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Article:

How do Different Student Constituencies (not) Learn the History and Philosophy of their Subject?

Case Studies from Science, Technology and Medicine¹

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1. Introduction: themes and summary of the argument

Why should H.E. teachers concern themselves with how their students do or don't learn? Much has been said recently about the alleged merits and demerits of 'student-centred' learning, especially on the extent to which student autonomy in the learning process is beneficial to their long-term interests.² This paper is not a contribution to that debate. Rather it focuses on how teachers might uphold their conventional educational responsibilities but make their role *more* effective. Its central thesis is that this role is most effective when treated

¹ This paper was presented at a meeting of the International History, Philosophy and Science Teaching Group in Denver, Colorado, November 2001.

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² Donna Brandes and Paul Ginnis: *A Guide to Student-Centred Learning*, Cheltenham: Stanley Thornes, 1996;

David Newble and Robert Cannon, *A Handbook for Teachers in Universities and Colleges: a Guide to Improving Teaching Methods*, 4th ed., rev. London: Kogan Page, 2000;

P. Ramsden, *Learning to Teach in Higher Education*, 1992, New York/London, Routledge;

K. Trigwell and M. Prosser, 'Improving the quality of students learning: The influence of learning context and student approaches to learning on learning outcomes.' *Higher Education*, 22, (1991). 251-266.

L. Sparrow, H. Sparrow, and P. Swan, 'Student Centred Learning: Is it Possible?' In A. Herrmann and M. M. Kulski (eds.), *Flexible Futures in Tertiary Teaching* (2000). *Proceedings of the 9th Annual Teaching Learning Forum*, 2-4 February 2000. Perth: Curtin University of Technology: <http://cleo.murdoch.edu.au/confs/tlf/tlf2000/sparrow.html>

not so much as the ‘teaching’ of students as the process of *helping students to learn*. This particular study concerns how university students of science, technology and medicine (STM) can be helped to learn the history and philosophy of their respective subject from practitioners in the history and philosophy of science, technology and medicine. But I will not be focussing on those students (sometimes the majority) who have no trouble learning to think in historical and philosophical ways about their subject. They are not the ones who require most help from us. More importantly, I look at those students who—despite the best efforts of their teachers—find the historical or philosophical sensibility to be difficult, repellent, uninteresting, irrelevant, pointless or simply weird. In the worst case scenario such students learn *nothing* substantial or valuable from classes in the history and philosophy of their subject, and become bored, alienated or hostile to the whole enterprise.

Accordingly, I aim in this paper to help fellow teachers avoid such unfortunate outcomes by sharing some perspectives on how to handle or even pre-empt the less positive responses of our students. It is based on empirical research on student learners of HPSTM at my own institution but it is also informed by insights kindly shared with me by colleagues both at Leeds and at other UK institutions of higher education. From those I have certainly learned that it is by no means only students on programmes of science, engineering and medicine that find something unfamiliar or peculiar in the pedagogical values and study methods of HPSTM.³ But my concern in this instance is *specifically* with students of STM, especially those who have no prior training in the humanities and thus find something baffling about the way HPSTM is taught. For example, it is disorienting for many that course textbooks do not supply authoritatively ‘correct’ answers but are rather the targets for critical discussion and interpretation. It can, moreover, be alarming for some that ‘independent’ thinking is required of them in order to get the highest marks—a distinctly alien and unsettling notion. Elsewhere I have suggested some generalizations about how such difficulties might be applied across the spectrum of STM undergraduates⁴.

