Introduction: Education as…

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The history of modern science and technology is a story that cannot be told without attending to the military, destructive, and violent purposes motivating the search for new knowledge and devices.[1] At certain times, the pace or novelty of developments have been seen as demanding social debate. The construction of atomic and nuclear weapons is perhaps the exemplary case where pause and concern has been evident about what the capabilities of some mean for the many.

At the start of the twenty-first century, warnings have been raised in some quarters about how — by intent or by mishap — advances in biotechnology and related fields could aid the spread of disease. Science academies, medical organisations, government commissions and security analysts, as well as individual researchers, are among those that have sought to engender pause and concern.[2] While varied in the terms and tones of their messages, each has raised a weighty question: Might the life sciences be the death of us?

The forewarning by Serguei Popov provides an illustrative example. As a leading scientist in the extensive Soviet biological-weapons programme until the early 1990s, he contributed to attempts to genetically enhance classic biowarfare agents as well as devise novel ones. Looking into the future on the basis of this past, in an article for *Technology Review* titled 'The Knowledge',[3]

1 For instance, see Rappert, B., Balmer, B. and Stone, J. 2008, 'Science, technology and the military: Priorities, preoccupations and possibilities', in *The handbook of science and technology studies*, London: MIT Press; James, A. 2007, 'Science & technology policy and international security', in Rappert B. (ed.), *Technology & security: Governing threats in the new millennium*, London: Palgrave.

2 For instance, see Lentzos, F. 2008, 'Countering misuse of life sciences through regulatory multiplicity', Science and Public Policy, vol. 35(1), pp. 55–64; Commission on the Intelligence Capabilities of the United States Regarding Weapons of Mass Destruction 2005, *Report of commission on the intelligence capabilities of the United States regarding weapons of mass destructio*n, Washington, DC, available: http://govinfo.library.unt.edu/wmd/report/wmd_report.pdf [viewed 1 November 2009]; Fidler, D. and Gostin, L. 2008, *Biosecurity in a global age*, Stanford: Stanford University Press; Institute of Medicine and National Research Council 2006, *Globalization, biosecurity and the future of the life sciences,* Washington, DC: NRC; InterAcademy Panel 2005, *IAP statement on biosecurity*, 7 November, Trieste: IAP, available: http://www.nationalacademies.org/morenews/includes/IAP_Biosecurity.pdf [viewed 1 November 2009]; National Research Council 2004, *Biotechnology research in an age of terrorism*, Washington, DC: National Academies Press; NSABB 2007, *Proposed framework for the oversight of dual-use life sciences research,* Bethesda, MD: NSABB; World Health Organization 2006, *Biorisk management: Laboratory biosecurity guidance*, September, Geneva: WHO.

3 Williams, M. 2006, 'The Knowledge', *Technology Review*, March/April.

Popov outlined a number of accomplishments and possibilities in the Soviet programme that were becoming within reach of far-less-well resourced efforts. This was due to the growth in understanding of basic life processes and the accessibility of sophisticated technologies. Among the many prospects outlined included increasing the virulence of pathogens, synthesising viruses from common laboratory materials, modifying bacteria to induce debilitating diseases (including multiple sclerosis), as well as using pathogens to interfere with specific cellular targets in order to alter cognition, behaviour, and perception.

In the article, as typically happens elsewhere, such dire claims were accompanied by questions of a sceptical bent: would novel bioagents make for effective weapons in practice? Are sub-state groups or deranged individuals really in a position to produce them? Could the claims of former weapon developer be taken at face value? If it is relatively easy to deliberately spread disease, why have there not been more instances of bioattacks? Would controls on the conduct of research and the spread of technology make us safer or place us in greater danger?

'The Knowledge' concluded with a bleak assessment that: 'I don't know what kind of or scientific or political measures would guarantee that the new biology won't hurt us.' But the vital first step, Popov said, was for scientists to overcome their reluctance to discuss biological weapons. 'Public awareness is very important. I can't say it's a solution to this problem. Frankly, I don't see any solution right now. Yet first we have to be aware.'

Awareness and Education: Disagreement in Unanimity

Arguably these sentiments do not just represent the thinking of one man, but rather characterise the state of international thinking today regarding 'what must be done and by whom?'[4] As examined in the next section, a diverse array of assessments have been put forward about what dangers are associated with the life sciences and what should happen as a result. Calls for increased education of some kind have figured in recommendations across a range of concerns — from ensuring the physical safety of labs, to vetting experiment proposals, to tackling diseases that undermine economic development and thereby collective

4 See Rappert, B. and Gould, C. (eds) 2009, *Biosecurity: Origins, transformations and practices*, London: Palgrave.

well-being.[5] Education is envisioned as necessary in both those responses that call for informal self-governance by science communities as well as those that demand formal regulations.

However, as I have argued elsewhere, once one moves from such general calls to specific actions, a number of difficult choices must be addressed.[6] Initial indications of these are given in Box 1. It lists some basic questions that arise in considering what should be done.

Claims of what is appropriate biosecurity education are potentially contentious because they are bound up with the exercise of authority and expertise. For instance, with regard to concerns about purpose mentioned in Box 1, some types of education focus on transmitting authoritative knowledge or values. However, particularly in relation to matters of ethics, resistance can be intense when some try to tell others what they should think. Alternative types of education instead stress the need to nurture individuals' own reasoning so as to enable them to think through ethical problems on their own. Still other types are not focused on individuals, but seek to further the ability of people to work together in joint deliberations.[7] Not only are these different approaches associated with alternative learning techniques and opportunities for questioning, they also suggest various ways of resolving what should be done.

