Why Compulsory Science Education Should *Not* Include Philosophy of Science[1]

Abstract. Like many readers of this journal, I have long been an advocate of having science students introduced to philosophy of science. In particular, influenced by the Philosophy for Children movement founded by Matthew Lipman, I have advocated such an introduction as early as possible and have championed early secondary school as an appropriate place. Further, mainstream science curricula in a number of countries have, for some time now, supported such introductions (albeit of a more limited sort) under the banner of introducing students to the "Nature of Science". In this paper, I explore a case against such introductions, partly in role as "Devil's Advocate" and partly exploring genuine qualms that have come to disturb me. Generally speaking, my judgement is that no justification is available in terms of benefit to the individual or to society of sufficient weight to outweigh the loss of freedom of choice involved in such forced learning. One possible exception is a minimalist and intellectually passive "Nature of Science" introduction to some uncontroversial philosophical views about science.
Key words: compulsory curricula, student freedom, autonomy, paternalism, group benefit versus individual benefit, school philosophy of science, philosophy for children, nature of science.

1. Introduction

Like many readers of this journal, I have long been an advocate (see my 1990a, 1994, 2002 & 2004) of having science students introduced to philosophy of science. In particular, influenced by the Philosophy for Children movement founded by Matthew Lipman[2], I have advocated such introduction as early as possible and have championed early secondary school as an appropriate place. Also, recent times have seen widespread enthusiasm[3] for philosophy of science (along with other meta-scientific disciplines) contributing to secondary school science education. (Mind you, what is commonly supported and what I had considered worthwhile differ considerably in the intellectual style of student engagement with philosophy of science.) Michael Matthews (1989b) notes the then (and chronic?) "crisis" in science education and observes that the enrichment of it by the weaving into curricula of history and philosophy of science would contribute to its resolution. Perhaps; but at what cost - and with sufficient benefit to outweigh that cost? In this paper, I explore a case against such enthusiasm, partly in role as "Devil's Advocate" and partly exploring genuine qualms that have come to disturb me.

Saying that school science students should be introduced to philosophy of science is too vague for present purposes. My first clarification is to say that what I'll be discussing is having such an introduction to philosophy of science as part of the *compulsory* core science curriculum that *every* student undertakes - (perhaps as an integral part of science curricula, perhaps taught discretely in its own right). However, that is still not clear enough for my purposes. What do I mean by saying: 'introduced to philosophy of science'? There are a number of possibilities.

a) The cognitively lowest grade possibility is that of simply apprising students of various *fairly well agreed upon philosophical views about science*.[4] (One might intend this, for instance, as part of a "Nature of Science" unit.)

b) Next cognitive level up in complexity would involve (also) apprising students of some *controversial issues* within philosophy of science and of some competing views concerning them.

c) More complex again would be to acquaint students with some of the key *arguments* advanced by philosophers in engaging in various controversies.

d) Yet more demanding would be to foster students' *own active philosophical engagement* in responding to those competing views and their associated argumentation. This would involve introducing them to some of the techniques of philosophising and fostering their own skills.

Finally, as what count as proper techniques for philosophising is itself, in part, controversial[5], one could have *meta*-philosophical counterpart theories to the meta-scientific a) to d), above. Label these counterparts: e) to h). No combination of the above contains any mutually exclusive elements.

Before proceeding, I would like to clarify a number of matters.

The first is to observe that I take each element in the range a) to h) to be *possible*. By this I mean that I take each of them to be activities that most early secondary school students could, to some extent, carry out. I may be wrong in this and it may be that only introductions to philosophy of science at the more passive end of the spectrum are "developmentally appropriate". When I say that I take each of these types of introduction to philosophy of science to be possible for most early secondary school students, I allow that the extent and complexity of any given type of introduction will plausibly be less than for the same students at a later stage of their intellectual journey. My point is simply that there are good grounds for thinking that none of these types is to be ruled out as too intellectually complex to be even worth considering. Concerning this I will simply refer the reader to the Philosophy for Children literature.[6]

The point of this paper is, however, *not* to discuss the factual matter of whether philosophy of science in various senses is possible for the students in question - I will assume that, to some extent, it is; rather, my focus is the question: 'even it if is possible for such students to be introduced to philosophy of science (in one or other of the above senses), *should* they be?'.

Second, I would like to expand a little more upon a key distinction among the types in the above list. In introducing d), I spoke of students' *active* philosophising about science (and in its counterpart h), it would be active *meta*-philosophising). In contrast, one can see a) to c) and e) to g) as more intellectually *passive*. What do I have in mind here by use of the terms 'passive' and 'active'?

One level of engagement with a discipline is to simply become acquainted with some of the ideas contained within it. Of course, even this will generally require some thought but the point of such thought is simply to come to know those ideas. In philosophy, as with most other disciplines, most ideas of one sort or another that are generated, are generated with a view to answering some questions that the discipline inquires into. Some of the ideas are widely accepted, some are controversial. Most philosophers do not just become acquainted with the extant literature concerning those questions they are interested in pursuing, they pursue the questions themselves and add to the literature. The distinction that I wish to draw between passive and active introductory philosophy of science is something like that. The academic philosopher is not just *passively* apprised of current ideas within a field, she is *actively* generating ideas in pursuit of answers to those philosophical questions that vex her.

Of course, I speak of an academic philosopher here; surely, it might be objected, in raising the question of secondary school students having an introduction to philosophy of science, it is not worth even contemplating the option of having them actively philosophise in the sense of generating publishable original philosophical ideas. Quite so (barring child prodigies). But I'm using the above model of an academic philosopher to distinguish two *kinds* of engagement with the discipline of philosophy. Within each of those kinds one can have differences of

degree. Consider what I have called 'passive' philosophy - merely becoming apprised of extant ideas that one has not thought up for oneself. Although I say 'merely' here, some such ideas are simpler than others and some, indeed, are so fearsomely complex and abstract that it is no mean achievement to clearly grasp them. Some areas of philosophy of science (ontological issues within the philosophy of quantum mechanics perhaps?) will be too difficult to even passively apprise early secondary school students of with any great hopes of success. Similarly, one can actively philosophise in the sense of thinking up ideas that have not been given to one even if those ideas are not publishable and even if those ideas are not indeed original at all in the sense that no one has ever thought them up before. An illustration might assist here. I had a discussion around a decade ago with some eight and nine-year-olds in a primary/elementary school class that I was demonstrating Philosophy for Children with during a workshop for the school's teachers. In mainstream philosophical terms, the topic was that of personal identity: what is it that makes me, me and what changes, were they to occur, would mean that *I* no longer existed? The group swiftly decided that most of the body was irrelevant and that if I became disembodied and became a "brain in a vat" then it would still be me. We them played around with the idea of having all of the actual stuff in the brain, all of the cells, change over time. Their view was that it would still be me even though not one bit of my current brain was the same as it had been in past "time slices" of me. So, what was it that continued through such change and constituted me? In effect, their answer was that it was the software, not the hardware. Their view was that although my thoughts, feelings and so forth were states of the brain ("patterns" in the brain as one pupil put it) and thus required brain stuff to be states of, the stuff could change so long as the "patterns" stayed the same. This raised an interesting possibility: say one could scan someones patterns and impose them upon some sort of computer, now say that the person has her brain destroyed, would she live on as the computer? They thought that she would in virtue of the pattern "living on", even though the *stuff* was different. At the close of the lesson I left them with a question: 'what if we had transferred her pattern into *two* computers, not one - which computer, if any, would she be?'. None of the above discussion is original in the sense that it has not occurred already in the relevant literature. However I take the members of that class (some more than others of course) to have been engaging in what I have called 'active philosophising' - they came up with ideas as opposed to having ideas imparted to them - I consider it to have been a nicely rich exercise in philosophising for people of that age. In the past, I have advocated that students be introduced to philosophy of science in *all* of these senses, or aspects, as soon as they have reached the level of cognitive development usual in secondary schools. I now have misgivings about any of this being worth the effort - not because impossible, as noted above, I take each to be possible to some extent, but because not sufficiently desirable to outweigh its cost. The only possible exceptions are some elements of a) and, less plausibly, perhaps of be).

