Education in an Era of Convergence

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The universities are often radical in their approach to society and conservative in the way they themselves reflect society – namely in what and how they teach. The fundamental reason lies no doubt in the fact that academic disciplines are the basis for the organisation of knowledge for teaching purposes.[1]

I. Introduction

This conference and the associated journal are relatively unique. It is surprisingly rare for those writing in ways that cut across their discipline's own bounds to be taken to task by scholars from that other discipline for what they might have misunderstood. In a blistering critique of many law and technology scholars at a conference keynote some years ago, Professor Karen Yeung gave horrific examples of legal academics writing about artificial intelligence in ways that showed a clear lack of understanding. This happened because all peer reviewers were legal scholars and, while the contributions were clearly legal, they were based off incorrect assumptions. The presenters at this conference and submitters to the journal bravely face exposure of misunderstandings (through reply not review), and it is fair to say perform much better than those who shout from their own disciplinary tower.

The standard way in which education works, however, sets people up for latter scenario. From high school, many students see themselves aligning with either STEM (science, technology, engineering, mathematics) or HASS (humanities and social sciences) and choose subjects accordingly. Even those who straddle both through school tend to make a choice one way or the other for university, where they become even more acculturated within particular ways of thinking. Learning is typically filtered through "disciplines" and organised by faculties. Even those doing "combined degrees" or taking a program across multiple faculties often study each separately. For those going on to academic careers, they are almost always employed by one Faculty and there are many incentives (promotion, funding, recognition) for staying within a disciplinary lane. There are some that do cross-disciplinary research (indeed, likely everyone attending this conference), either through being in a rare position of having dual expertise, through self-education, or through collaboration. But there are significant institutional challenges so that, for many across the computing/law divide, Yeung's criticism is valid.

The limitations of disciplinary approaches to research and education are not new. The quote commencing this paper is from a 1972 OECD publication but applies to most universities today. Then, as now, there are exceptions.[2] The disciplinary focus within tertiary education varies according to the educational culture and structures of different countries. In the US, the 'liberal arts college' encourages students to complete a broad range of subjects, and 'law' as a *graduate* program is encountered on completion of a broader *undergraduate* program. In Australia, many law programs require undergraduate students to take another program alongside their legal studies, but students travel along two streams with few if any opportunities to explore topics at the intersection. Other

[1] James R Gass, 'Preface' in OECD Centre for Educational Research and Innovation, *Interdisciplinarity: The Problems of Teaching and Research in Universities* (1972) 9

[2] Guy Berger, ''The Interdisciplinary Archipelago' in OECD Centre for Educational Research and Innovation, *Interdisciplinarity: The Problems of Teaching and Research in Universities* (1972) 58-69.

jurisdictions, like some Australian universities, allow law students to enter law programs direct from high school and conclude their students without necessarily encountering other kinds of knowledge.

The disciplinary divide in academia is not mirrored in the worlds of government, industry and civil society. There are some jobs where one is following a purely disciplinary path, but far more where what is required is a range of understandings and skills that cut across traditional disciplines. Ideally, a person working in "legal tech" for example would have a deep understanding of law's purpose and practice,[3] the relevant technical skills (including computer and/or data science), and some business skills. The range of disciplines involved for those doing policy work is even greater – addressing cybersecurity challenges would ideally be done by those who understanding parts of computer science, mathematics, networking, psychology, law, criminology, international relations, business, and policy. Of course, it is unlikely that anyone would have all of those backgrounds, so people use similar devices to those used for cross-disciplinary collaborations in academia – relying on self-teaching and collaboration.

This paper asks what alternatives there might be within the education system. It is a short provocation rather than a broad-ranging inquiry, focusing on examples that are familiar to me rather than a comprehensive international survey. It focuses on law/computer science collaborations and asks three questions (increasingly controversial): (1) What might be done within disciplinary programs, such as law, to prepare students to work wisely alongside engineered systems? (2) What might be done to develop students' skills at cross-disciplinary problem-solving throughout their education? (3) Should we offer undergraduate degrees oriented not around a discipline but a problem-space; for example, should computational law be a new discipline? Before turning to these, however, the next section provides a short background on disciplines, categorisation of research and teaching, and institutional pressures against crossing boundaries.