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5 As a sample of such calls, see Report of Royal Society and Wellcome Trust Meeting 2004, 'Do no harm — Reducing the potential for the misuse of life-science research', 7 October; World Medical Association 2002, *Declaration of Washington on biological weapon*s, Washington, DC: WMA; National Research Council 2003, *Biotechnology research in and age of terrorism*, Washington, DC: National Academies Press; British Medical Association 1999, *Biotechnology, weapons and humanity,* London: Harwood Academic Publishers; United Nations 2005, *Report of the meeting of States Parties to the Convention on the Prohibition of the Development, Production and Stockpiling of Bacteriological (Biological) and Toxin Weapons and on their Destruction*, BWC/MSP/2005/3 14, Geneva: UN, available: http://www.opbw.org [viewed 1 November 2009]; National Science Advisory Board for Biosecurity 2008, *Strategic plan for outreach and education on dual use research*, 10 December, available: http://oba.od.nih.gov/biosecurity/PDF/FinalNSABBReportonOutreachandEducationDec102008.pdf [viewed 1 November 2009].

6 Rappert, B. 2007a, 'Education for the life sciences' in Rappert, B. and McLeish, C. (eds) A Web of prevention: Biological weapons, life sciences and the future governance of research, London: Earthscan, pp. 51–65. Available: http://people.exeter.ac.uk/br201/Research/Publications/Chapter%203.pdf [viewed 1 November 2009].

7 See Päsänen, R. 2007, 'International education as an ethical issue' in Hayden, M., Levy, J. and Thompson, J. (eds) *Research in international education*, London: Sage, pp. 57–78.

Box 1: The Who, What, and How of Education

What should education entail by way of subject matter?

> Should it include the characteristics of diseases from expected dangerous agents, the physical and biological security otf laboratories, the history of offensive programmes by states, or the potential of civilian research to further the spread of disease?

Who needs to be educated?

> Should they be pathogen investigators, bioscientists as a whole, those associated with life sciences in general, or the public?

What is the purpose of education?

> Should it seek to 'implant' knowledge or 'elicit' understanding?

Who is the educator?

> In other words, who is expert?

How can audiences of practising scientists or other practitioners be reached?

> How can their attention and active engagement be secured?

This volume examines a variety of attempts to bring greater awareness to security concerns associated with the life sciences. It identifies lessons from practical initiatives across a wide range of national contexts as well as more generic reflections about education and ethics. In offering their assessment about what must be done and by whom, each of the contributors addresses a host of challenging practical and conceptual questions. As a result, the volume will be of interest to those planning and undertaking activities elsewhere. In asking how education and ethics matter in an emerging area of unease, it will also be of interest to those with more general concerns about professional conduct and social problems.

Security and Biology: Dilemmas at Intersection

Before exploring the issues associated with education in more detail and introducing the chapters, this section continues focusing on the security implications of the life sciences. As will be argued, determining what to do by way of education is not only challenging because of the choices available in how to foster learning, but also because of the stubborn dilemmas, ambiguities and uncertainties associated with understanding the issues at stake. While it might seem plausible that growing knowledge and capabilities equate with growing agency for hostile actions, much scope for contest is also evident in conception of the issues at stake. The manner in which this is done has implications for what kind of education should be pursued, with whom, and how.

Consider, then, a number of contentious areas:

Running Faster

While in recent years some commentators have forwarded concerns about how developments in science and technology might aid the deliberate spread of disease, in practical terms, overwhelmingly research has been looked at as a way of countering identified threats. This is most marked in the US. Here a substantial expansion has taken place in biodefence and biodefence research. While in the financial year 2001 the US civilian biodefence funding totalled $569 million, in 2008 it was more than $5.3 billion.[8] Research has been a core component of this expansion, with funding in excess of $3 billion per year since 2004, much of it led by the National Institutes of Health.[9] In other words, the technologically sophisticated nightmares often envisioned have justified a similarly sophisticated response.

With the emphasis placed on staying ahead of threats through more research, worries have been expressed whether the shift in funding has established inappropriate priorities, blurred the boundary between internationally permissible defensive work, or created dangers regarding the accidental or intentional release of pathogens.[10] With regard to the latter, the substantial expansion of biodefence funding has resulted in a corresponding increase in the number of individuals and facilities working with pathogenic agents. Given the conclusion of the FBI that the perpetrator of the anthrax attacks in 2001 was an American working within the US Army Medical Research Institute of Infectious Diseases,[11] the question has been posed more than once as to whether the multi-billion-dollar increase in biodefence has resulted in a proliferation of dangerous knowledge, skills and materials. At the time of writing, intense

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8 Franco, C. 2009, 'Billions for biodefence', *Biosecurity and Bioterrorism*, vol. 7(3): pp. 291–309.

9 See Center for Arms Control and Non-proliferation 2008, *Federal funding for biological weapons prevention and defense, Fiscal years 2001 to 200*8, Washington, DC: Center for Arms Control and Non-proliferation.