In what follows, it will emerge that some topics within philosophy of science seem more deserving of forming part of the compulsory science curriculum than others. To illustrate the spread of issues that I once had in mind (see my 1994) as appropriate for science students to wrestle with, consider the following:

We often talk of "the scientific explanation of….." but the philosopher will want to know just what it is for something to be a *scientific* as opposed to some other sort of explanation, what, that is, the features distinctive of something constituting a *scientific* explanation are. Or, are there none and scientific expectations and, say, religious explanations, are "chalk and chalk" and not "chalk and cheese"? Is there, indeed, one notion of scientific explanation at all? Is explanation by appeal to, say, the law of gravity to be grouped with explanation by appeal to some relevant statistical regularity? What of teleological, or goal directed, explanations in biology like that of, say, the phenomenon of phototropism in some plants? And must an explanation be true to be a proper explanation? If so, what's meant by 'true'? And what would be sufficient grounds for saying that we know some theory to provide the true explanation of something? Can any explanation ever be certainly known to be true, or even

known to be probably true or even approximately true? How about known to be false? Does successful (or unsuccessful) prediction have any special status here? What is the logical relationship between evidence and theory anyway? Is observation theory-neutral or does it presuppose theory? If the latter, can an observation be epistemically privileged and constitute evidence against a theory? When, if ever, is it appropriate to abandon belief in a theory? How can we find meaningful, or understand, terms in theories that purport to talk about entities, properties etc that we cannot directly apprehend? What are the limits of observation anyway? Can terms that occur in two quite different, rival, theories mean the same when the theoretical construal of what they refer to is quite different? Indeed, is there a tight, or even any, distinction to be drawn between the definition of terms in theories and what we hold to be factually true of the referents of those terms? Is there a right answer, or absolute truth, concerning the questions science asks, or are hypotheses just true relative to an individual, culture, historical period, or whatever? Should science even bother with the notion of truth when considering a theory or is getting empirical fit goal enough? Is science value-free? Can it be? What is the difference between a fact and a value anyway? Are science and religion complementary or in rivalry? And so on.

Then there is a range of questions within applied ethics concerning the governance and applications of science. For instance, one might ask whether there should be any limits placed on scientific and technological change. If so, what limits are desirable and who should have control in these matters? Who should decide upon the goals of scientific/technological research? - scientists/technologists, private industry, government, or…? Does whether it is pure or applied research under discussion affect the issue? What should the goals of scientific/technological research be? What priorities should there be? What should the professional ethics of the scientists/technologists be? Should the answer vary according to whether or not the employer is government or private industry? What is morally important in the debate among environmentalists and industrial and economic "progressivists", just what's good for humans (now and later) or also what's good for other species? What limits (if any) should there be on experimentation involving sentient creatures? Should some truths never be known and some research never be attempted? Should women and girls be given positive incentives to choose scientific/technological career paths? What are the moral dimensions of such bio-ethical issues as genetic engineering and in-vitro fertilisation? And so on.

Generally speaking, these questions fall into two broad camps: semantic/epistemic issues and ethical ones. As for *meta*-philosophy of science the issues are basically how one should inquire into these matters and what would count as a correct answer to any of those questions.

As will emerge, the two broad topic groupings seem to deserve separate consideration although, ultimately, my answer is to favour neither. I am now pessimistic concerning the worth of introducing students to either of these groups of issues in any of my above senses of 'introducing'? Again, I stress that my pessimism does not concern the possibility of most students being able to address such questions to some extent[7], it concerns the *merit* of them so addressing such questions. I also stress that I make no particular assumptions about the pedagogical format of any such introduction to philosophy of science. It may be that philosophy of science is to be taught as a discrete subject in its own right or it may be that it is to be taught in a manner that integrates it into science lessons. *Nothing* that I say hangs on which of these obtains.

In what follows, I will first outline a bit of theoretical framework upon which I will be drawing and then apply it to the issue at hand.

2. Individual Autonomy and General Grounds for Its Denial

2.1 *Introduction*

Clearly, the issue at hand is a moral one and, as a preface to my below thoughts on it, I should point out that, meta-ethically, I am not a moral realist or objectivist. That is, I do not construe any moral value judgements as even candidates for truth or falsity, unlike: 'phlogiston exists', 'two plus two equals four' or 'Jesus was the son of God'. I construe my moral values as, rather, merely forcefully held action-guiding stances or preferences of mine. In that sense then, the following is not *establishing* any position except relative to those principles. That said about their status, the *content* of my set of moral principles is not so wildly unusual that my values will fail to connect with the moral values of at least a good number of readers. I should also point out that my observations rest upon a number of empirical claims about the sorts of lives most school leavers will lead. It seems to me that these claims are plausible and uncontroversial and I offer them with no empirical research support. Indeed, for most of them, I doubt that any relevant research has been done. It may be that my judgements concerning various matters of fact are more ill-informed than I think and I "flag" this as a possible focus of objection and I will simply proceed with various empirical assumptions as boundary assumptions of the paper. These "cards on the table", let me proceed.

2.2 *The Onus Argument*

Another assumption I will make is that, generally speaking, people are capable of the exercise of free will in some sense[8] necessary for them being held to be moral agents.

As a further background assumption of the paper, I will adopt, without argument, the moral position that people should be able to act and think as they please unless there is an overriding reason to warrant preventing that. I take this to apply to anyone, young or old, as some sort of *prima facie* right. One can legitimately suppress freedom to differing degrees or extent (for instance, restrict the range of options available to a person or allow them to carry out the type of action to some degree but not to a larger degree) and one can suppress it at some times in some circumstances and not others in other circumstances but there has to be *good enough reason*. Further what are readily available as over-riding moral considerations that warrant freedom suppression for some individuals, or groups of individuals, may not be considerations available for other individuals or groups. (Suppressing someone's freedom of action on the grounds that, say, he is insane and dangerous, is obviously not a warrant that transfers to a sane, non-dangerous, agent.) However, regardless of the detail of the applicability or success of particular warrants in particular cases, the general "logical geography" of any such discussion is the *same.*

The structure of the present paper is, then, that of such an *onus argument*. Applied to the case of individual freedom, there is no obligation to show that freedom should not be suppressed; the onus is on the would-be freedom-suppressor to come up with good arguments for such suppression and the "default" moral position favours permission of these freedoms. In what follows, I will be considering some such possible arguments and, in the process, articulating some moral principles upon which they rest. Normative ethics[9] as a domain of philosophy seeks general principles as grounds for the appraisal of moral agents' activities and for the guidance of ones own conduct - including ones intervention in the lives of others. Particular judgements about the propriety of how one intervenes in the lives of others are exercises in applied ethics. The paper is thus such an exercise. Generally speaking, such interventions are *ad hoc* and short-term but sometimes they are *sustained*.

This leads to an observation: compulsory schooling *is* a *sustained* exercise in force in which individual freedom of action and freedom of thought are interfered with. Individuals are incarcerated for years on end and made to act in ways they would not freely choose to and to acquire beliefs and skills they would not freely choose to acquire[10]. Comparable institutions

in such suppression of freedom that come to mind are prisons, psychiatric institutions and, for those countries with military conscription, the armed services.

As with those other institutions, those favouring any sort of *compulsory* schooling should give morally sound reasons to warrant their denial of students' individual freedom. As noted, it is a central part of the strategy of this paper that I do not see myself as having to defend student freedom here. Some have positively advocated it and, indeed, schools of a remarkably freedom granting sort have existed[11]. To repeat, there is an onus here to be discharged by those who choose to do this restricting of student freedom (or who advocate such restrictions). It may be a good thing, it may not. It may be a good thing for some students in some subjects at some level but not for others. Just what the mix of freedom granting and freedom limitation should be is a matter of appealing to ones normative ethical principles and, via some empirical premises, drawing off some judgements on these matters[12]. In effect, this article is trying this out for a fairly comprehensive spread of candidate types of introduction to philosophy of science. The process must appeal to some moral principles as driving premises in my arguments, as possible grounds for such freedom limitation. Of course it is possible that some readers may have moral grounds that appeal to principles different to the ones I consider[13] but I would think that the sorts of principles to which I will be appealing are commonly enough held for the article to connect with a good number of readers. Certainly the sorts of consideration that I raise are ones that are common within philosophy of education discussions concerning compulsory/free schooling (see, for instance, works cited in note 2). It is also possible that if nothing else were available as a warrant for the limitation of student freedom than the sorts of arguments that I consider, and consider to fail, then this might well mean that not just the mooted introductions to philosophy of science would be unjustifiable impositions upon student autonomy but, *mutatis mutandis,* other parts of the existing curriculum would also be unjustifiable, including, perhaps, much science education. One way of looking at this is to say that this is some sort of quasi *reductio ad absurdum* of my position - surely school curricula are, in the main, warranted. Another way of looking at it, however, would be to consider that perhaps there is a larger problem with our education system than we currently allow. Either way, my point remains: the onus is on whoever wishes to limit the freedom of another to make out a morally sound case for doing that. Either that onus can be discharged, or it can't. The argument of the present article is that, at least by appeal to some broad ethical principles and on the assumption of some plausible empirical propositions, that case *can't* generally be made out for most sorts of across-the-board secondary school introductions to philosophy of science. I may be wrong but if I am, then that is a matter of counter argument pointing out the errors in what follows.