II. Background

Knowledge and skills can be carved up in various ways. However, these are typically divided into "disciplines". Disciplines can be thought of as "bundles of knowledge"[4] or can be associated with academic identity, subject-matter, epistemological approaches, and knowledge communities.[5] The nature and boundaries of each discipline are both contestable and flexible, evolving within and across universities and academic communities over time.[6] A preference for specialisation within rather than learning across disciplines is also contingent. For example, early universities often had a more holistic view of knowledge and a greater commitment to breadth,[7] and it has been argued that transdisciplinary, problem-oriented research is growing in importance as a category of knowledge-generation.[8] Law has a particular status within these kinds of disciplinary divisions as it predates the emergence of universities. My colleague, Roux, has described law as a "multidisciplinary field in which doctrinal research is but one of many mono-disciplinary and interdisciplinary forms of

[3] Mireille Hildebrandt, 'Grounding Comptuational 'Law' in Legal Education and Professional Legal Training' in Bartosz Brozek Olia Kanevsaia and Przemyslaw Palka (eds), *Elgar Handbook on Law and Technology* (2023).
[4] Burton R Clark, *The Higher Education System: Academic Organization in Cross-National Perspective* (Berkeley, CA: University of California Press, 1983) 16.
[5] Ruth Neumann, Disciplinarity, in *The Routledge International Handbook of Higher Education* (Routledge 2009) 487, 487, 490.
[6] Ibid.
[7] Ibid 489.
[8] Gibbons, M., Limoges, C., Nowotny, H., Schwartzmann, S., Scott, P. and Trow, M. *The New Production of Knowledge: The dynamics of science and research in contemporary societies* (London: Sage, 1994).

research being pursued."[9] While any particular description may be contested, legal research is not limited to a self-contained set of methodologies – with doctrinal analysis often presented alongside empirical findings, philosophical analysis or policy development.

Despite this, there are institutional silos into which all research and teaching is sorted. In Australia, there are classifications for both research and education, which are not aligned, but are used for various purposes including funding, statistics, and peer review. Research classifications operate at division level, group level and field level.[10] One can place a particular project within the various codes. Imagine a project on the use of technology in legal institutions and legal practice. One might attribute this to "law and legal studies" as a division, "law in context" as the relevant group inside that division, and "law, science and technology" as the relevant field. Alternatively, one might start with "information and computing sciences" as the division, "applied computing" as the group and then perhaps "applied computing not elsewhere classified". One might also look to other groups within "information and computing sciences" depending on what one is doing, for example: "artificial intelligence" "data management and data science", "human-centred computing" or "information systems". Classification of education, on the other hand, is done by "broad fields", "narrow fields" and "detailed fields".[11] Here, the nearest equivalent for a course covering this subject matter from a legal perspective would be the broad field of "society and culture", the narrow field of either "law" or "justice and law enforcement" and, depending on context, one of the detailed fields underneath (eg "legal practice" in "law" if there is a course on the use of technology in legal practice or "justice administration" in "justice and law enforcement" if there is a course on the use of technology in courts). One could also start with the broad field of "information technology" and go from there (for example, to programming within computer science). Codes are presented as lists with headings and subheadings, rather than a web of complex connections – so the legal codes and the computing codes are non-adjacent even though work is done at the intersection. Such projects or programs would rely on the use of multiple codes, which generates institutional challenges given one's faculty receives little recognition for work outside their "division(s)" and funding bodies are historically less interested in work that they feel a different body could fund. Depending on institutional culture, strategic behaviour may drive academics back to their disciplinary homes.

These kinds of classification inevitably simplify both research and education and project a snapshot of what is done and matters at a particular point in time. A law degree, for example, may require students to gain some knowledge or skills in the narrow field of "office studies" and in detailed fields such as "English language" and "written communication", particularly given the importance of text in understanding, interpreting and communicating law.[12] And while these are sometimes explicitly taught (if not captured in the data), far less attention has been paid to understanding the computational basis for legal search, prediction, text generation, or the use of systems to operationalise legal rules..