10 See Enserink, M. and Kaiser, J. 2005, 'Has biodefense gone overboard?', Science, vol. 307(5714), pp. 1396–98; Leitenberg, M., Leonard, J. and Spertzel, R. 2004, 'Biodefense crossing the line', *Politics and the Life Sciences*, vol. 22(2), pp. 1–2; Klotz, L. and Sylvester, E. 2009, *Breeding bioinsecurity*, Chicago: Chicago University Press.

11 Bhattacharjee, Y. 2009, 'The danger within', *Science*, 6 March, pp. 1282–83.

political debate is taking place in the US and elsewhere regarding what sort of screening and oversight of individuals should occur and who should control it. The underlying question of how much and what kind of defensive work is prudent remain topics on which governments and commentators have offered wildly opposing views.

In part, the question of what is appropriate defensive research is disputable because the ultimate ends served by that work are debatable. Much of the original increased funding in the US was designated for traditional 'Category A' agents (for example, anthrax, smallpox, plague). To some extent, in response to criticism about how this was establishing inappropriate research priorities, many of the funding programmes broadened their mission over time beyond a narrow conception of biodefence.[12] However, owing to the multiple dimensions in which goals can be mutually co-opted in the researcher–funder relation, determining the significance of official priorities has meant agendas and outcomes require a fine-grained analysis.

Everywhere and Nowhere

One aspect of increased research scrutiny that has animated much debate is the suggestion that work carried out in universities or other traditionally open organisations might be inappropriate to conduct or communicate. Unlike questions about the safety or physical security of labs, this does not so much relate to how research is conducted, but rather to its so-called dual-use dimensions. This usage of the term refers to the potential use of knowledge and techniques for beneficial and hostile purposes. Therefore, since 2003 a number of funders, publishers and organisations (in the West) have introduced oversight processes to assess the risks and benefits of individual instances of research to determine whether they need to be modified or withdrawn.[13]

It is notable that such procedures rarely conclude that manuscripts, grant applications or experiment proposals should not be undertaken or restricted. For instance, in 2003 a group of 32 science journals agreed general guidelines for modifying, and perhaps rejecting, manuscripts where 'the potential harm of publication outweighs the potential societal benefits'.[14] However, it would seem no manuscript has ever been rejected on security grounds.[15] As far as is known to the author, the same could be said of the funders that have established

12 See Franco 2009, op cit.

13 Rappert, B. 2008a, 'The benefits, risks, and threats of biotechnology', *Science & Public Policy*, vol. 35(1), pp. 37–44.

14 Journal Editors and Authors Group 2003, *PNAS*, vol. 100(4), p. 1464.

15 Van Aken, J. and Hunger, I. 2009, 'Biosecurity policies at international life-science journals', *Biosecurity and Bioterrorism*, vol. 7(1), pp. 61–72.

submission-oversight systems.[16] Perhaps even more notable with these review processes is the infrequency with which they have identified items 'of concern' in the first place.[17]

While data on research controls within government departments (especially defence-related ones) is not readily available, in relation to universities and other publicly funded agencies it seems justifiable to conclude that — barring dramatic changes — oversight processes will identify little research as posing security concerns and will stop next to nothing. This situation raises questions about the ultimate purposes and prospects of formal oversight procedures as well as who is conducting assessments and how (see below).

Formal Policies and Informal Practices

While many recently introduced formal dual-use procedures intended to weigh the perceived societal benefits and security risks of civilian research have not ruled any work should be halted, evidence suggests individual scientists might be acting otherwise. In 2007 the National Research Council and the American Association for the Advancement of Science (AAAS) conducted a survey of 10,000 AAAS members. The 2009 report of that survey indicated that one in six respondents had made some changes in what research they did, how it was communicated, or who it was done with.[18]

The small response size (16 per cent for completed surveys and 20 per cent for partially completed ones) means it is not possible to treat the findings as representative of any grouping. However, even without making generalised claims, disparities between the reported practices and the outcomes of recently introduced review processes are notable.[19]

While some have taken the survey findings to indicate scientists are already acting responsibly to reduce risks,[20] it seems more justified to ask further questions. One obvious question would be: why is there such inconsistency between the willingness of researchers to report forgoing aspects of their work with dual-use potential and the inability of formal process to do the same (or

16 These include the UK Biotechnology and Biological Sciences Research Council, the UK Medical Research Council, the Wellcome Trust, the Center for Disease Control, and the Southeast Center of Regional Excellence for Emerging Infectious Diseases and Biodefence.

17 So across all the journals in the Nature Publishing Group, roughly 15 papers were subjected to a special security review in 2005 and 2006. For further figures, see Rappert 2008a, op cit.

18 National Research Council and the American Association for the Advancement of Science 2009, *A survey of attitudes and actions on dual-use research in the life sciences*, Washington, DC: NRC and AAAS.

19 Though in this regard, 25 per cent of respondents to the survey indicated they had worked with 'select agents' in the past, therefore suggesting a possible reason for both the changes made to research practices and the awareness of dual-use concerns.

20 National Academies 2009, *Survey samples life scientists' views on 'dual use' research and bioterrorism*, Press Release 9 February.

even find any aspects of concern)? Within organisational sociology, the disparity between formal procedures and informal practices is a long-standing topic of commentary. Such a situation is not necessarily an occasion for arguing who has made the right decisions, but rather one for asking how alternative assumptions about proper working practices are informing conduct.