So, what might be advanced as grounds for a general forced introduction to philosophy of science in secondary schools?

With other freedom-suppressing institutions, some counterpart reasons appeal to things that seem not to apply to the case of schools. Imprisonment, for instance, might be warranted by some sort of retributivist argument. That, however, does not generally apply to school students; although some may be bad, they are not incarcerated in schools *because* they have been bad. Other arguments, however, do seem relevant to our current concern.

Psychiatric institutions might warrant their patients' loss of freedom by arguing that their patients are, in one sense, not able to exercise such autonomy at all (having ceased to be free agents, if ever they were) or are not able to exercise it *properly*. This might well be an argument that is plausibly transferable in kind, if not in degree, to the context of schooling. As for what is forcibly done to patients so incarcerated, this might, at least in some instances, be warranted by what is for the *individual patient's good* and sometimes by what is for the *good of society*. Each of these seem plausibly transferable to the case of schooling.

Governments might warrant conscripting citizens into the armed services by appealing to the good of the country, or, as I will call it using the common phrase, "the good of the group". Again, this sort of rationale seems plausibly transferable to the case of schools.

So, in summary, the loss of freedom involved in compulsory schooling might be justified by suggesting that students shouldn't exercise autonomy on these matters because, in some sense, or to some degree, they are incapable of doing so. And, in justification of the *detail* of what is then forced on them as their curriculum, it might be argued that such a curriculum is good for the *individual* students, or that it is good for the rest of us (the *group*), or both[14].

There are two elements in such a piece of reasoning. One is meant to warrant depriving the student of decision-making power. The other is meant to establish the worth of the detail of what some other people decide will happen to her. The suggested warrant for doing the first is that the student is incapable of making the decision, or of making it *properly*. In the next subsection, I will spend a little time unpacking this idea of "student incapacity to decide" and outline a little bit more theoretical framework before turning to the particular case of imposed-by-others school philosophy of science and its possible warrant.

2.2.1 Student Incapacity to Decide and Outside Intervention

Decisions as to what should be done involve three elements in the deliberations of the decider[15]. One is a set of values, goals, priorities, purposes and so forth. The second is a set of empirical beliefs about the options available and the consequences of each of those options. The third is some capacity to process the first two elements, to reason, so that a judgement results as conclusion. Ideally, the values etc that feed into the deliberation (in role as premises) would be well thought-through, critically examined and "sound". Also, the information about options and consequences (that again feeds in as premises) would be comprehensive and correct and known to be so. Finally, in the ideal case, the reasoning that leads from these premises to the final conclusion would be ably done such that the judgement that is thereby reached optimally serves the decider's values, given what is known about the options available to the agent and the consequences of those options. Of course, things are rarely ideal. Agents decide matters on the basis of ill-thought-out, and sometimes evil, values, and/or considerable ignorance as to what they could do and what will result from choosing various options, and/or having reasoned incompetently.

Despite all that, generally speaking we let *adult* agents with those faults (to varying degrees) choose what to do; we let people make all sorts of decisions even when, in our view, all three elements contributing to the making of such decisions are to some extent deficient. Of course, *sometimes* we intervene - say with a potential suicide - much seems to depend upon the *severity* of the consequences of a poor decision. Also, other things being equal, we are more inclined to intervene if the agent is likely to do something impinging upon others. Although there are limits, we grant adults the power to do considerable damage to themselves (lousy marriage decision, lousy job decision, lousy house purchase and lousy educational decision) - however incapable they are as deciders. We would not think of, say, subjecting them to a forcible remedial introduction to the philosophy of science! We do, however, tend to intervene more in the interest of *other* people affected by an individual's poor decisions. I mention the case of adults here, not because I wished to focus upon them particularly, but because I find it curious that most of the grounds for not letting students make decisions seem to not be applied to adults; yet the differences, I suggest, are not ones of *kind* but ones of *degree* (and do not always favour adults anyway).

Compared to the way we treat adults, we seem much more intrusive when it comes to school students, even secondary school students. The usual reasons advanced in the philosophy of education literature (see, for instance, works mentioned in note 12) concern age and

experience. But it can't be a matter of age in and of itself or of experience in and of itself. Presumably it is more a matter of what one usually gains as one becomes older and more experienced. Of course one gains all sorts of things so some attention should be focused on those things relevant to the point at hand. These are the three elements mentioned above - for short: knowledge, values and reason. Sometimes students are poor deciders in virtue of deficiencies in one or more of the three elements outlined above but so can adults be; again, the difference seems more one of degree than of kind (and not always in favour of the adult). It seems to me that there is an important "double standard" operating here. Why treat adults one way and school students another even in those cases where their competence as deciders is comparable?[16] The onus is on those who wish to distinguish the cases to come up with a relevant difference between them. This matter deserves more exploration; however carrying out that exploration would be more involved than a short paper allows and I will, having flagged the seeming inconsistency, ignore it and return to my focus upon school students. Nonetheless, it is instructive to keep at the back of ones mind the question: 'would that reason warrant doing that action to an adult?'.

In any event, in one sense, even the youngest of students can make some sort of decision so I assume that whatever grounds we have for worrying about student incapability would be not so much that they were incapable of making some sort of decision, it would be more motivated by worrying that the student would very likely make the *"wrong"* decision. Those grounds would be some combination of challenging the student's knowledge, values or reasoning powers as somehow not up to the task at hand. Even then, we are happy to have students make all sorts of decisions despite qualms about quality of those decisions. So, given that an important freedom is under threat, that the student might make the wrong decision has to be considered to be potentially detrimental *enough* to override that freedom loss. Detrimental to whom? - as already noted, perhaps to the individual agent, perhaps to the group, or both. Presumably any judgements on such matters will be on a case by case basis (although grounds might exist for "bundling" cases together as relevantly similar and that is our scenario in "across-the-board" compulsory philosophy of science). Moreover, if students are not to make the decision because of their incompetence yet the decision is nonetheless to be made, just made by someone else, then presumably the other person making the decision had better be sufficiently more likely to not also be making the "wrong" decision.

So, presumably the idea is that the decision made by the other party will be better for the student (the individual) or better for society (the group) or both than if the decision were to have been made by the individual. In the next subsection, I wished to expand a little bit upon these notions.

2.2.2 Intrinsic and Extrinsic Goods, or Benefits

Before finally turning to the particular curricular issue of school philosophy of science, I would like to outline one further conceptual refinement for later deployment. What is good for someone (or some group) is commonly subdivided into intrinsic and extrinsic goods[17]. My understanding of, say, 'it is *intrinsically* good for Jane to be happy' is that it is good *in and of itself* for her to be so. Here, saying that such happiness is good is not a claim that has to be warranted by appeal to some further end that the happiness is good *for*. In contrast, to say that it is *extrinsically* (or instrumentally) good for Jane to be rich is to signal that being rich is *not* being claimed to be good in and of itself but, "means-to-end" style, instrumentally serves[18] some *further* valued end. So, one might consider it extrinsically good for her to be rich because, say, then she can afford lots of international travel and such travel is extrinsically good because it yields understanding of other cultures and such understanding is (intrinsically) good. (Of course, a state of affairs might be both intrinsically *and* extrinsically good - understanding another culture might be intrinsically good yet also extrinsically good in that it instrumentally serves the cause of challenging ones own cultural

assumptions which instrumentally serves the cause of reconstructing ones culture into its optimal form which, say, is itself intrinsically good).

The usual view would be that such chains of extrinsic goodness tracking (this is good because of its connection to that and that is good because of its further connection to so and so....) on pain of constituting a vicious infinite regress, must end with something considered intrinsically good (and so and so is good because of its connection to such and such which is good *in and of itself*).

So what we have above is individual freedom of action being suggested to be at least intrinsically good (and, arguably, extrinsically as well but I won't pursue that) but with the suggestion that that *prima facie endorsement* is *defeasible* in some scenarios by such freedom clashing with some greater good (directly with a more important intrinsic good or less directly via an extrinsic good "means-to-end" chain). Further, such overriding goods might be for the individual's benefit, or for the group's, or both.