Having a limited, single-discipline perspective on these broader problems can create significant problems. An over-enthusiastic embrace of rules as code that fails to recognise the important role

[9] Theunis Robert Roux, 'The Incorporation Problem in Interdisciplinary Legal Research' (2015) 2 *Erasmus Law Review* 55, 56.
[10] See 1297.0 Australian and New Zealand Standard Research Classification (ANZSRC), 2020 (released 30 June 2020).
[11] See 1272.0 Australian Standard for Classification of Education (ASCED), 2001 (released 29 September 2015).
[12] Mireille Hildebrandt, 'A Vision of Ambient Law' in Roger Brownsword & Karen Yeung (eds), *Regulating Technologies: Legal Futures, Regulatory Frames and Technological Fixes* (Oxford and Portland, Oregon: Hart Publishing, 2008) 175.

played by uncertainty and contestability can lead to ossified law.[13] Conversely, a simplistic view of programming may fail to recognise the ways in which it is impossible to simply create "isomorphic" code without the need for choices outside the words of the rules themselves.[14] Similarly, the inappropriate application of prediction tools to sentencing decisions and the New York lawyer's over-reliance on Chat GPT might be seen as the result of a failure to understand law and artificial intelligence respectively.

In a world in which people will be doing these kinds of tasks, we need to move beyond the boxes into which we are commonly sorted. On the research side, this conference is an example of such activity. But, on the teaching side, how is this best accomplished? Is this a question of introducing (some) computer science into law programs and vice versa, of creating more opportunities for students to work in cross-disciplinary teams, or should we create programs that are less aligned to traditional disciplines? Is the solution in cross-disciplinarity or multi-disciplinarity (juxtaposing disciplines), trans-disciplinarity (combining theory and method in new ways to solve particular problems), or interdisciplinarity (integrating disciplines)?

III. Bringing other disciplines into legal education

There are long-standing tensions in the purposes of legal education. This includes the twin goals of teaching an 'academic' discipline and training future legal practitioners. It also includes a tendency to regulate curricula, with resulting constraints on innovation. There is nevertheless a growing recognition that a legal education should not be purely about legal doctrine as such, but ought to include other skills and knowledges.

An understanding of (some) technologies is important for legal education in a variety of contexts. Future lawyers might use technology in document construction, practice management, legal information systems, due diligence, discovery, document management, legal research, dispute resolution, and so forth, thus an understanding of both *how* to do these things and the affordances and limitations of particular methods and platforms is essential.[15] Future lawyers might also be interested in legal issues raised by new technologies – from the challenges of applying discrimination law to machine learning systems, to administrative law challenges inherent in automated decision-making, to the regulation of technology as such. There is, of course, overlap between these things as particular uses of technology in legal practice or institutions might be regulated, directly or indirectly, in order to ensure core values (eg rule of law, professionalism) are preserved.

Legal education programs may adapt to ensure that relevant knowledge and skills as a result of these developments are built into the curriculum. An example, at my home institution UNSW Sydney, was a mini-curriculum review on technology in the law curriculum led by my colleague Professor Michael Legg.[16] The review recommended ensuring that "technological innovation and its impact on legal practice, law and society" was recognised as an important cross-cutting theme throughout the curriculum. It referred to existing elective courses such as *Designing Technological Solutions for Access to Justice* (where students learnt how to design and build a legal application using a no-code

[13] Mireille Hildebrandt, 'Grounding Comptuational 'Law' in Legal Education and Professional Legal Training' in Bartosz Brozek Olia Kanevsaia and Przemyslaw Palka (eds), *Elgar Handbook on Law and Technology* (2023).
[14] Merigoux et al (forthcoming CRCL).
[15] Mireille Hildebrandt, 'Grounding Comptuational 'Law' in Legal Education and Professional Legal Training' in Bartosz Brozek Olia Kanevsaia and Przemyslaw Palka (eds), *Elgar Handbook on Law and Technology* (2023).
[16] Report available: Michael Legg, UNSW Mini-Curriculum Review Report on Technology and the Law School Curriculum [2017] UNSWLRS 90 (2 November 2017), http://www5.austlii.edu.au/au/journals/UNSWLRS/2017/90.pdf.

platform) and *Financial Law and Regulation in the Age of FinTech* and proposed new courses including an introductory course in programming. It pointed out that the rise of technology increased the importance of more general skills such as emotional intelligence, legal project management and legal analytics that could be gained through adaptation of existing courses. While the review led to changes, they were not adopted in full (in part due to financial and operational constraints due to COVID-19) – for example, there is no introduction to programming course available as a law elective.