In relation to the themes of education central to this book, the disparity also raises the issue of how practitioners communicate concerns. Particularly in light of the lack of dual-use educational provisions as part of university degree programmes and the absence of professional attention to this topic in recent decades, how the scientists surveyed became concerned by hostile applications is an important matter that could signal pathways for educational interventions, such as seeking to make explicit practices that were previously implicit.[21]

Individual versus Cumulative Developments

It seems reasonable to argue that one reason why dual-use risk-benefit review processes have not halted grant applications, manuscripts, and experiment applications is the difficulty of establishing the possible hazards associated with single-research inputs against the backdrop of pre-existing knowledge and capabilities. Despite ongoing attempts,[22] making risk determinations is highly problematic. Even if reasonably robust assessment procedures could be devised, it is not clear that threats derive from discrete projects, so much as how cumulative developments in knowledge, know-how, and technologies enable additional possibilities for action. Just how that is happening is essential to understanding what is possible (see below).

Therefore, rather than focusing on whether particular experiments should go ahead, it seems more fruitful to ask what directions should be funded in the first place.[23] Some of the lines of biodefence undertaken in the US and elsewhere (particularly those associated with characterising threats) might be questionable in terms of their necessity. Positively, directions of work that might enhance security by fostering international collaboration and development, as suggested in the *DNA for Peace* initiative, could be supported.[24] This 'macro' attention towards research directions is not without problems too, such as how

21 For a discussion of this as a prevalent form of ethical training, see Halpren, S. 2004, *Lesser harms*, Chicago: Chicago University Press.

22 Royal Society 2009, *New approaches to biological risk assessment*,29 July, London: Royal Society.

23 Johnson, D. 1999, 'Reframing the question of forbidden knowledge for modern science', *Science and Engineering Ethics*, vol. 5(4), pp. 445–61.

24 *DNA for peace: Reconciling biodevelopment and biosecurity*,available: http://www.utoronto.ca/jcb/home/documents/DNA_Peace.pdf [viewed 1 November 2009].

to anticipate research results. However, what is clear is that attention to date on dual-use issues has been directed at individual elements of research at the expense of other approaches.

'Dual Use' is... 'X' is...

In the paragraphs above, 'dual use' refers to the potential for knowledge and techniques to serve beneficial and hostile purposes. In doing so, it is roughly in line with the highly influential report by the US National Academies, *Biotechnology Research in an Age of Terrorism*.[25] However, like other terms with a rising currency of late — such as 'biosecurity'[26] or 'codes of conduct'[27] — 'dual use' has its own history. It is often taken to mean different things by different people. That ambiguity has no doubt been part of its attraction.

This indistinctness brings certain hazards too. One is a lack of clarity and corresponding misunderstanding in what is being argued about the relation between science and security. For instance, Atlas and Dando have offered a distinction between three dual-use aspects of the life sciences to avoid conflations. They distinguish between: 1) how notionally civilian facilities can be used to develop biological weapons; 2) how agents and equipment intended for peaceful purposes can be used in the production of bioweapons; and 3) how knowledge generated through science can aid those seeking to produce weapons.[28] They argue each is associated with its own conundrums and require specific types of responses — mandatory international inspections and transparency in the case of facilities; balanced export controls and domestic oversight in the case of agents and equipment; and a culture of responsibility in relation to knowledge.

Other matters are at stake in our use of terminology and concepts than possible misunderstanding. As McLeish argues, questionable assumptions can often underlie reference to the dual-use presumptions that rarely get scrutinised because of the ready labelling of science and technology as such. As she argues, much of the security analysis relies on an outdated linear model of innovation wherein science is applied to produce new technologies. In addition, the locus of concern with dual-use issues in many commentaries often shifts in an uneasy and unacknowledged manner between the transfer of materials, the intention of users of knowledge and technology, and the physical characteristics of technology itself.

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25 National Research Council 2004, *Biotechnology research in an age of terrorism*, Washington, DC: National Academies Press.

26 See Rappert and Gould (eds) 2009, op. cit.

27 Rappert, B. 2007b, 'Codes of conduct and biological weapons', *Biosecurity & Bioterrorism*, vol. 5(2), pp. 145–54.

28 Atlas, R. and Dando, M. 2006, 'The dual-use dilemma for the life sciences: Perspectives, conundrums, and global solutions', *Biosecurity and Bioterrorism*, vol. 4(3), pp. 1–11.

For such reasons, the language adopted to characterise the security dimensions of science and technology can also cloud understanding.[29]

What are Biological Weapons?

Greatly aiding efforts to prevent the deliberate spread of disease is the widespread denunciation of any such act. As opposed to other fields, such as nuclear science, weaponising the latest research findings is generally seen as inappropriate in the life sciences. Within customary and international law, as well as the rhetoric of states, 'biological weapons' are set apart from other weapons in that they are treated as a distinct category.[30]

In some ways this has only displaced controversy to the question of what counts as a biological weapon in the first place.[31] This is most evident in debates about the appropriateness of biochemical compounds as instruments of force.[32] The use by Russian security forces of a fentenyl gas (an opium-based narcotic) during the Moscow theatre siege in 2002 provides one example of the types of options being pursued by states for law enforcement and military operations that might be designated 'biological'. Additionally, governments such as the US have examined more sophisticated biochemical choices to alter consciousness, behaviour and emotions.[33] The acceptability and permissibility of such biochemical agents is fought out, in part, through terminology. Proponents make use of labels such as 'calmatives', 'incapacitants' and (misleadingly) 'non-lethal weapons'.[34] Should such developments lead to a legitimate role for bioagents as a means of force, the implications for the current stigmatisation of biological weapons would likely be substantial.