For instance, an objection to an individual exercising freedom of action by stealing goods from someone else's house might be that, although it is intrinsically good for an individual to exercise such freedom of action, that goodness is outweighed via the following argument: if the individual is permitted to exercise such freedom of action then there is a high probability of that individual being apprehended by the police and having to serve a jail sentence as a result and serving such a jail sentence would result in the individual having a less happy overall life than would otherwise be the case. So, although it is intrinsically good for the individual to exercise such freedom, it is extrinsically bad for them to do so because it is extrinsically bad for them to serve a jail sentence because of its connection to lower overall life happiness. (This is assuming that having as happy an overall life as possible is an intrinsically good thing.) Finally, *enough* happiness will be lost to outweigh the importance of the amount of freedom loss involved in preventing the person from carrying out the theft. In this case, the warrant for overriding the individual's freedom has been a *paternalistic* one appealing to that individual's own good (ultimately to the intrinsic importance of him having as happy a life as possible).

However one could also have a warrant that appealed to the good of other individuals or of the group. One might argue that the theft will decrease the happiness of the householder in a fairly direct way and that the loss of happiness of the latter is more intrinsically important than the loss of freedom of the would-be thief were the theft to be prevented. Or one might argue by reference to more indirect consequences like a breakdown of society's institutions, interpersonal trust and so forth which are themselves connected to the happiness of society's members and that such happiness is intrinsically important and the loss involved would outweigh the loss of freedom involved in preventing the would-be thief from thieving.

Of course, the argument warranting the loss of freedom on the part of would-be thief might be some *combination* of the above. Things are also complicated (in this case and in other exercises in applied ethics that appealed to intrinsic or extrinsic goods) because intrinsic values can be present to a greater or lesser extent and causal connections linking extrinsic goods to them can be weak or strong.

I sketch all of this to illustrate the sort of elements that will have to be present in any argument warranting compulsory school philosophy of science given its loss of intrinsically important freedom of action on the part of students. There will have to be other things valued (ultimately intrinsically but, in the initial event, appeal might be made to extrinsically valued states of affairs) either for the individual or for the group or both. Moreover, it will have to be judged that, if left to make the decision, the individual would *not* decide in a way that would sufficiently[19] serve those other values and if some other party made the decision, the decision

would sufficiently serve those other values. In short, matters are rather more complicated than sometimes occurs in discussions concerning curricular proposals such as this one.

3. School Philosophy of Science as a Case in Point

3.1 Introduction

That little bit of framework in place, I now refocus on the case of compulsory philosophy of science within school science as an application of it. Presumably, if we are to sanction such an overriding of student freedom of choice, we have to be saying that the introduction that they would get to philosophy of science is of such importance (in some way) that it indeed would legitimately override that freedom. The worry would be that, if left to choose for themselves, too many would be incapable of exercising autonomy *properly* and would make the wrong decision, would choose *not* to study philosophy of science. Presumably, being introduced to philosophy of science is judged too important in some way for that to be risked. Further, deploying some of the points from above, presumably that importance is to be found in what is, intrinsically or extrinsically, good for the student and/or what is good for some other group of people like, say, the rest of us in society[20]. Let me address each of these possible warrants in turn.

3.2 Benefit to the Individual?

3.2.1 Introduction

It seems to me that the chances of it being plausible to say that students benefit individually from an introduction to philosophy of science depends to some extent upon what *sort* of introduction we have in mind. It also depends upon how we unpack '*benefit* for the individual'. Apart from the intrinsic/extrinsic distinction already outlined, a further complexity concerns the framework of values by reference to which benefit is to be judged.

Conceivably, this framework could be that of the individual in question. It is sometimes the case that people later look back fondly on something they were forced to learn at an earlier time. The earlier "time slice" (Johnny) resented, say, being made to learn piano but the later "time slice" of the same individual (John) loves playing the piano and is glad that his earlier wishes were overridden. In effect, one way of thinking of this is that the earlier restraint upon the agent's autonomy is justified by appeal to the *later endorsement* by the *same* agent of that exercise in force against him as having been *for his benefit*. (In a sense, this is *retrospective* "choice" by the agent. Put another way, one would warrant ones suppression of Johnny's freedom by, in effect, conceiving of oneself as acting as the means by which *John* exercises autonomy as to how he is to be.) Of course, at that earlier time, one could hardly claim to be acting in a way justified by this sort of argument unless one was in a position to confidently *predict* the judgements of the adult that the child will become. But perhaps we can do so reliably enough on occasion. Mind you, if it is an across-the-board compulsory curricular item that is in question, one would have to be in a position to predict that at least the *majority* of ones students would have such a change of mind (but *not* be able to predict *which* ones wouldn't). I know of no longitudinal empirical research studies concerning this but, anecdotally, I find it simply implausible to hold that that the *majority* of students would look back upon philosophy of science, or meta-philosophy of science, in *any* of our earlier senses (a to h) in that way[21]. *Some* would, of course. Indeed, some would enjoy it at the time so it wouldn't even involve a *change* of mind. But we are talking about *compulsory* "across-the-board" study for *all*. In short, I think that we can make a reliable prediction as to what the "Johns" would think: most of them would not thank us for the introduction to philosophy of science they received; it would be viewed as another useless waste of time, like some other

parts of the school curriculum. This "retrospective endorsement" potential warrant is then, in my view, a "non-starter".[22]

Presumably then, the benefit of any of this spread is to be judged by reference to the values framework of "us", the freedom suppressors. As noted, sometimes, even with adults, we sometimes override individual agents' autonomy on *paternalistic* grounds. We do not let them do what *they* think will be good for them but make them do what *we* think will be good for them. (An instance cited earlier is the attitude most societies have to potential suicides.) So, never mind what John thinks about what happened to him back when he was Johnny, never mind what value *he* places upon having whatever vestigial philosophical understanding remains with him after school, it may be that *we* think that it is good for him (and good *enough*, recall, to have forced it upon him[23]). Paternalistic warrants of compulsory curricula are a commonplace in philosophy of education (see, for instance, works cited in note 12); the issue is whether any such is plausible for *this* particular curricular proposal.

So, the upshot of all of this is that the question at hand is: 'can an argument justifying compulsion be mounted in this second, paternalistic, sense of 'individual benefit' for any of our spread of types of introduction?'.

3.2.2 Meta-philosophy of Science?

I don't see a positive response to this question to be plausible with the *meta*-philosophical series e) to h). Again, for *some* people, yes, but for the *majority*? - I don't see it. (And it has to be for the majority, otherwise it would hardly be generally for the *individual's* benefit and we would be sacrificing the many for a few.)

First, consider *extrinsic* benefit. What on earth would be the life circumstances that one would be imagining the *majority* to be in such that it would be extrinsically beneficial *for them* to have whatever meta-philosophical understanding remains after their introduction to it years ago in schooling? Indeed, even if circumstances were more favorable than is the case in the proposed scenario and most students ended up with a *robust* meta-philosophical understanding or capacity to meta-philosophise about science, it is hard to see how any of this sort of thing would be instrumental to their increased happiness, increased success in their life goals or what not.

Perhaps, though, such meta-philosophical understanding is of *intrinsic* benefit to the individual (as judged by some outside party, in this case, me, in the first instance, then you). The most promising candidates look to be the passive meta-philosophical e) to g). Some longstanding literature in philosophy of education (see, for instance, Hirst and peters, 1970 and Peters, 1973) advocates the merits of a so-called liberal education in which students are introduced to an understanding of the major forms of human inquiry. Having such understanding of those forms is judged to be intrinsically worthwhile. One such form includes philosophy and one branch of philosophy is philosophy of science. Understanding such an intellectual activity is a meta-level task. I have enough sympathy with this to value a robust understanding of those forms (including philosophy and its subset philosophy of science) as an intrinsically worthwhile element in an individual's intellectual profile. Moreover, as noted earlier (see note7 in particular), I take such meta-philosophical understanding, or even active meta-philosophising, to be within students' capacity *but*, to the *degree* that it would plausibly occur, I, at least, do not value having individuals with such an intellectual profile to a *sufficient* extent to warrant interfering with their autonomy. In short, I do not fully share that view within philosophy of education that has, as a key aim of schooling, that it educate students in the sense of introducing them to the major forms of human inquiry; the aim is, to too great an extent, futile. (My own view here extends beyond the form, philosophy, but that is a story for another time and place.)

So, it is not as if meta-philosophical understanding of various sorts or the robust capacity to meta-philosophise is without intrinsic benefit, it is just that the capacity to have that understanding of, or to meta-philosophise about, philosophy of science *to the degree* that is plausibly achievable for the average student by compulsory science education[24] is not of sufficient intrinsic benefit to outweigh its cost: the loss of individual freedom entailed in achieving it.

If not meta-philosophy of science, can philosophy of science be warranted as of benefit to the individual? I will consider versions a) to d) in two groupings which align with the active/passive distinction spoken of above.