Such exercises, which have also been conducted formally or informally elsewhere, tend to focus on some things more than others. So "legal tech" courses are particularly popular. For example, a number of universities created courses that followed the approach in Georgetown which was a partnership with company Neota Logic.[17] There are also *many* courses that are about the application of and development of law to issues associated with different technologies or technology as such. Law programs often include both, with varying volumes and foci. Some have gone further than others. The University of Technology Sydney created a "legal futures and technology" major within their law degree, which includes both courses on "legal technologies" as well as those addressing the application of law to technology and innovation.

One of the more ambitious proposals is to ensure law students (or practitioners) learn about computational methodology in a legal setting in depth.[18] In a recent paper, Hildebrandt proposes that students or practitioners of law would master seven learning outcomes requiring a deep understanding of relevant legal technologies and the different kinds of computational approaches, the ability to assess capabilities and limitations (and substantiate these by asking the right questions), and the ability to understand the contribution of different types of legal technologies to the study and practice of law in constitutional democracies.[19] Students in this scenario would be primarily legal in their expertise, but would have a sufficiently deep understanding of relevant aspects of computing to be able to make decisions about technology. Software engineers and computer scientists might be involved in teaching the courses, but they would be adopting a critical perspective from the standpoint of law. At the end, the students would not be able to build systems, but they would be far better equipped than lawyers currently are to evaluate their appropriateness.

A different approach is to encourage law students to learn more about computer science and other technical disciplines is to encourage dual degrees in those disciplines. As mentioned earlier, in Australia, many but not all universities require law students to either have a degree in another discipline or to undertake such a program simultaneously (these are called "dual" degrees). At my institution, for example, undergraduate students cannot take a law degree without enrolling in a dual degree in one of the following programs (in alphabetical order): actuarial studies; arts; city planning; commerce; criminology and criminal justice; data science and decisions; economics; engineering; fine arts; international studies; media; medicinal chemistry; philosophy politics and economics; science (including computer science, advanced mathematics and advanced science); science and business; social sciences; social work; data science and decisions; politics, philosophy and economics; psychological science. The list is somewhat arbitrary and demand driven. While this provides students with extensive disciplinary knowledge and skills in another field, there is no attempt to bring the different strands of learning together. At no point, for example, would a student studying computer science and law be required to consider how these things might relate to each other

[17] Artificial Lawyer, How Neota Logic Helps Deliver Access to Justice with Legal Tech, 8 March 2018 https://www.artificiallawyer.com/2018/03/08/neota-logic-helps-deliver-access-justice-legal-tech/,
[18] Mireille Hildebrandt, 'Grounding Comptuational 'Law' in Legal Education and Professional Legal Training' in Bartosz Brozek Olia Kanevsaia and Przemyslaw Palka (eds), *Elgar Handbook on Law and Technology* (2023).
[19] Ibid.

(although they may choose to explore such questions through project choice within some subjects in either discipline). Thus, whether cross-disciplinary thinking takes place is at the whim of the student; there is no curriculum-driven method to encourage or require this. Students are also making decisions direct from high school and they have little context for why computer science might be useful to combine with law, whereas the relevance of commerce is more obvious. The result is that for 2023, for example, 181 students enrolled in commerce/law compared to 15 in computer science/law.

While this section has focussed on introducing other disciplines into a legal education, it is worth pointing out that the converse also exists. Engineering programs will often include courses that focus on ethics, and this may be mandatory in some jurisdictions. There are also courses that expose computer science students to law and/or ethics in light of the more specific issues associated with automation and artificial intelligence.[20] As in the case of legal education, discussed above, these are cross-disciplinary interludes that provide context, skills and knowledge sourced from other disciplines that is relevant to future professionals.

Most of the approaches to bring computational thinking are cross-disciplinary, although Hildebrandt's proposal brings computer science and software engineering into a conversation with law and thus points to a more interdisciplinary approach.