By contrast, in this paper, I aim to explore the constituency-specific nature of the pedagogical challenges involved. I do this by

³ Graeme Gooday ‘Report on LTSN HSTM Workshop, Leeds, 30-31 May 2001’:
http://www.prs-ltsn.leeds.ac.uk/hist_science/articles/hstmrep.html, 2001

⁴ Graeme Gooday, ‘The Challenges Of Teaching History and Philosophy Of Science, Technology and Medicine To ‘Science’ Students’, 2000:
http://www.prs-ltsn.leeds.ac.uk/hist_science/discussions/problems.html

reflecting upon experiences of my own and of colleagues of ‘service’ teaching HPSTM to groups enrolled on specialised undergraduate programmes in science, medicine and technology. The particular constituencies I consider are the vocationally oriented groups at the University of Leeds: first year psychology students (history of psychology and history of technology); second year students of information technology (computer ethics) and fourth year medical students (medical ethics). Although my analysis is thus highly limited in scope, I aim to draw out broader generalizations about how particular kinds of student constituencies can be helped to learn HPSTM—generalizations that other teachers of HPSTM might in future apply, extend, refine or challenge.

My overall contention is that university teachers encountering a particular kind of student constituency in service teaching should not merely know the relevant area of HPSTM. They should also seek—especially at the start of teaching—to develop knowledge of their students and how they learn. The following two points seem most pertinent to know about:

i) *What* these students actually know about the relevant area of HPSTM (if anything) before the class begins. With that knowledge the teacher can help them build upon what they already know.

To try to do otherwise, e.g. by making incorrect or unhelpful assumptions about what students already know, can make it very difficult for them to follow where the teacher wishes to take them. I have written elsewhere on this as the Canute fallacy.⁵ What I have learned from colleagues is that this problem can be avoided simply by *asking* students what they already know by means of questionnaires or oral brainstorming in the first class. It can be pleasantly surprising to find out how much students know and understand about some aspects of our subject—and not a little shocking to find out how little they know or understand of other aspects with which we might have expected some familiarity.⁶

⁵ Graeme Gooday: ‘Expunging King Canute, or, the virtues of starting by finding out what your students can actually do and what they do actually know’, 2000: <http://www.prs-ltsn.ac.uk/contentions/current/gooday1.html>

⁶ John Pickstone, ‘Past and present knowledges in the history of science,’ *History of Science*, 33 (1995), pp. 203-24 discusses the potential value of bringing ‘anachronistic’ understandings of present day science to bear in learning about the science of the past.

ii) What *practices, strategies* and *expectations* of learning their students have acquired in previous or concurrent areas of study. In this context, by practices I mean the learner's habituated actions, by strategies I mean the procedural decisions for problem-solving and by expectations I mean the outcomes that students anticipate from the learning process. By knowing about these aspects of their students' initial orientation to the learning process, teachers can help them (if necessary) reconfigure those practices, strategies and expectations so that they can be more effectively geared to learning the topic of HPSTM in hand.⁷

This is very important since students of STM can bring with them learning practices from their specialist fields of study that can inhibit their effective learning of HPSTM. Too often students and teachers only begin to realise the mismatch between their respective perspectives at the end of a course—when it is too late to do much about it.

It is to the latter topic that I shall devote most effort in this paper since it is perhaps most amenable to generalization from one cohort of students to another and between different institutions. First, however, let me explain a little more about my focus on student 'learning'.

2. Re-centring the student: a neo-Copernican revolution in pedagogy

For those familiar with recent educational theory—especially school teachers—it would be somewhat truistic to claim that the most important point in evaluating the educational process is not what teachers try to teach, but what learners actually succeed in learning.⁸ After all, who could disagree that the success of any educational scheme is primarily to be judged by the accomplishments of students rather than of their teachers? A teacher might well be justified in taking personal pride in a brilliantly constructed and elegantly delivered lesson, or in the clever and insightful remarks, s/he makes in discussion. But if students do not share their teacher's connoisseurship in these matters by not appreciating the sophistication of their teacher's lesson, those qualities alone cannot be guaranteed to make for successful pedagogy. From this

⁷ I agree with Helen Valier that this analytical framework would probably not be (immediately) comprehensible to the students themselves as actors' categories. Teachers obviously need to address such questions to students with strategically framed questions that elicit the relevant responses from students.