What are 'Effective' Biological Weapons?

As a final area of contention, much disagreement is evident today regarding the extent of biothreats. Some of this stems from underlining presumptions about

29 It should be kept in mind though that ambiguity in meaning is often highly valuable in building shared agendas.

30 This in contrast to the suggestion by many of those involved in offensive programmes that biological weapons are not different from others. See Domaradskil, I. and Orent, W. 2003, *Biowarrior: Inside the Soviet/Russian biological war machine,* Amherst, NY: Prometheus, p. 150; Balmer, B. 2002, 'Killing "without" the distressing preliminaries', *Minerva*, vol. 40(1), pp. 57–75.

31 See Rappert, B. 2006, *Controlling the weapons of war: Politics, persuasion and the prohibition of inhumanity*, London: Routledge, Chapter 6.

32 For an overview, see Pearson, A., Chevrier, M. and Wheelis, M. (eds) 2007, *Incapacitating biochemical weapons: Promise or peril?*, Lanham, MA: Lexington Books.

33 Dando, M. 2009, 'Biologists napping while work militarized', *Nature,* vol. 460, p. 950; British Medical Association 2007, *Drugs as weapons*, London: BMA House.

34 See Rappert, B. 2003, *Non-lethal weapons as legitimizing forces?: Technology, politics and the management of conflict*, London: Frank Cass.

what counts as a concern. Certainly within the West, much emphasis is with sub-state groups. The limited number of bioterror attacks in the past and the difficulties experienced by even well-funded groups using classic pathogens (for instance, the Japanese Aum Shinrikyo cult[35]) suggest a low likelihood of mass casualties by terrorist groups acting alone.[36] Therefore, the possibility that such groups could or would want to make use of today's cutting-edge science is even more remote, at least anytime 'soon'.

However, the situation is more complex than this. Even if it is accepted that inflicting mass casualties requires a well-resourced state programme, concerns can derive from the fear and disruption caused by deliberate spread of disease. As illustrated in the case of the 2001 anthrax letters, attacks need not inflict mass casualties to be highly consequential. 'Weapons of mass disruption' rather than 'weapons of mass destruction' sums up a contrast.

Concern can intensify when the basis for disruption is analysed. Fundamental to the international prohibition of bioweapons today is the view that these weapons are especially abhorrent. That orientation is expressed in international accords such as the Biological Weapons Convention. The continuing promotion of such agreements and related rules, in turn, reinforces this negative standing. Indeed, it is the manner in which biological weapons are treated as distinctly repugnant that would likely contribute to significant fear and disruption in the case of an attack.

Education as…

The previous section posed some major weaknesses in thinking about the life sciences–security relation. When this is understood to involve uncertainties and unknowns where much scope exists for disagreement, the question of what should happen by way of education becomes less straightforward than it might initially appear.

This section adds further density to the picture. While some of the who's, what's, and how's of education were noted above, this section examines the multiple roles, functions, and standing sought for education. The goal is not to consider the details of what teaching efforts should include, but how education in general

35 See Furukawa, K. 2009, 'Dealing with the dual-use aspects of life science activities in Japan', in Rappert and Gould (eds), op. cit.

36 As argued in Ouagrham-Gormley, S and Vogel, K. 2010, 'The social context shaping bioweapons (non) proliferation', *Biosecurity & Bioterrorism*, Volume 8(1) and Leitenberg, M. 2001, *Biological weapons in the twentieth century: A review and analysis*, Washington, DC: FAS, available: http://www.fas.org/bwc/papers/bw20th.htm [viewed 1 November 2009]. For a critical response to the claims in this chapter by Popov, see Macfarlane, A. 2006, 'Assessing the threat', *Technology Review*, March/April.

is positioned within debates about the science–security relation. By considering the many things education can be understood as, this section will help position the practical initiatives and proposals summarised in the next section. As will be apparent, the issues at stake extend well beyond what individuals sitting at benches know or think.

…Prerequisite

Education can be treated as necessary for other security-related activities to be undertaken. For instance, much store has been placed in professional codes of conduct since 2001.[37] Such options have been said by many to be a way of promoting self-governance. The circulation of codes would foster a culture of responsibility by making scientists more aware and providing ethical guidance. However, efforts to devise meaningful codes have largely floundered. In no small part, this has been due to the lack of prior awareness and attention by researchers as well as science organisations to the destructive applications of the life sciences.[38] Before codes can help teach, education is needed.

Also, consider the dual-use reviews noted in the previous section. The Wellcome Trust, the British Biological Sciences Research Council and the British Medical Research Council are among those funders that have established grant-review procedures. Each relies on applicants to self-identify cases where work could generate outcomes open to misuse for harmful purposes. In light of the limited professional attention to this possibility in recent decades, it seems quite likely that a lower identification rate is taking place than would be the case with a highly dual-use-aware community of applicants.