3.2.3 Active Philosophising about Science?

What of d) then? This was, recall, *active philosophising* of the kind that one might hope to have occur in a philosophy of science unit in an undergraduate philosophy major (although, no doubt, achieved in schools to a different *extent*[25]). I will spend some time on this as it is both the most ambitious of our spread and the type of school philosophy of science that I have been most enthusiastic about in the past (and which those most active in having philosophy have a presence at school level, the so-called Philosophy for Children movement, would also have in mind).

If present to a fairly substantial extent, I can see an *extrinsic* benefit in this (at least as I, in the analytic tradition, construe the business of philosophising) in that I consider such a capacity to reason and carry out sophisticated conceptual analysis to transfer to all sorts of life circumstances - not just, but including, those involving science[26]. Mind you, that might be more a case for a generalised critical thinking or philosophy "course" than for philosophy *of science* in particular. Remember that, in this context, it is not just fostering the capacity to philosophise that is to be warranted; more particularly, it is fostering the capacity to philosophise *about* issues of the sort illustrated earlier. So, is philosophising *about science extrinsically* warranted? Despite my general sympathy with school-level philosophising, I have two hesitations one of which I will turn to immediately and the other of which I will return to later after a small diversion into discussing intrinsic warrants.

One hesitation concerns the *semantic/epistemic* philosophical issues about science in particular. It doesn't seem to me to be plausible to hold that the average person has any great improvement in their life through being able to philosophise about such matters- the issues are simply too remote from most people's lives for such philosophising to impact directly, or indirectly, upon their prospects of, say, happiness or the fulfilment of their life goals. So, my suggestion is that being able to philosophise about such things as, say, the problem of induction is not of *extrinsic* benefit to most individuals. If one considered general philosophical skill to be extrinsically beneficial to the individual, there seem to be more promising candidates elsewhere in the spread of possible philosophical *topics* than these. Those that come to mind include political philosophy, normative, meta- and applied ethics, philosophy of religion (particularly arguments for and against the existence of God), free will and determinism and so forth. Most people who are introduced to philosophy are introduced to it at an undergraduate level and do not proceed beyond first year. The spread of topics considered in most undergraduate first year courses is fairly carefully chosen with a number of considerations in mind. One of these considerations is student interest - choosing issues that students are likely to find interesting and be ones that they have had some quasi-philosophical prior thought about. These are the issues that most often crop up in students' lives and, I would suggest, those that it is of greatest importance that they have fairly well thought-through views upon. In Philosophy 101, philosophy of science, in the sense of our

semantic/epistemic issues, is a rare inclusion[27] and it is easy to see why if one is to be warranting such intellectual activity in terms of individual *extrinsic* benefit.

I have so far, been considering the possibility of such philosophising about semantic/epistemic issues being *beneficial* to the individual in an *extrinsic* way. That is, that having that philosophical suite of skills focused on those topics would result in greater happiness (or fulfilment, or some-such) for *that* individual. Perhaps, though, it is better considered as being of *intrinsic* merit, that, regardless of what good consequences do or do not flow from being able to philosophise to some extent about semantic/epistemic issues to do with science (and having done so in school), it is just a good thing in and of itself. Some might find comfort here but I cannot. I can view happiness as intrinsically a very good thing and freedom of thought and action as intrinsically very good things[28] but I do not rate philosophising about semantic/epistemic issues concerning science as in the same league. As raised earlier, I think that those who would conceive of such capacity being intrinsically beneficial to the individual would be appealing to some sort of liberal education style of "educated person" as being intrinsically a good way for people to be. Never mind what connection it has, or hasn't, to happiness, or fulfilment, or whatever, it is just a good way for a citizen to be - for its own sake. For a citizen to have such capacity is, in some sense, for them to be in a better state than a citizen of a less philosophically enabled sort. I am enough on the side of the Western intellectual tradition to have some sympathy with this. ("Better Socrates dissatisfied than a fool satisfied" or whatever the saying is). And, at one time, this was the major rationale I gave for active school philosophising about science (see my 1994 for some views in support of a liberal education). at that stage, I saw fostering such capacity as warrantable in virtue of being a part of the task of giving students a "liberal education". I now reject this. A major concern is the subject matter involved. I can think of better areas of philosophy than the ones under discussion as candidates for inclusion in the intellectual profile of "the educated person" (think Philosophy 101 again for such philosophical topics) and such other candidates *are* rivals in that they compete for the same curricular time and space. Rather than at the core of my conception of a liberal education, being able to philosophise about semantic/epistemic issues to do with science is peripheral, an optional extra. If the gaining of a liberal education is to outweigh freedom loss, then it will involve more central aspects than this. In any event, as noted earlier, I, at least, have become less committed to the idea of a liberal education and of introduction to the major forms of human inquiry as an intrinsically worthwhile aim of schooling; at least, as a worthwhile aim of *compulsory* schooling. You may not share my views; all I can do is ask you to reflect upon your own values and consider your own prioritisation of freedom and this aspect of a liberal education.

So, for me, at least, any warrant for such *compulsion* in terms of individual benefit would have to be an *extrinsic* one in which philosophising about such issues to do with science *resulted in* greater happiness (or fulfilment, or some such) for the individual. Yet, as noted above, I consider it fairly clear-cut that, for most individuals, carrying out such philosophising about such semantic/epistemic matters (to the extent resultant from having done it at school) is not generally of any *extrinsic* benefit at all *to the individual*.

Earlier, when I said that, even if being able to philosophise was of benefit, being able to philosophise on *semantic/epistemic* issues seemed less defensible than being able to do it on the usual Philosophy 101 issues, I mentioned ethics, including applied ethics. Perhaps, then, a better case can be made for our second basket of issues - *ethical concerns surrounding science*. Certainly, if laying out my core profile of the "educated person", having the capacity to philosophise about moral matters (including ones concerning science) would be high on my list of things that I would judge to be *intrinsically* beneficial, to be an aspect of how I think that it is good *for the individual* for him/her to be. It might not be in the same league as happiness and fulfilment and so on yet still counts as a substantial good in and of itself.

This brings me to the second of the hesitations I foreshadowed above. It is more than a hesitation really; in my view, it is a catastrophic objection even if all of the above worries are somehow allayed. (It applies to both groups of issues within philosophy of science although I will only speak here of the ethical ones and applies not just to the question of intrinsic merit under current discussion but to that of extrinsic merit, as will be returned to below.) The objection is similar to one raised earlier concerning meta-philosophy of science. The objection is that, even if one considered having the capacity to philosophise about ethical issues concerning science to be of intrinsic benefit to the individual, the proposal is open to the concern that such capacity to philosophise about the ethics of science will not generally be achieved to a great enough *extent* to be worth the loss of autonomy involved. In my experience of teaching both sorts of question to undergraduates, the ethical ones seem easier for students to think ably about than the semantic/epistemic ones but I still worry about whether it is worth their time given the *level* of philosophical skill possessed by the average "pass" student at the course's close. In the case of my undergraduates, they were volunteers and were, in any event, of higher average intellectual ability than that of high school students. With school students, the benefit to them thus goes down (as they are less able) and the cost goes up (they would mostly *not* be volunteers but would have to be compelled to do philosophy of science, even ethics of science). My misgivings thus multiply. We are not talking about an elite group here; we are talking about the average student and, moreover, not even the average undergraduate but the average secondary school student. Nor are we talking of them being taught by academic philosophers but by science teachers[29]. We are also talking about a smallish amount of curriculum time[30]. Finally, we are talking about a residual effect some years down the track. I consider it plausible to suggest that whatever philosophical skill was engendered in school by an introduction to philosophy of science, even active philosophy of science, would not, across-the-board, be very robust owing to the first three factors. Moreover, what remained down the track would be even less robust. Is the benefit, for most people, of having rather dubious philosophical competence in thinking about, in this case, ethical issues concerning science, large enough to justify overriding their freedom[31]? I suggest that it isn't. Of course, it is only *some* of their freedom of thought and action that is being transgressed but to do it at all requires justification. One standard ground advanced in the philosophy of education literature for limiting a student's freedom is that one thereby enables student subsequently do things that they would not otherwise have been able to do (in terms introduced in note 10, restricting negative freedom is warranted by the resultant increase in positive freedom). But, in this case, it is hard to be confident in much enablement at all.

All in all, I offer the judgement that, even for the more promising "ethics of science" group of issues, the warrant fails in terms of there being sufficient *intrinsic* benefit for most individuals of an introduction to philosophy of science focusing upon *active* philosophising about science.