⁸ Michael Matthews, *Science Teaching: the Role of History and Philosophy of Science*, London, Routledge, 1994 c

point follows my next: who could argue against the claim that what is 'taught'—however interestingly or intelligently—is not always 'learned' by the recipient? What matters most to teachers might be entirely opaque or incomprehensible to the majority of students and pass completely over their heads. What teacher has not at some point been disappointed by the way that some of their most subtle and eloquent efforts at teaching have sometimes appeared to have had no impact whatever on the quality of their students' subsequent writing in essays or examination papers?

For those who teach at universities, placing such a focus on the primacy of students' learning outcomes is still a relatively unfamiliar practice. It is especially alien for those traditionalists who seem to conceive their role in education as being part of a one-way process that is centred on the greater knowledge of the teacher. One might unfairly caricature one common view of this as the 'decanting' view: that teachers have a duty to (try to) draw upon their vast font of erudition and pour their hard-won learning into the (putatively) empty vessels of their students' minds. Whilst admirable for its emphasis on a sense of scholarly duty, this approach perhaps misses the point that students' minds are not empty vessels—and indeed, it misconstrues the process of student learning to be an entirely passive process of imbibing wisdom poured in from 'above'. A more pernicious variant of this sort of position is what I call the 'broadcasting' view. In this teachers effectively shielded from any personal knowledge of their listeners, loudly enunciate their views while leaving it up to the wit of the omni-competent student audience to 'tune in' to the relevant transmission frequency to be able to receive the teacher's message. In this approach, students who are unable to tune in appropriately can be tempted to transfer to classes run by teachers who broadcast on a more accessible frequency! In both approaches (especially the latter) there tends to be a telling asymmetry in explanations of student success vis-à-vis student failure. While teachers accept the contractual responsibility to supply relevant knowledge and to take the credit for students who perform well, students who under-perform tend to be blamed unreasonably for being solely responsible for such failures, usually by teachers attributing such deficiencies as obtuseness, laziness, inattentiveness or wilful neglect of studies.

A more productive view of the educational process is to treat students as active participants in the learning process—indeed as the participants in the educational process to whom most attention should be given. Close attention should be given to the students, especially as

people who by the time they graduate should have acquired through the learning process some degree of autonomy, independent judgement and self-confidence. For the traditional teachers discussed above the adoption of a student-centred approach would probably entail a discomfortingly radical shift of perspective. Indeed moving students to the centre of the pedagogical universe is in some ways akin to a form of Copernican revolution. We have to abandon the long-entrenched view of students passively orbiting around a resolutely fixed scholarly earth! And taken to its full conclusion, this approach is indeed just as shocking as the loss of an earth-centred universe was for Ptolemaic astronomers. It is, after all, the teachers who are not so much the grounding of the entire universe, but the ones with the greatest mobility to move through exalted orbits in response to the demands of our students.

From the point of view of the broadcasting model, this move is just as shocking as ‘audience reception’ theory was to early broadcasters who considered themselves to have great power over passive audiences. Media theorists have since realised that audiences construct ‘understandings’ of broadcasts in ways that depend on their existing listening/viewing practices and the prior understanding(s) that they bring to bear on them.⁹ If audiences often take away from a programme something other than the broadcaster’s intended message, this is not evidence of the *incompetence* of listeners or viewers. Rather this should be seen as a natural consequence of the complex way that audiences respond to broadcasts. Broadcasts are, after all, only one of the many resources that audiences use to develop their understanding of the world, and they can only make sense of these broadcasts by drawing upon the assumptions, interpretive apparatus and analytical practices that they already possess. Following the analogy through we can see that students construct ‘understandings’ of our teaching in ways that depend on their pre-existing interests, patterns of thinking and prior knowledge of the subject. It should thus be entirely unsurprising if some or all students take away from a lecture something other than their teachers intended—either less than the full message or a different message altogether. We should in fact see this as a natural consequence of the complex way that students respond to our teaching, this being, after all, only one of the many resources that students can draw upon in making an active contribution to the learning process.