The US National Science Advisory Board for Biosecurity (NSABB) was established to advise the federal government how to respond to the dual-use potential of the life sciences. It similarly advocates a system for the oversight of experiments that relies on lead investigators to undertake the initial determination of whether their work is 'of concern'.[39] In recognition of the need for those making such assessments to be cognisant of security threats though, as well as other provisions it recommends that: 'All federal agencies involved in the conduct and support of life sciences research […] should require that their employees, contractors, and institutional grantees train all research staff in the identification and management of dual-use research of concern.'[40]

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37 Rappert, B. 2009, *Experimental secrets: International security, codes, and the future of research*, New York: University Press of America.

38 Rappert 2007b, op. cit.

39 NSABB 2007, *Proposed framework for the oversight of dual-use life sciences research: Strategies for minimizing the potential misuse of research information*, Bethesda, MD: NSABB.

40 NSABB 2008, *Strategic plan for outreach and education on dual-use research issues*, Bethesda, MD: NSABB.

Some have argued this goes far enough. An alternative model for oversight proposed by a group at the University of Maryland advocates independent peer reviewers should carry out the identification of what is of concern. In part, this was justified by citing the likely limits on the security expertise of researchers, even if they had undergone some formal training.[41]

…Deficiency Correcting

Much of the current analysis of what practising researchers know — be that regarding laboratory physical security[42] or wider ethical/arms-control issues — posits a deficiency model.[43] That is to say, they note a lack of knowledge held by certain groups. Education is advocated as a way to correct that ignorance. Knowledge is taken to be good: more knowledge leads to better decisions. Depending on the size of the hole perceived and the value attached to additional knowledge, a call is made for voluntary or mandatory measures, often through formal teaching.[44]

The particulars of how deficiency is portrayed are highly consequential in framing what kinds of problems exist and how they can be addressed. Take the case of the NSABB Working Group on Communication.[45] In line with the review processes adopted by certain journals, the NSABB Charter required it to 'advise on national policies governing publication, public communication, and dissemination of dual-use research methodologies and results'. At the first public meeting of the NSABB in late 2005, the Communication Working Group stated it would:

- Identify concerns and examine options and strategies for addressing issues related to the communication of dual-use research information.
- Develop draft recommendations for the NSABB that will facilitate the consistent application of well-considered principles to decisions about communication of information with biosecurity implications.[46]

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41 Harris, E. 2007, 'Dual-use biotechnology research: The case for protective oversight', in Rappert and McLeish (eds) op. cit.

42 For a range of analyses of what is known by researchers around the world on this matter, see the publications of the International Biological Threat Reduction Group and Sandia National Laboratories at http://www.biosecurity.sandia.gov/main.html?subpages/documents.html.

43 For a further discussion of this model within discussions about science, see Bush, J., Moffatt, S. and Dunn, C. 2001, 'Keeping the public informed?', Public Understanding of Science, vol. 10, pp. 213–29.

44 For an instance of the latter, see Rappert, B. and Davidson, M. 2008, 'Improving oversight: development of an educational module on dual-use research in the West', Conference Proceeding for Promoting Biosafety and Biosecurity within the Life Sciences: An International Workshop in East Africa, 11 March, Kampala: Ugandan Academy of Sciences.

45 For a further analysis of this example, see Rappert, B. 2008b, 'Defining the emerging concern with biosecurity', Japan Journal for Science, Technology and Society, vol. 17, pp. 95–116.

46 Kiem, P. 2005, 'Working group on communication of dual-use research results, methods, and technologies', Meeting of National Science Advisory Board for Biosecurity, 21 November, Bethesda, MD.

As such, 'the problem' was to reduce the prospect that otherwise benignly intended findings might aid development of bioweapons. This framing shifted quite quickly. By July 2006 'the public' assumed a prominent position within deliberations of the working group. Because of an acknowledged lack of understanding of science, the fear repeatedly expressed was that future media reports could spur the public to demand (inappropriate) dissemination restrictions. In response, the Communication Working Group's main charges deriving from the NSABB Charter were modified to:

- Facilitate consistent and well-considered decisions about communication of information with biosecurity implications.
- Demonstrate to the public that scientists recognise, and are being responsive to, concerns about the security implications of their work.[47]

With the latter requiring the public to be properly informed about the dangers posed from open publishing (manageable, relatively limited, etc.). This re-specification was in line with a wider movement within the NSABB deliberations to focus on the 'threats *from* science' (and thus the need for new polices and oversight measures) while also considering the 'threats *to* science' (from new polices and oversight measures). In this way, alternative notions of who is deficient suggest other problems and solutions.

Following on from this, more knowledge is not always seen as good, at least not entirely. While it might regularly be advocated that researchers should be more cognisant of the dual-use potential of science and technology, the same cannot be said of 'the public'. Much debate is evident about just how loudly security concerns should be made known to the population at large.[48] Scant efforts made prior to 2001 (and even since) by scientists to popularise how their work might aid the production of bioweapons indicate the historical pattern of *not* seeking to foster wider debate and awareness. So while many have dismissed the security concerns associated with the publication of certain experiments — such as the IL-4 mousepox and the synthetic creation of poliovirus — because their findings were already well known among specialists,[49] the question can be asked why such possibilities were not more widely mooted before.

This last point also raises the prospect that without more engagement from practising researchers, policy and security analysts might be forming inappropriate threat assessments because of the haphazard way certain concerns have received a wide airing.

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47 Kiem, P. 2006, 'Working group on communication of dual-use research results, methods, and technologies', Meeting of National Science Advisory Board for Biosecurity, 13 July, Bethesda, MD.