As for *extrinsic* benefit, it is true that science impinges upon modern citizens' lives and having some capacity to arrive at well thought-through positions on various ethical issues to do with science might well have some extrinsic benefit for individuals in terms of guiding their *actions* - say, their involvement in a pressure group, or the way they vote. But two objections apply. The first is to question the *extent* to which people's actions would be different as a result of having done their school (active) ethics of science course. How many of those students would be individually benefited in terms of their happiness or whatever in virtue of having differently guided actions? I suspect that no empirical research has been done on this[32] but it seems to me to be very plausible to suggest: not many. And, as a second objection, I revisit the "incompetence" point. We would only be talking of an improvement in individual benefit if the quality of philosophising gained from having done such course work were to be good enough such that the actions informed by such philosophising were better thought-through to some worthwhile extent. As worried about earlier, it is simply not plausible that, *for most students*, we would get very much better future thinking, and thus

actions, simply as a result of an introduction to active philosophising about ethical issues to do with science as part of a science education curriculum - the input is too meagre.

To sum up then: is it really of any great benefit to most students that they are able to philosophise badly on ethical issues concerning science? My answer is: 'no'. (The problem is even worse for our earlier semantic/epistemic issues which are generally harder to philosophise about competently and more remote from students' future life concerns.) So, better Socrates dissatisfied than a fool satisfied? Perhaps. But our scenario is more like a collection of "fools" being satisfied or dissatisfied; after all, there are not a lot of Socratic-level thinkers out there or Socratic-level teachers of them.

3.2.4 More Passive Philosophy of Science?

So much for the benefits, or lack thereof, of *active philosophising* about science, at least for most students and to the extent gained from their science curricular philosophy of science efforts. What about the other variations I outlined? Would some other, less cognitively challenging, form of introduction to philosophy of science fare better? The other three are relatively passive. The only variations among them concern the amount and level of controversiality of the philosophical thinking concerning science that one asks students to know about (even if the goal is not that they do much such thinking themselves). Despite this, it seems to me that b) and c) are still rather demanding for the average secondary school student (and science teacher for that matter) and the residual knowledge that John would possess as a result of Johnny's lessons about philosophy of science would be too vestigial[33] to be of enough (intrinsic or extrinsic) worth *to John* to warrant overturning Johnny's freedom to choose what to learn. This is at its most apparent with the semantic/epistemic issues but applies as well to the ethical ones.

In terms of a (paternalistically judged) individual benefit that applies for most individuals, the one that seems to me to be most plausibly warranted is a). As I introduced it, I conceived of it as possibly part of a "Nature of Science" unit and all that would be transmitted to[34] students would be mainstream, fairly well agreed upon, philosophical views about science. I doubt that one could plausibly argue that, for most people, understanding the nature of science increases their overall happiness, or assists them in achieving their life goals, or anything of that sort.

Some such argumentation seems to be present in the science education literature however. Randy Bell and Norman Lederman (see their 2003, 353) report considerable enthusiasm for seeing science education as having a role in improving citizens' capacity to make decisions concerning the impact of science upon their lives. There are two slants that one can put on this line of thinking. One conceives of this capacity as being for the benefit of the individual and that is my current concern. The other conceives of it as being for the benefit of the group and I will return to that in the next section (of course both benefits might be argued for quite consistently). Conceived of as a benefit for the individual, it would have to be being said that an individual's happiness (or whatever) is sufficiently improved by such things as 'participating in the debates surrounding [science and technologically based] issues' (Driver et al., 1996, 18 - quoted by Bell and Lederman, 2003, 353) and having 'all the resources necessary for judging the truth of [scientific] knowledge [claims] independently of other people'[35] to outweigh the loss of freedom involved. Bell and Lederman summarise the claim as: 'By knowing the characteristics of scientific knowledge and the way it is constructed ... citizens will be better able to recognize pseudoscientific claims, distinguish good science from bad, and apply scientific knowledge to their everyday lives.' (2002, 353). Driver *et al.* called this 'the democratic argument' for such understanding of science (1996, 18 - as quoted by Bell and Lederman, 2003, 353). The challenge is whether that improved ability is cashed out in enough benefit to the individual (increased happiness or whatever) to be worth it. Bell

and Lederman's own article is concerned to suggest that an individual's knowledge of the nature of science is somewhat inefficacious in its influence upon their decisions. Their research was intended to begin to fill a gap in the extant research literature concerning the actual *utilisation* of ones knowledge of the nature of science in reaching decisions on issues concerning science and technology and was small-scale and used scientific experts as opposed to standard school leavers as the Nature of Science "knowers". Although small-scale, it is an interesting exercise in that the expert participants represent a "best case scenario" for the extrinsic worth of the hoped-for increased abilities. The best that seems to be able to be said for claims that the level of knowledge of the nature of science gained from its inclusion as part of secondary school science education will impact to any significant extent upon most students' future decision-making concerning science and technology issues is 'maybe' - empirical research does not yet support the claim.

Even if things were rather better supported than that and it was clear that most students *did* carry from their Nature of Science secondary schooling increased capacities to make decisions concerning scientifically based issues and actually exercise to those capacities when making judgements, so what? How will this be of benefit to most individuals in the sense of increasing *their* happiness (or whatever) to any extent worth curtailing their freedom for? These decisions are simply not closely enough connected to *most* people's everyday lives for such individual decisions to affect their level of happiness. Some, perhaps but most?

Generally speaking then, I take to be implausible to suggest that an introduction to philosophy of science in the passive, type a), "Nature of Science" sense will be of any *extrinsic* benefit to individuals. So, presumably, if we are to paternalistically warrant this instruction at all, it will have to be because of some conception we have of the *intrinsic* merit of people having some particular intellectual profile regardless of whether they ever employ their philosophical knowledge to their benefit in their day-to-day lives.

Again, perhaps this is part of what one would normally have in mind as the "liberally educated" person. However, I am somewhat cautious of conceiving of even this sort of passive knowledge of the (uncontroversial) *philosophical* nature of science as being sufficiently intrinsically good for the individual to outweigh their loss of freedom[36]. Still, if any case can be made out for a compulsory introduction to philosophy of science on the basis of intrinsic benefit to the individuals concerned, then it seems to me that this particular minimalist variety is the best candidate for it. One merit is that, as the least intellectually demanding sort of introduction, it is likely to be the best taught and learned and thus the proposal is less open to the "incompetence" objection raised more seriously against its fellows. My endorsement or otherwise of type a) introductions would be, in part, contingent upon (currently absent) evidence concerning residual knowledge possessed by John as a result of Johnny's earlier instruction in the nature of science.

As just noted, I am not confident about the merits of a case in favour of passive "Nature of Science" type a) introductions being sufficient to outweigh the loss of freedom involved; but even if I am wrong and the tilt does go in favour of students having whatever knowledge they retain from such introductions, one further challenge remains. If we are to restrict individual freedom to gain sufficiently worthwhile knowledge, is there something *even more worthwhile* for the individual that vies for the same time and space? Given the crowded curriculum, it is not enough to consider freedom versus passive knowledge of philosophy of science in isolation from other possibilities. Such other possibilities might not involve philosophy at all[37] and considering them, beyond noting their presence as candidates, is beyond this paper's scope. *Within* philosophy I have already flagged a greater enthusiasm for some other areas of philosophy (think Philosophy 101 again for a spread of more promising topics, or consult the P4C materials[38]) as arguably more important to have as parts of citizens' intellectual profile than *active* philosophising *about science* and the same comparative value judgement plausibly applies again with our "Nature of Science" *passive* philosophical knowledge. Even if students

are not introduced to active philosophising about such topics instead of using the same curriculum time for a passive introduction to philosophy of science there would perhaps be more merit in even passive introductions to some such topics than to philosophy of science[39].

3.2.5 Summary

In summary, I have suggested above that it is implausible to defend any of our versions of an introduction to philosophy of science by appeal to either the *intrinsic* merits of whatever knowledge and skills result from such introductions or to their *extrinsic* merits in terms of, ultimately, increased happiness (or whatever) for the individual involved. Generally speaking, I suggest that there is not enough benefit *for the individual* to outweigh the loss of freedom that is its cost. Most promising, though still dubious, is a).

3.3 Benefit to the Group?

As mentioned above, another possibility is that such education is not to be warranted in terms of its benefit for the individual so much as it being *beneficial for the rest of us*, "the group", to have all individuals so educated. In short, individuals are to have knowledge and skills forced upon them not for their sake but for our sake.

Again, we have a spread of possibilities from the most cognitively challenging active meta-philosophising about philosophy of science (h) down to passive knowledge of uncontroversial findings within the philosophy of science (a). As before, I will consider the former first.

