.

Computing touches on every aspect of human endeavour, and where there are humans, there are issues of ethics.

At UG level it is important students understand why ethics is important. At PG level it is important to understand how to follow ethics.

"It is necessary to understand that there are boundaries to the way that we treat others in society and that we should not produce outputs "at any cost" including costs which are not immediately obvious".

Although a minority did state ethics as not particularly important, all comments respond to the importance of ethics in a positive stance. There is no reference to the particular importance of ethics with regards to emerging technologies although the final response could be inferred as such, for example, '*not producing outputs at any cost*'.

Rate the following as reasons why ethics is not taught as part of your Computer Science and/or Computer Science related programmes from 1 (strongly disagree) to 5 (strongly agree).

Key points taken from Table 4 (question design influenced by Stravrakakis et al. (2022)) show that over 60% of academics strongly disagree that ethics isn't a key part of CS. 75% disagree that there is a lack of staff expertise with over 60% strongly agreeing or agreeing that there is a lack of staff availability. Over 60% strongly agree or agree that there is a lack of time (too many other things to teach). Why is there a lack of staff availability seeing as that over 75% deem ethics as important within the CS curriculum? There is confidence in staff expertise although his clarified further in a later question within the survey. Nearly 50% strongly disagree or disagree that the content they teach is too far away from ethics while 37% strongly agree or agree that this is the case. There maybe certain specific modules that maybe deemed as not requiring reference to ethics but due to limited expansion of this question it can only be inferred. For example, networking architecture although as noted in an earlier response, and further paraphrased, where there is human interaction or decision-making, there are themes of ethics to be considered.

This question was followed with an opportunity to provide further insight as to why ethics might not be taught. Limited responses were given. The one response included discussed:

Ethics is 'kind of' taught in the degree in my institution. It features only within the context of individual modules. For example, it features within the project module, since there is a requirement for ethics to be considered as a requirement of the BCS. As a topic, it also features within the level 3 AI module, but is integrated within the curriculum. The impact of IT is also mentioned during level 1 modules too. There are no plans to have a separate module on ethics, but ethics will continue to be featured within individual modules. Context is important.

Are there plans to teach ethics on Computer Science and/or Computer Science related programmes at your institution? If so, what time frame.

Options included: 1–2 years, over the next 5 years or 'no scheduled plans'.

100% of respondents answered that there were no scheduled plans for teaching ethics on computer science related programmes. Note that this question was directed at only academics that responded earlier as to not delivering ethics education across their computer science programmes. This could be perceived as a concern that there is no such consideration although this may depend on the level of expertise of the staff or their academic position and thus, insight as to whether change is imminent.

Do you feel you need more training on computer science ethics education?

62.5% answered yes that they feel they do need more training on computer science ethics education. 37.5% answered 'no'. Even though earlier in the survey 75%

disagreed that there was a lack of staff expertise, a significant proportion deem further training is required. However, this question is focused on the individual perspective and not on the department / school as a whole. Ultimately, within the discipline of computer science we are not necessarily ethics experts although naturally it forms a part of our curriculum to a greater or lesser extent depending on the programme.

How often do you schedule the teaching of ethics education?

This question and the following questions were directed to respondents that answered 'yes' earlier in the survey on whether they teach ethics on their computer science programmes. Results shown in Fig 3.

Around 50% of respondents regularly teach some form of ethics education across one or several modules which is positive. However, over one third very occasionally or never do so but a small percentage of 12.5% note they teach ethics as a standalone module. Rather than relying on a standalone course for teaching the ethical implications of the technology students will produce, there is a growing movement to embed ethics throughout the entire computer science curriculum (Jarzemsky et al. 2023).

Is the teaching of computing ethics embedded across your programme of curriculum?

66.67% answered yes that the teaching of computing ethics is embedded across their programme of curriculum. This question focuses more specifically on the entire programme across all year groups as opposed to just acknowledging that it is taught as part of the programme. 33.3% answered no, perhaps suggesting that standalone modules are used. However, embedding ethics topics and discussions throughout computer science coursework can help empower students to become more proactive in considering social impacts of their work, and other positive side effects (Jarzemsky et al. 2023).