⁹ Denis McQuail, *Mass Communication Theory*, 4th ed, London, Sage, 2000.

And understanding the student contribution to the process of learning HPSTM is what I consider next.

3. Understanding students' practices, strategies and expectations in learning HPSTM

Historians of science interested in the 'reception' of theories and philosophers interested in the nature of model-building are surely well qualified to understand the complexity of the learning process. When learners enter into an unfamiliar field of knowledge, their entry is never *just* a simple unidirectional process of picking up knowledge. In STM as much as in HPSTM, novices need to secure the appropriate practices, strategies and expectations to be able to articulate and use such knowledge in accordance with the values of their specialist field. Effective pedagogy in HPSTM thus requires teachers to focus on how best to help 'newcomer' students actively secure these prerequisites of learning. With this aim in mind, I contend it is best to consider our students as coming to us already equipped with a set of learning practices, strategies and expectations that are contingent on their prior experiences of life and learning. It is not reasonable to expect that students will drop all their previous learning habits at the very moment they enter our classrooms, and somehow immediately pick-up by some mysterious power of telepathy what entirely new approaches to learning they might need in taking up the study of HPSTM. And unsurprisingly students do indeed start off learning HPSTM with the practices, strategies and expectations from previous learning experiences—how could it be otherwise? This claim can be seen as an extension of what Wittgensteinians might call the *practice-laden* character of student learning¹⁰—supplemented by theses concerning the strategy-laden and expectation-laden character of learning (see below). From the point of view of the HPSTM teacher, it is thus important to find out which (if any) of these pre-existing practices of student learners will positively help them to learn our subject, which might have a positively antithetical effect on the learning of HPSTM. My thesis is that it is the teacher's job to help our students build on the positive features of their learning practices and overcome the negative features.

¹⁰ I am grateful to Andrew Warwick for introducing me to the concept of practice-ladeness. See A. Warwick, 'Cambridge Mathematics and Cavendish Physics: Cunningham, Campbell and Einstein's Relativity, 1905-11, pt II,' *Studies in History and Philosophy of Science*, 24 (1993), pp.1-25.

For the sake of brevity I will focus on the *negative* features in this paper simply because these are,

i) perhaps the easiest from which to draw out generalizations, and;

ii) of most pressing concern to the HPSTM teacher.

In this sense, I aim to help H.E. teachers to understand the particular kinds of counterproductive ‘baggage’ that students can bring with them, and for them in turn to help their students gently jettison this baggage in becoming more effective learners of HPSTM. An important point here is that HPSTM teachers have not always fully appreciated the significance of the practice-ladenness of learning when dealing with students from science-related disciplines. Techniques for effectively learning HPSTM can differ greatly from effective techniques for learning STM, and differ in ways and to an extent that both teachers and students have not hitherto fully apprehended. Having myself once been a science undergraduate facing the prospect of learning HPSTM, basically I see the problem as a clash of cultures. Some of the deeply acculturated assumptions and learning strategies, which science students acquire as effective means of progressing in the sciences, can be—and usually are—highly counter-productive when applied to the humanities. I think it is not unusual for science students to see the scholarly values of HPSTM teaching as bafflingly vague, gratuitously subjective and self-indulgent, whilst the pedagogical practices employed seem to lack a proper emphasis on ‘getting the right answer.’¹¹ Whilst I am open to correction about the details of this phenomenon, I am convinced that teachers of HPSTM cannot do their job to the best of their ability without having at least some sense of the ‘inertial’ nature of their students’ approach to learning their subject.