3.3.1 Meta-philosophy of Science?

I certainly hold that meta-philosophical expertise is something that it is beneficial for a society to have as a resource. It is good for the group that, in some sense, the group has the capacity for meta-philosophising - about philosophy of science as well as about other areas of philosophy. Why so? First, this is an *intrinsic* good (on my values, at least) in that, in and of itself, I favour a society in which certain intellectual activities occur - including meta-philosophy. I am even willing to trade this off against happiness such that, even if "the greatest happiness of the greatest number" were to be better served by increasing football and fast food than by preserving its capacity for meta-philosophising, I would prefer the latter. And, I suspect that it is also *extrinsically* a "good thing" in that another part of what I intrinsically value as the intellectual qualities of the group is that it contains the resources for philosophising and, if that philosophising is to be at its best[40], then *how* it is to be conducted should itself be a matter for critical reflection - that is, for meta-philosophical scrutiny.

However, for the *group* to have the resources, it is not necessary that *all individuals*, or even most, within the group have them to any extent much at all. As with other areas of complexity and difficulty, it would suffice that some individuals are appropriately competent, that society had resident experts to whom, in effect, to sub-contract the task of performing meta-philosophical thought. That way, the task will be done competently; something that is presumably of importance if it is thought important enough for the group to bother to have it done at all. Having a general population that is capable of meta-philosophising poorly seems without point (yet "poorly" is all that one could plausibly hope for, on average, for a very intellectually demanding task[41]).

Similarly down the scale. In what way is it good (for the group) to have the general populace having patchy passive knowledge of rival meta-philosophical views and arguments or even (still patchy) knowledge of whatever might be meta-philosophically uncontroversial[42]? I see

no satisfactory answer to this challenge. Again, saying this is not to deny that having experts within the group who have this knowledge to a robust extent is extrinsically or intrinsically good for the group - for much the same set of reasons as outlined above. (Indeed, knowledge across this spread is extrinsically warranted simply by appeal to its role as background to the already endorsed active meta-philosophising.)

In summary, the group is well-served by expert meta-philosophy[43] but not well-served by widespread inexpert meta-philosophy or knowledge of meta-philosophical positions and arguments. Freedom suppression needs better warrant than is available here.

What, then, on our next suite of possible curricula - philosophy of science in some form or other?

3.3.2 Active Philosophising about Science?

Much the same concerns arise about widespread *active philosophising*. The challenge is to give an account of how it is (intrinsically, or extrinsically) beneficial for the group to have widespread incompetent philosophising occurring about issues within either of our two topic groups. *Expert* philosophising by experts within the group I will take as beneficial for much the same reasons as before. But what of *in*expert philosophising about science (in either of our topic groupings) by the general populace? Is that plausibly of sufficient (intrinsic or extrinsic) benefit to the group to warrant forcing it on individuals?

Perhaps it could be conceived of as *intrinsically* good for the group to have the level of dinner table and coffee shop and bar conversation move to a higher plane than that of gossip and mortgages and sport, even if the conversations were philosophically inept. Let me allow this (although, again, other Philosophy 101 style topics seems more promising). However for any such value judgement to warrant *forced* acquisition of such skills, one would have to believe that such a shift in intellectual interests would occur in the *majority* of population and occur to an *extent* that outweighed the loss of choice of what to learn. It seems to me to be simply unbelievable to suggest that any such shift would occur to any great extent as a result of the population's contact with school philosophy of science[44]. (It is much more plausible to suggest that such a shift would result if students' *entire schooling* had a philosophically active flavour to it but that is not the suggestion at hand - although perhaps it should be[45].)

As for *extrinsic* benefits for the group, one that I have entertained in the past is that society might be well-served by an intellectually active and vigilant citizenry that had the capacity to have well-thought-through views on various ethical issues (in particular) to do with science. Bad decisions by those with a vested interest in them might be less frequent if subject to more scrutiny and challenge. This motivation seems to connect to the so-called 'democratic argument' mentioned above but this time with the group, not the individual, being the focus of the claimed benefits of such engagement Also, note that I am seeing active philosophising about science as the ingredient rather than passive knowledge of the nature of science (including of its ethical dimensions). I still think that such a situation, were it to obtain to a *robust* degree, would be good for the group. But I doubt that it could obtain to any great extent - given the restraints upon its presence in the science curriculum. Again, the likelihood is more that our high school graduates would have the capacity for ill-thought-through challenges than well-thought-through ones. In the face of this, I can't see how widespread *poor* philosophising is of *enough* benefit to the group to warrant forcing it upon individuals. Having citizens vote on the basis of well-thought-through values, sound factual information and highly honed reasoning skills would indeed be some sort of ideal. It is, however, and ideal not likely to be very closely approximated as a result of the minimal amount of active philosophising that there would be room for in secondary school science curricula.

Again, note that none of this is to deny the benefit to the group of *expert* philosophy of science. Nor is it to comment on semi-expert philosophising by a subset of the group that is larger than academic philosophers though smaller than the general populace. I have, in the past (see my 1994 and 2004) , advocated having scientists and controllers of science with the capacity for philosophising about science and one might extend that to journalists, science teachers[46] and so forth; one might even extend it to undergraduate and secondary school science majors. Nothing that I have said so far challenges these earlier views of mine. All that is challenged is "across-the-board" compulsory secondary school philosophising about science - at least if it is the fairly limited activity I take to be possible within secondary school science curricular "time-slots".

What, then, of our more intellectually passive variations of an "introduction to philosophy of science"?

3.3.3 More Passive Philosophy of Science?

These form the series a) to c) and vary primarily in the richness of the philosophical thinking to be made available to students. When discussing possible benefit to the *individual*, I suggested that the minimalist, "Nature of Science", knowledge of uncontroversial philosophical views about science was *perhaps* worth restricting a person's freedom for in that, as a result of instruction, that person would, to some extent, be *intrinsically* worthier, more closely approximating the ideal of "the liberally educated person" that I had some sympathy with. Moreover, given that it is the least cognitively demanding of our spread of "introduction" types, it has the greatest chance of being learned and retained to the greatest extent. But whatever the merits for the individual might be, would such knowledge benefit the *group* - either intrinsically or extrinsically? And would more robust, but still passive, introductions, although I judged them to be of insufficient benefit to the individual, be of sufficient benefit to the group to warrant their imposition upon individuals.

Concerning type a), note that, as it is already a loss of freedom that has been possibly warranted on paternalistic grounds, appeal to the group's benefit might combine with that hesitant warrant to be more clearly sufficient justification for compulsory instruction in the nature of science. Such an introduction may thus not require a "stand-alone" warrant appealing simply to benefit to the group. As it is the form of introduction that seems most popular in the science education literature (see the "democratic argument" discussion mentioned above) I will deal with it first and, given the complexity of the argumentation, spend some time upon it.

First, as with earlier discussion, I consider it to be intrinsically valuable for the group that the group has knowledge of uncontroversial philosophical theses concerning the nature of science within its knowledge base; but that could be so with experts being the repository of that knowledge and that intrinsically meritorious state of affairs for the group could be brought about by selective teaching of such theses to a subset of the group. That is not the scenario under examination here. The issue at hand is how *intrinsically* meritorious it is for the group for that knowledge (to whatever extent gained from compulsory science education) to be widely present among its citizens - is that just a good way for the group to be, in and of itself, never mind what the knowledge is good for?

It does seem to me that citizens having such basic philosophical knowledge is, to a weak extent, *intrinsically* beneficial to the group. I say 'weak' because, as earlier indicated, although I judge a society formed of citizens with such knowledge to be intrinsically superior to one that is not, it is hardly in the same league as the intrinsic merits of having, say, a society of happy citizens. It is also decidedly unclear to me as to whether such an intrinsic benefit outweighs the loss of freedom involved for all of those individuals forming the group.

Perhaps, though, that possible slight group benefit can be combined with a possible slight individual benefit I found some favour with earlier to form a joint case for a).

It is not, however, quite clear how this would go.

It seems to me that if one considers the *intrinsic* benefit for the group (of having group members having whatever "Nature of Science" knowledge remains once they leave school), this is no more than the summation of the intrinsic benefits of having such knowledge in the individuals. To see this, it might be useful to rehearse what is going on with this sort of *intrinsic* benefit warrant.

If I say that I favour compulsory "Nature of Science" instruction in virtue of the consequent change in the intellectual profile of the group in virtue of school leavers having in their heads some residual knowledge of the "Nature of Science" then that seems to be merely me saying that I value not just some individuals having such knowledge but all individuals having such knowledge. As I construe this possible warrant anyway, it doesn't seem to me that there is an *extra* group *intrinsic* benefit that I have in mind beyond the benefits produced by adding up those associated with the individuals involved. I value John having some such knowledge as just a good thing in and of itself. Ditto for Jane and ditto for Jeremy and Jenny and so on. In this scenario, for me to *intrinsically* value the group having such knowledge is just for me to value John having the knowledge, and Jane etc.