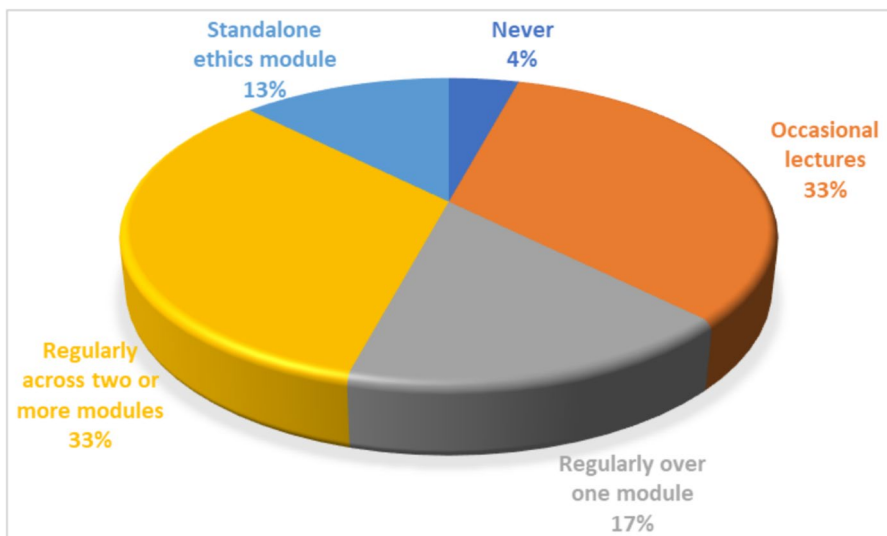


Fig. 3 Frequency of ethics education delivery

Are you given instruction/training sessions on the teaching of computer science ethics?

91.67% answered no that they do not receive any instruction or training on the teaching of computer science ethics. Only 8.33% answered yes to having received instruction or training. This question was posed to elicit if such instruction is widely available within institutions however, with this statistic it should be proposed that this be enquired about further particularly when we are now considering more challenging concepts around AI and data impact. However, it could be assumed that there is frequent challenge within departments to manage the different expertise and allocate appropriate training. Similarly, educators will have varying expectations on how this instruction should be delivered and its importance to their discipline.

If you are actively engaged in the teaching of computing ethics, would you be prepared to give some insight briefly on the types of content used in your teaching.

Common themes noted included ethics being taught in modules labelled namely 'professional studies'/'professional practice' or 'computers, society and professionalism' or 'research' using case studies. Another theme included embedding ethics and equality, diversity and inclusion (EDI) issues within final year projects which are included as part of the assessment criteria. There were two references to Generative AI in which such issues were discussed in one seminar. Data Science was mentioned once in which ethics was discussed in regard to data bias. A few final thoughts also included that the inclusion of ethics was 'light' and that there is a recognition that ethics should be more widely embedded across the programme.

Conclusion

This survey was completed by 32 academics from computer science departments across at least 15 universities associated with the CPHC. Over 85% of respondents stated that ethics is important within computer science programmes. Ethics is noted as being important although one-third noted it was not widely embedded across the curriculum so it may be assumed that the subject is taught standalone or focused within a select number of modules. Professional studies was noted as a module where this discussion of ethics takes place along with the final project module taken during a student's final year of study. 46% of academics do however, schedule the teaching of ethics regularly either across one or several modules. Interestingly, 91% of respondents stated that they have not received any instruction or training and that 62% felt that they do need more training on the subject matter. This awareness of the importance of computer science ethics and its limited communication across the curriculum indicates more exposure to such themes is required. Academics appear to have limited or no training in its delivery and would benefit or are interested in further instruction. This may suggest a more collaborative approach is required with academics with expertise on ethics such as psychologists, ethicists or philosophy. However, the technical knowledge is required in order to dig deeper into the challenges of, emerging technologies such as AI. Our graduates will lead on such future system design and so we must afford the time to enhancing our ethics delivery. One further

final outcome sought to assist with the shaping of a proposed follow-up study was to gather a list of topics or activities academics currently deliver during the teaching of ethics within computer science. Some of the following topics were gathered:

- Data privacy and security, discussing real-world case studies of data breaches and their ethical implications;
- Ethics of representation and stereotypes (sex/gender, race, sexual orientation, etc.). Ethics of choices (forcing user to make decisions vs. choice, inaction vs. action);
- Ethics of manipulation (gambling, reward mechanics, emotion, etc.);
- Consequences and values when choices are made; Use cases from contemporary examples to teach good ethical practices;
- Digital divide; Automated data processing - bias and impact;
- Authorised data capture and use, data bias, deanonymisation.

This proposed follow-up study will involve collaborative working with associated academics on curriculum review and design of ethics content to better support academics and future student outcomes. This small scale study has collated unique findings into the perceived importance of ethics education, its prevalence within the curriculum, academic awareness and their associated expertise. There is also an evident engagement for further training and development. This is a UK perspective in which a drive can now be made to deliver an inclusive curriculum with emerging themes shaping informed, ethical graduates of the future.

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Declarations

Conflict of interest On behalf of all authors, the corresponding author states that there is no conflict of interest.

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