48 For a discussion of this, see Rappert, B. 2007c, *Biotechnology, security and the search for limits: An inquiry into research and methods*, London: Palgrave, Chapter 5.

49 As in Block, S. 2002, 'A Not-so-cheap Stunt', *Science*, vol. 297(5582), pp. 769–70.

…Irrelevant

Another way to question the treatment of education is simply to question its utility. A fundamental tenet in social research is that behaviour is more influenced by situational conditions than personal dispositions. In other words, what people do is highly dependent on the situations in which they find themselves and the pressures they experience. As such, it is little wonder so many doctors, biologists, engineers and others in the Soviet Union were willing to take part in its offensive programme. While it is unclear how many involved knew about the international prohibition enshrined in the Biological Weapons Convention, it does seem clear that familiarity with the text would have done little to alter their participation.

Besides such coercive environments, it can be said that standards of ethics and practice are intertwined with the imperatives under which individuals operate. For instance, how those in hospitals deal with the confounding choices about life and death experienced on a daily basis must be understood as being indebted to the social organisation of the hospital itself.[50] In these settings, mundane issues such as the relative power of nurses, doctors and administrators are highly pertinent in what decisions are made. Therefore, it would not be enough for nurses to receive instruction about ethical principles for them to act in a way they would regard as right. Similarly, in the case of laboratory researchers, the cultures and reward structures of labs (for example, 'publish or perish') can reduce the prospects of individuals acting in a way they judge as proper, or can work against the recognition of ethical problem in the first place.[51] This can take place whatever individuals believe should be the case.

Thus in any discussion about education, it is necessary to ask where it can be made to matter and what weight it can be expected to bear.

…a Social Problem

While the extensive participation of experts in offensive bioweapons programmes during the twentieth century suggests limitations to education, this history also indicates the potential for it to contribute to hostile activities. When ethics instruction is conceived as the dissemination of values, just what those values are is central in evaluating the benefits of what is learnt. If duty to

50 Chambliss, D. 1996, *Beyond caring: Hospitals, nurses and the social organization of ethics*, London: University of Chicago Press.

51 National Research Council 2009, *Ethics education and scientific and engineering research: What's been learned? What should be done?*, Washington, DC: NRC, Chapter 6. For a wider examination of this, see Vaughan, D. 1996, *The Challenger launch decisio*n, Chicago: Chicago University Press.

one's country[52] is taught to be the paramount concern, then it easy to envision how education might not always be a 'force for good'.[53] The method of education can foster relations of subordination too that are contrary to maintaining peace.

More widely, efforts to instruct always come with commitments and assumptions. These can mean that education functions to maintain existing inequalities.[54] So while the unacceptability of biological weapons is generally unquestioned within diplomatic circles today, that does not necessarily make for a non-problematic common pedagogical message. As Richard Falk suggested, the recent regime restricting bioweapons must be seen in its political context. Writing in 2001, he suggested this context was one in which the US was trying to divert public attention away from existing US nuclear capabilities. It was against this selective prioritisation that he asked whether:

> The ongoing process that supports CW [chemical warfare] and BW [biological warfare] regimes, as well as the nuclear non-proliferation treaty regimes, [should] be re-evaluated and possibly rejected? From the perspective of the equality of states, a fundamental norm in international law, are these regimes embodiments of the hegemonic structure of world politics that controls and deforms diplomatic practice?[55]

Herein, what is good and why must always be understood 'in context', though what counts as the right context is the stuff of political debate. Any education message is going to contest competing notions about what is right. When approached in this way, it is not hard to see how others could interpret efforts taken in one country to promote security mindedness as imperialistic.

Somewhat less critical, certain types of education can be thought to take time and energy away from dealing with causes of problems. For instance, abstract and hypothetical instruction about ethical problem-solving that is removed from the real experiences of individuals can do more harm than good. To the extent that ethics is taught without reference to power relations that give rise to practical conflicts and dilemmas, it can mask the sources of tension and perpetuate inaction.[56]

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52 Or group difference, see Nelles, W. (ed.) 2004, *Comparative education, terrorism and human security*, London: Palgrave.

53 Moving outside a consideration of biological weapons, it can be noted that the education system in a wide range of countries does little to dissuade individuals from using their knowledge and skills to perfect forms of killing.

54 Saltman, K. and Gabbard, D. (eds) 2003, *Education as enforcement: the militarization and corporatization of schools*, London: Routledge; Apple, M. 2000, *Official knowledge: democratic knowledge in a conservative age,* London: Routledge; and Harber, C. 2004, *Schooling as violence: how schools harm pupils and societies,* London: Routledge.

55 Falk, R. 2001, 'The challenges of biological weaponry', in Wright, S. (ed.), *Biological warfare and disarmament*, London: Rowman & Littlefield, p. 29.

56 For an analysis of this, see Chambliss 1996, op cit., Chapter 4.

…a Diversion

Consider another concern, that of treating education as distraction. This does not pertain to those being educated, but to those talking about the need to educate others. For instance, in recent years the awareness and training of scientists has been a topic of international consideration within the States Parties meetings of the Biological and Toxin Weapons Convention (BTWC). Since the failure in 2001–02 to agree a legally binding verification measure for the convention, yearly meetings have been structured through an intersessional process. In this, governments engage in non-binding discussions about selected topics. The education of scientists figured as a significant theme within the 2003, 2005 and 2008 meetings.