Before proceeding to case studies I should emphasise I am not proposing that teachers find out by biographical or psychological interrogation all the relevant features of each student’s previous lives: only that they be aware of the fact that students will come with some sort of baggage. Put another way, the particular way that a student learns from us (or perhaps doesn’t) might be idiosyncratic to his/her previous schooling, collectively specific to a particular learning group, dependent on a generational cohort or linked to a disciplinary dependence on the ‘parent subject’. But the means by which a teacher can deal with this need not depend on knowing the precise aetiology of these matters. All

¹¹ See Gooday ‘The Challenges Of Teaching History and Philosophy Of Science, Technology and Medicine...’ and Pickstone, *op.cit.*

that is required is an ability to listen to students and gauge their reactions to us with a view to overcoming any barriers that they find in trying to learn from us.

4. Case study 1: psychology,

Among psychology students in the United Kingdom, the history and philosophy of psychology was recently voted their least favourite subject! It seems that many psychology students commonly adopt the exclusivist assumption that every part of their education should be directed primarily to making them better psychologists, and the most extreme consider that their education should consist exclusively of psychology courses. This perhaps reflects the way that for many psychology students, they are taking a vocational degree programme and can only hope to succeed in the employment market if they are as well-equipped in the technicalities of psychology as their peer-group trained at other institutions.

Those with less extreme views consider they should only take courses in HPSTM if it can help them achieve higher marks in their psychology courses, and can deeply resent spending any time on study that is not thus directed. A colleague (Janet Cunniff) who teaches the history of psychology to psychology students has found an effective way of challenging this assumption when they explicitly bring it to her classes. She tells them that learning about psychology as a discipline is very much like learning about a fellow human being: in order to understand the way they are now you have to ask intelligent and sensitive questions about their past and thus learn about where they came from. Similarly, she tells them that in order to understand psychology as it is now, it is necessary to understand its past and thus come to 'know' it in a comfortable biographical sense as one knows a good friend. This reflexive strategy of using psychology on psychology students seems by all accounts to have been very effective and has won many of them over to the merits of studying the history of their subject

From discussing this approach with her, I personally learned a great deal about how to appeal to those students of psychology who challenge an institutional obligation to learn any subject other than psychology. This was important in teaching a course in the history of technology in which psychology students were the single largest constituency. The strategy I adopted when faced with the disaffected *ennui* of 'why do we have to learn this?' was to treat the history of technology as a set of historical case studies in the social psychology of

human responses to technology. It is indeed remarkably easy—and not at all contrived—to treat the history of television, radio, computers, nuclear power, biotechnology and domestic technology as a set of questions of why people responded as they did to the technological choices with which they were faced. Translated thus into their framework of values, and playing along with their expectations of how learning should benefit their vocational pursuits, these students become surprisingly amenable to some of the more radical perspectives of gender analysis. Students sceptical of the relevance of feminist treatments of technology—whether male or female—can soon be encouraged to take it very seriously when encouraged to reflect on the differential responsibilities and prerogatives concerning technology among men and women in their own families, especially those of successive generations. This directed study enabled them to develop a keener appreciation of the historically changing nature of their subject, and of the conditioned nature of their assumptions about technological usage. By getting them to think about the *changing* social psychology of technology in gendered terms, one can encourage students to think both historically and in a critical philosophical vein about the relationship between their degree specialism and the everyday world around them.

That being said, some empirical surveys undertaken on these students by questionnaires revealed that such strategies did not work across the board. A significant number of these students were nevertheless resistant to the idea that they should take their critical thinking with them into their essays and examinations. When faced with the pragmatic decision of what to say about their insights into either the history of psychology or history of technology, such students tended to expect their tutors to tell them the ‘correct’ answers to the questions they had to consider. This may in part be attributable to the way in which such students are very firmly inculcated into the view that psychology is a science and thus that it produces clear-cut answers of a distinctive certitude. According to the principle of practice-ladenness outlined above, these students thus tacitly or explicitly assume that all learning associated with psychology is of a similarly ‘cut and dried’ in its conclusions—even if it is of a historical and philosophical nature. When faced with this problem, teachers have to work hard to persuade students to renegotiate their assumptions about what the outcome of learning should be. One major strategy in this is to persuade students that their teachers do not secretly maintain a set of ‘right’ answers which have to be guessed at, but that there are still many genuinely ‘open’

questions on which it is reasonable to expect individuals to develop individual view points. In addition it is vital to build up the self-confidence of such students about their developing expertise in HPSTM so that they do not feel hamstrung by anxieties that inhibit their individual input to historical and philosophical questions