IV. Cross-disciplinary courses and experiences

For three years now, I have taught a course *Regulation for Cyber Security* in partnership with the Faculty of Engineering. There are three cohorts of students participating – Law students in my course and Engineering students in both the basic and extended version of the *Security Engineering and Cyber Security* course (extended students must have a sufficient level of programming skills, whereas the basic course includes Engineering students not doing a computer science / software engineering program, such as Nuclear Engineering). The courses have common lectures, which include topics such as security mindset, risk, secrets, human factors, insiders, privacy, data, organisational cultures, elections, and communication and change. All draw on real world examples and are non-technical; for example, the single point of failure challenge is illustrated through changes in historic castle design. The Engineering students cover an additional series of topics such as measuring bits of security, cryptography, integrity, web protocols, and security by design. Extended students also analyse examples of programming vulnerabilities. Law students have interactive seminars covering the most relevant legal and regulatory frameworks – the regulatory landscape, private law obligations, critical infrastructure regulation, privacy and surveillance law, digital identity, cyber crime and the law of war. The assumption there is that many of the basic topics (eg tort law, contract law) are familiar, and the work is in applying them to new contexts. The students come together for tutorials which are scenario-based problem situations, such as the introduction of automated vehicles or the (legal, regulatory and technical) responses that will best avoid repeat of an incident.

The goal of the course is not only to teach content, but also to provide future legal and cyber security professionals with an opportunity to work together (particularly in tutorials). The reality of a data breach is that both lawyers and cyber security teams will be involved and will need to communicate effectively across the professional divide. Further, as a society, cyber security (like climate change or any other complex problem) cannot be solved through a purely technical *or* purely legal/policy

[20] For example, Mireille Hildebrandt, *Law for Computer Scientists and other Folk* (OUP 2000) and Macquarie University's COMP2400 *Intelligent Machines, Ethics and Law* which is co-taught by experts in computing, philosophy and law (https://unitguides.mq.edu.au/unit_offerings/154743/unit_guide).

solution. Our hope is that some of the students from the courses may provide future, innovative thinking about how the vulnerabilities of our current systems might best be addressed.

Our course, as described above, is not unique in its transdisciplinary approach although its administrative difficulty in a university setting makes it rare. No new 'discipline' is being created around cyber security; rather, the focus is on a problem (here, cyber security) and the goal is to look broadly at different ways the problem arises and is addressed. The students are disciplinary (and marked as such through their different enrolments) and are called on to bring that deeper knowledge to each problem. The theory is of course better than the practice. Issues include the facts that tutors will themselves come from one discipline (mostly computer science), that law students are a clear minority (about 10%), and that it requires the students to move beyond their 'comfort zone' – some embrace that while others ignore content and discussion whose relevance they dismiss.

V. Integrated and problem-oriented degree programs

Many disciplines have been formed out of problem-spaces and other disciplines to focus on a particular problem-space. Examples include urban studies and environmental studies,[21] as well as criminology. Some universities are experimenting with broader kinds of problem-solving spaces. A residential college at the University of Sydney, St Andrew's College, launched a Centre for Education offering a Certificate of Complex Problem Solving to students already enrolled in an undergraduate degree.[22] The University of Technology Sydney offered a Graduate Certificate in Transdisciplinary Learning, focussing on educators seeking to learn about transdisciplinary education.[23] These latter examples are significantly broader than a degree that focuses on a single problem-space (like criminology), and could not realistically replace as opposed to supplement some other course of study.

Another shift is the tendency of (some) programs to take a "problem-based" approach to learning. An example is the way that medicine is currently taught at my university. It used to be that students, at least at the start of their degree, learnt the various bodies of skills and knowledge – anatomy, physiology, biochemistry, pharmacology, pathology, and so forth. Later in their degree, there were opportunities to bring the strands together when learning more concretely about diagnosis and treatment. Now, students begin their studies not by learning the various disciplines in separate subjects, but rather through scenarios that contextualise the presentation of diverse disciplinary content.[24] While I am not an expert in medical education, I am interested in that approach because it orients the student around a context (eg "Beginnings Growth and Development") and provides them with diverse knowledges (human life cycle, cell biology, developmental biology, sexuality, relevant psychiatric conditions, nutrition, relevant clinical skills) to navigate that space as (future) doctors.