However, from its inception, questions have been raised about the value of the intersessional process. At least one reason is that it distracts delegates from attempts to agree verification instruments or other compulsory measures.[57] Worse still, over time it might establish low expectations. Even if one concludes the BTWC intersessional process has been useful, how long 'mere' discussion should go on is open to debate. Comparing biosecurity education against other possibilities for action (or even more generic education possibilities) shows how the worth of any activity can be queried.

…Guardianship

Alternatively, and more positively, the education of scientists could be seen as a way of ensuring conventions and agreements — such as the BTWC — remain meaningful. This is because further awareness of the security implications of science and of the international instruments for the prohibition of bioweapons leads to more engaged scientific communities. By taking greater notice of and participation in the relevant activities, practitioners could help ensure governments are aware of their own commitments and labour to undertake effectual actions. By extending the range of those working to eliminate bioweapons, this could also reinforce the stigma against the deliberate spread of disease.[58]

57 See Chevrier, M. 2002/03, 'Waiting for Godot or saving the show? The BWC Review Conference reaches modest agreement', *Disarmament Diplomacy,* No. 68, available: http://www.acronym.org.uk/dd/dd68/68bwc.htm [viewed 1 November 2009].

58 For a further argument of these points, see Revill, J. and Dando, M. 2008, 'Life scientists and the need for a culture of responsibility: After education…what?' *Science and Public Policy*, vol. 35(1), pp. 29–36.

…Catalyst

Additionally, the widespread concord regarding the value of awareness and education could be utilised as a stepping-stone for moving ahead on other matters. Within the recent meetings of the BTWC a number of issues, such as promoting international co-operation and verification measures, have proven highly contentious. Likewise, proposals for oversight and dual-use reviews of research can generate heated debate. However, awareness and education are matters on which those from security, scientific, diplomatic, and other backgrounds can reach general consensus. Therefore, achieving understanding and progress here could help secure advancement in relation to more overtly problematic areas. It might also help indicate how to establish progress. In relation to the BTWC, the discussion-only terms set for the intersessional process since 2003 have led to an absence of the international targets and metrics. As a comparatively approachable topic, setting international standards for education could be agreed as a way of opening peoples' imaginations to the possibility of setting other measurable goals.[59]

…Enrolment

The last two sub-sections, in particular, questioned whether education is orientated towards being an end itself or a preliminary step towards another, secondary, end. As has happened in relation to codes of conduct, contrasting assumptions can underlie similar calls for action. In the case of codes, those (often implicit) assumptions related to whether their adoption would placate the need for additional oversight measures or whether they were part of a stepwise movement towards comprehensive systems of control (for instance, the licensing of scientists).[60]

This suggests the need to interpret calls for education as part of enrolment processes. Through setting agendas, framing problems, and establishing interested networks, what is being done today is helping to form possibilities for future action. Whether through purposeful direction or unintended preoccupation, the choices made about what kind of education should be pursued or how it is being discussed are shaping directions for the future. Just how much this is taking place and in which directions are important considerations.

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59 For a discussion of possible international goals, see Dando, M. 2008, 'Acting to educate life scientists', *Bulletin of the Atomic Scientists*, 31 October, available: http://www.thebulletin.org/web-edition/columnists/malcolm-dando/acting-to-educate-life-scientists [viewed 1 November 2009].

60 Rappert 2009, op cit.

The Chapters

The previous section suggested the range of possibilities that can be sought from education as well as talk of education. The remaining chapters demonstrate that variety by describing diverse efforts to educate scientists and others about the life science–security relation.

The chapters in Part One begin by extending the analysis of education presented in this introduction to questions of ethics. Selgelid examines the intersection of ethics and dual-use concerns. His goal is not only to outline the ethical dimensions of the multiple uses of research, but also to ask why bioethics has had so little to say until recently about this topic. In Chapter 2, Sture analyses what lessons past developments in medical and business ethics hold.

Part Two recounts national experiences to promote awareness and institute educational measures. In doing so, the chapters detail the current attention paid to biosecurity and dual-use issues in the countries under consideration. As will be evident, different countries are in very varied situations with regards to their past engagement and to their basis for moving forward. In describing their experiences, Garraux, Friedman, Minehata and Shinomiya, Barr and Zhang, Connell and McCluskey, as well as Enemark, provide many entry points and models for promoting education.

Part Three moves on from national activities to reflect on international possibilities. Mancini and Revill review their efforts to establish a collaborative Biosecurity Education Network. Part of that entailed the presentation of tailored educational material to life-science students. In Chapter 10, Whitby and Dando consider the rationale for the Biosecurity Education Module Resource noted by Mancini and Revill, including how it could figure within the work of civil organisations as well as the BTWC. Johnson then asks how ethics training about security issues could be made professionally relevant for scientists, in particular, by advocating the potential of role-playing exercises.[61] In the Conclusion, Bezuidenhout and I draw together strains from these chapters in an effort to point the way for future action and research.

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61 For a further consideration of role-playing exercises for biological weapons, see Rappert, B., Chevrier, M. and Dando, M. 2006, In-Depth Implementation Publications of the BTWC: Education and Outreach Bradford Review Conference Paper No. 18, available: http://www.brad.ac.uk/acad/sbtwc/briefing/RCP_18.pdf [viewed 1 November 2009].