5. Case study 2: Medicine:

While medical students often have concerns for professional training even more narrowly focused than their counterparts in psychology, their longer period of training perhaps lessens the urgency of avoiding humanistic digression. The challenge for HPSTM teachers is more that medical students are often uncomfortable with open-ended debate about questions of life, health and death. Most of them anticipate facing a future professional responsibility for dealing with morally fraught situations in which their actions might cause death or permanent harm. It can thus be very unsettling for them to be told by teachers of medical ethics (and history of medicine) that the answers to some such questions are not necessarily clear-cut and require the exercise of mature reflective judgement. Learning through study of real-life medical case studies, however, helps them to learn how to deal with these matters in a rehearsal of real-life practice in debate with their peer-group. Particularly valuable in medical ethics is the use of the Socratic method to show students that as adults experienced in moral debates they come to the study of ethics with some well-formed abilities to adjudicate the 'right' action in particular cases. Moreover, when faced with classic examples of 'bad' practice in clinicians' handling of patients, they are able to identify rapidly the nature of the inappropriate behaviour and come to some conclusions about appropriate alternatives. From this the students can develop confidence in their own judgement and an ability to deal with fellow students when disagreements arise over professionally sensitive matters.

While medical students can readily be persuaded of the value of training in medical ethics, they are not unusually a little more sceptical about the rationale for studying history of medicine.

Some common responses from them have included the following in various degrees of counter-productiveness and sophistication:

- i) Why should we learn about medicine's past? What we want to know is how to cure people better today!

- ii) All very interesting but how does this history stuff help me become a better doctor?
- iii) Isn't it useful to know how history shows how we've (eventually) arrived at the right cures/therapies today?
- iv) History of medicine is disturbing because it shows how often people in the past thought they had it right and hadn't—and the same might be true today.
- v) Is this history of medicine stuff meant to show us (wrongly?) those medical judgements and therapies only work relative to context?

Colleagues who run classes in the history of medicine to medical students not uncommonly find themselves initially faced with incomprehension, suspicion or unhelpful assumptions among their charges. Using historical case studies of important medical techniques, it becomes possible quite quickly, however, to see the many benefits of historical training. One such (by Helen Valier) focuses on how the introduction of insulin treatments in the 1920s served to transform diabetes from an acute terminal illness to a chronic disease with long term implications for the administration and financing of relevant kinds of healthcare. It also holds enormous implications for the doctor-patient relationship when the diagnosis of diabetes requires over a dozen independent biochemical tests rather than the doctor's qualitative diagnosis from similar past cases. Such cases impress students with the way that current medical practice has arrived at particular notions of 'best practice' in treating patients which are neither unequivocally the most beneficial to individual sufferers nor obviously the most universally progressive for society at large. Historical studies of changing treatments can thus helpfully raise medical students' awareness to the recurrent problems intrinsic to so-called 'progress' in medicine and (perhaps) to the possibility that alternatives to current procedures might be possible (albeit still problem-laden).¹²

Another valuable case study (by Adrian Wilson¹³) concerns the introduction of the obstetric forceps in the eighteenth century by a new breed of surgeons turned 'man-midwives. This can raise awareness of the issues posed of introducing instruments to clinical situations. Important topics here include: what is the rationale for introducing potentially injurious technology to replace the more sensitive—if less powerful—

¹² Roberta Bivins and Helen Valier, 'Organization, ethnicity and the British National Health Service' forthcoming in J. Stanton (ed.) *Innovations in Health and Medicine*, London, Routledge, 2002 (forthcoming).