Both of these ideas – creating new programs and disciplines around a problem space and adopting a problem-oriented approach to learning – are related. These fields (urban studies, environmental studies, criminology and medicine) are all well established and have their own research and

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[21] Guy Berger, 'The Interdisciplinary Archipelago' in in OECD Centre for Educational Research and Innovation, *Interdisciplinarity: The Problems of Teaching and Research in Universities* (1972) 35, 46.
[22] Information is available on the St Andrew's College website, at https://www.standrews.education/certificate-of-problem-solving/.
[23] Information is available on the UTS website, at https://www.uts.edu.au/study/find-a-course/graduate-certificate-transdisciplinary-learning, which also notes that the course will not be offered in 2024.
[24] H Patrick McNeil and others, 'An Innovative Outcomes-Based Medical Education Program Built on Adult Learning Principles' (2006) 28 Medical Teacher 527.

education codes in the Australian classification system. They are, similar to Roux's observation about law, multidisciplinary fields in which there are mono-disciplinary and interdisciplinary forms of research. They can also be taught in a more or less interdisciplinary or transdisciplinary way – for example, the older and newer ways of teaching medicine.

Would this kind of approach work for problem spaces at the intersection of computer science and law? Examples, some of which would require integration with other disciplines beyond those two, include:

- Computational law (say, as defined as per the Journal of Cross-Disciplinary Research in Computational Law);
- Ensuring responsible/ethical development and use of systems, including artificial intelligence systems;
- Developing national/organisational policies and strategies for cyber security.

Not all of these have sufficient scope to become a full degree program, at least at this stage, but the potential is there. For example, I believe there is a strong argument for full length programs in cyber security that go beyond the technical dimensions of the problem. At the moment, most cyber security training is streams or electives within a computer science program and the cyber security "body of knowledge" CyBOK is biased towards acquisition of relevant technical knowledge.[25]

The most common kind of critique of such specialist degrees is that they represent a kind of intellectual dilettantism and that students undertaking such programs will lack the depth of capabilities associated with any particular discipline. This assumes that the boxes associated with disciplines are the best way to classify capabilities in the first place. Students in a hypothetical Bachelor of Cyber Security would have a narrower lens on the landscape of law compared to a Bachelor of Laws graduate. However, there is an implicit assumption here that the scope suggested by the various disciplines are purer or more serious than the problem-based organisation of capabilities. In that sense, the argument is circular. Students of problem-oriented programs like those imagined will have a fuller picture of the problem being studied, whereas students of discipline-oriented programs will have a fuller picture of disciplinary knowledge and skills. They draw lines in different places, but neither is necessarily less serious.

Another critique of bypassing a disciplinary approach is the reliance on disciplines for standards that distinguish education from indoctrination.[26] In particular, if academic freedom is justified on the basis of disciplinary expertise, then the state ought not intervene in in the design of programs and courses. However, if a program sits outside a discipline, there are no clear standards for requiring students to learn specific facts or understand particular theories (as opposed to others), rendering the program more vulnerable to accusations that it is biased.[27] This problem is likely to be particularly apparent in problem-spaces where there is political disagreement on how the problem is framed, as in the case of climate change. There is also no clear community (that in disciplines takes the form of societies, journals, departments and so forth) with the authority to assess the quality of research or educational enterprises. While one can build such communities (as was done for criminology, for example), that is essentially the project of discipline-creation rather than operating outside the boundaries of disciplinarity.

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[25] See CyBOK v 1.1, https://www.cybok.org/knowledgebase/.
[26] Robert Post, "Debating Disciplinarity" (2009) 35(4) Critical Inquiry 749, https://doi.org/10.1086/599580.
[27] Ibid.

VI. Final thoughts

The three approaches discussed – adding in computer and/or data science to law programs, creating transdisciplinary classrooms, and building interdisciplinary or transdisciplinary programs – each has (just like technology) both advantages and limitations. If the goal is to prepare future lawyers to work better alongside engineered systems or those building the systems to be more aware of the context in which they will be used, the first approach may be preferred. In that case, Hildebrandt's approach is the most comprehensive. If the goal is to ensure to prepare students to work in teams with those from other disciplines (the approach many academics in their research), then the second approach might be favoured. The two might also be combined with Hildebrandt's learning objectives recrafted so as to be relevant to both law and computer science students, with each bringing their own disciplinary knowledge into team-based evaluation projects (as least within the proposed more advanced course).

However, if we truly want a holistic approach to problem-solving in important areas at disciplinary intersections, we might at least experiment with the third approach. Not all at once – cyber security might be a better place to start than computational law. It would also need to be done in a way that mirrored the problem-based approach to medical education – students should be in as good a position at the end as if they had studied relevant parts from the various disciplines separately. It is not a question of 'dabbling' but a question of redrawing the boundaries of knowledge and skills.