¹³ Adrian Wilson, *The Making of Manmidwifery*, London, UCL Press, 1995.

clinical hand? Another point raised by this case-study is the central role of ‘tacit’ manual skill in medical practice—a point on which medical students are given little time to reflect upon in their mainstream teaching. This is especially valuable to contemplate in relation to the rapid changes in technology (why do they need to change?) and the need for medical practitioners to adapt to new technologies by developing new skills—lest they injure their patients through technical mishap (c.f. examples from early key-hole surgery in the 1990s). Then again, what also emerged from this case study is the question about who should make a technological intervention in medical practice and at what stage in the process? Important points are raised thereby for medical students about the need to ask *whether* a technological fix is actually required in a particular clinical context, and if so *which* technologies would best satisfy the concerns of both patient and doctor.

By means of such case-studies, medical students can come to see that, although history of medicine does not always yield stories and messages that bring great comfort to the 21st century practitioner, it is possible to show them how thinking historically can broaden their horizons in ways that can be of great value to their future professional practice.

6. Case study 3: Computing:

Computing students, by contrast, tend to feel a great deal more remote from the human context of their work, and initially doubt that the history and ethics of computing can be of anything more than anecdotal interest. In terms of the history of their subject, they rightly observe that the technology of computing changes so fast that it is very hard to see how anything that hasn’t happened in the last 10 years or so could possibly be relevant to them. As far as computer ethics is concerned, most of the students expect to work in large teams, so cannot easily see why they should be expected to take personal responsibility, especially if they expect to be told by laws and managers what to do. There are of course exceptions to these sweeping generalizations, especially among students who are more mature, or those who have worked in the computing industry and know the kinds of changing human contexts in which their work will later be deployed.

One strategy I have adopted, one originally developed in the context of teaching engineering ethics to engineering students, was to encourage computing students to see themselves as future *professionals* on a par (perhaps) with doctors, lawyers, architects etc. That way their view

of themselves and their likely future status can be given enough of a boost that the students can be flattered into imagining an important active role in either changing the technology of computing or having a major role in protecting human welfare in their work. Certainly such students do start to take a little more interest when given case study materials that illustrate the kinds of power and responsibility they will have in their future professional work. But they are still often reluctant to learn the ethics of the subject by engaging in a critical analysis of their own views on the ethics of hacking, privacy and software copying. These students find it strange enough to be expected to make critical judgements of standards in textbooks on computer ethics. It is even more bizarre for them to be expected to have *their own* well-reasoned views about these subjects—let alone to be self-critical about them! Hardly anything in their previous experience in computing has prepared them for this.

Even so, by getting them to debate these topics among small groups with guided questions on carefully chosen *flawed* discussions of the topic in hand (e.g. on computer ‘cracking’, privacy or software copying), their appreciation of the critical mode of discussion is soon enhanced. This is especially so, when critical discussion is harnessed to peer-assessed class presentations that require them to reply to questions and critical comments from their audience. This also gives them an opportunity to develop an awareness of the possible internal inconsistencies of their own positions, especially on the admitted widespread practice of unauthorised software copying. A very useful approach to this subject is role-play: to imagine that they have written some important new software, and from that point of view to interrogate the arguments put forward by those who favour the free copying of software. Very quickly students find it difficult to sustain the claim that there is no particular moral problem in allowing anyone to copy whatever software they feel like copying. From that philosophical challenge they can start to develop the self-aware and self-critical perspective that will help bring them into the world of professional computing and perhaps even make them more valuable employees.

7. Conclusion

By learning about how our students learn, we as teachers of HPSTM experience the learning process in a way that enables us to understand more readily the perspective of our students as learners. From my experience and that of colleagues, it is clear to me that this is an effective

approach and perhaps the best way of helping our students learn the relevant field of HPSTM. Of course, I do not claim that all the challenges and solutions discussed above apply to all such students in all institutions at all levels. Nevertheless, I hope that my characterization of some such problems with some students resonates usefully with the experiences of at least some other university teachers of HPSTM and helps them to reflect on how their own students learn.