So, why am I going through all of this? Because it looked as if I could perhaps add two weak warrants to get a strong one - an attractive possibility given that the only sort of warrant I got on the basis of individual benefit for any form of introduction to philosophy of science was, just possibly, a weak intrinsic benefit for type a). But it won't work; there is nothing extra to add from individual intrinsic benefit that is not already there from group intrinsic benefit.

So, I am not particularly sanguine concerning appeal to *intrinsic* benefit to the group either by itself or by attempted "combination" with the earlier weak warrant appealing to intrinsic benefit to the individual as justification for a passive, type a) "Nature of Science" style of compulsory introduction to the philosophy of science. What, then, of the possibility of a warrant appealing to *extrinsic* benefit, cashed out eventually by appeal to something like society's happiness?

I did not see sufficient *extrinsic* benefit for the *individual* in such knowledge but is there any for the *group*? I think that in this case a distinction *can* be drawn such that one can have a benefit for the group which is, in one sense, not just a summation of individual benefits. As an illustration, consider the case of moral indoctrination, of instilling, without any particular critical examination by the student involved, a moral code into a student's head. Having this happen to a student may be of no particular extrinsic benefit to him in that, if one tracks connections to intrinsically valued things like his happiness, he might well be better off without that code. A life of undetected and successful crime, say, as a businessman, may lead to great personal happiness and that might occur across most individuals. However, having that code generally indoctrinated into society's members might well be warranted by appeal to the overall happiness of the group. This is not to say that that group happiness is any more than the happiness of all of the individuals summated, it is just to observe that a larger sum *total* happiness might be achieved this way than by avoiding mass indoctrination even if, generally speaking, an individual didn't benefit from her own indoctrination. So despite its failure as a warrant at the level of the individual, might compulsory "Nature of Science" instruction be warranted by appeal to the extrinsic benefit of the group, say, as ultimately cashed out by greater sum total happiness of the individuals forming that group?[47]

Possibly. Insofar as citizens vote and engage with one another in civic ways and insofar as some of those actions actually draw upon this sort of knowledge, having a population that is

aware of uncontroversial philosophical knowledge of the nature of science (especially its ethical dimensions) would be to its extrinsic benefit. An individual may not gain much from his own instruction but, along with his fellow citizens, might gain from such instruction generally occurring. Better decisions would be made by the group (as postulated above when considering the so-called "democratic argument") and plausibly this would result in some increase in, say, the happiness of the group overall. Although it seems to me to be a benefit of dubious *extent*, it does seem more plausible that such uncontroversial philosophical knowledge about science will be of more *extrinsic* benefit to the *group* than to the *severally considered* individuals possessing it. Mind you, it is hardly in the same league as, say, literacy. Having citizens compulsorily made literate by their schooling seems to me to be of greater extrinsic benefit for the group (not to mention the individuals within it) and to have a more clear-cut moral status as outweighing the loss of freedom which is its price. It is, however, by no means as clear to me that the increase in group happiness consequential upon compulsory instruction in the nature of science is of such *magnitude* as to outweigh the loss of freedom of all of the individuals involved. Even if such knowledge "stuck" to a considerable extent in the minds of the adult citizens students became (a big "if"), there is still the point that for this *extrinsic* benefit to flow, the knowledge has to actually make a difference in the way citizens conduct their civic business. As we have seen with Bell and Lederman's 2003 paper, it is by no means clear that there are grounds for optimism here.

All in all, it seems to me that, once again, if there is a warrant here, it is a weak and dubious one; yet it seems that a good number of the warrants that have primarily motivated the presence of "Nature of Science" instruction in the compulsory secondary school science curriculum fall into this category. Concerns have to be raised that an unwarranted error has occurred.

As for the other, more sophisticated but still passive, versions of "an introduction" it seems to me that, as the sophistication of the knowledge involved increases, it becomes increasingly implausible that any sort of benefit for the group is present[48]. The potentially strongest case remains the *intrinsic* merit of having a society more comprised of citizens who are to a more sophisticated extent than with a) "liberally educated humans". But the difficulty remains that of curricular *success*. The more sophisticated the cognitive demand, the less successful the curriculum in terms of student knowledge acquisition and retention. The less successful it is, the less there is to be put on the positive side of the ledger to outweigh the negative costs of freedom loss (and there will be more freedom loss if the stuff is harder to understand and students have to study more). Distorted, fragmented understanding seems hardly worth the effort yet it does not seem plausible that anything greater than that would be available across-the-board unless a considerable priority shift occurred in the weighting of curricular items. All that might be worth the effort, *if* one was *already* doing a passive "Nature of Science" style curriculum, is some sort of "blanket" awareness that the issues are not *all* as easy as the uncontroversial matters with which they have been acquainted in detail and, perhaps, some limited illustration of such further complications.

3. "Piggyback" Rationales for School Philosophy of Science[49]

So far, I have been considering rationales for the presence in compulsory secondary school science curriculum of introductory philosophy of science in one sense or another. Those rationales were trying to answer the question: 'can we justify such compulsory (secondary school) philosophy of science?'. I made the point earlier that it made no difference to the structure of my argumentation as to whether such philosophy of science occurred as a discrete curricular item in its own right[50] or it was delivered integrated into the business of normal first-order science lessons. Either way, it would take time to be dealt with and the issue was whether that time (removed from the domain of individual choice as to how to spend it) was well spent or not.

The point has been put to me by two of this journal's anonymous referees that perhaps one could warrant some sort of introduction to philosophy of science by considering it as an integral part of a science curriculum the compulsory nature of which was *already* warranted (never mind how for the moment). If it is important enough that people "do science" to make it compulsory and if, say, understanding the nature of science is integral to "doing science" then, as a subset of the whole, its compulsory nature is, *a fortiori*, also warranted.

My concern with this is that it is not as if there is a single thing called 'science curriculum' that is warranted or not as one total indivisible entity. Rather, it seems to me, one has various elements that might or might not be packaged together to form science curricular proposals of various sorts. Sometimes elements will be inextricably linked and will be better conceived of as mere aspects of the same whole rather than discrete elements in their own right but the general idea of packages is obviously correct.[51] So, I would be asking: 'even if some versions of compulsory science curricula not containing philosophy of science introductions in any of our senses were to be warranted,[52] are any curricula containing any such introductions as elements warranted?'. My answer is generally: 'no'. This may mean that I would not be favouring compulsory curricula, even if construed of as types of science curricula, that have as one of their aims: to have students understand what science is. Even if this minimally means having them understand the sort of thing articulated in "Nature of Science" programs, I am not confident of the point of it (see above, at length). Rather, I might argue for curricula which don't have that aim; perhaps all they will have is the aim of having students understand various *results* of science (those that will make a difference to their happiness, or whatever). If the restricted nature of such a curriculum does not deserve the name 'science education' and is but some lesser beast, then so be it; I have no interest in mere verbal disputes.

In short, I don't think that the "piggyback" suggestion makes a lot of difference. It merely rebadges the onus argument as one connected to the relevant element of the science curriculum.

4. Closing Remarks

So, all rather gloomy in my view - at least if what was in mind was pitched at *secondary* school science and it was conceived of as *compulsory* that students be introduced to philosophy of science. As far as I can work out, beyond a possible warrant for the most basic "Nature of Science" sense of "an introduction", it is hard to see enough benefit of any sort, for the individual, or for the rest of us, to outweigh the loss of student choice as to what is learnt.

Of course, none of this argues against a philosophy of science *option* for those who *choose* it. Nor is it to argue against compulsory philosophy of science for some subset of students, say, those who are probably *going to become scientists (or controllers of science or...)*. This is not to say that such arguments could not be mounted but they are not raised here. Finally, as flagged earlier, although narrowly focused upon philosophy of science, the general thrust of the above is broad in another way - much the same sort of freedom-valuing onus argument would seem to apply to other parts of the compulsory curriculum, including much of science[53]. Whether the onus can be discharged satisfactorily for other parts of the curriculum, or not, is not, however, my concern here.

Notes

[1] An earlier version of this paper was presented to the *Seventh International Conference on the History youand Philosophy of Science and Science Teaching*, University of Winnipeg, Winnipeg and subsequently published in its proceedings (see my 2003). I am grateful to those who engaged in discussion of the paper upon its presentation. I am also grateful to the advice of this journal's anonymous referees.

[2] Contact address for enquiries about the Lipman materials and approach: Institute for the Advancement of Philosophy for Children, Montclair State University, Upper Montclair, New Jersey, 07043, United States of America (url: http://frontpage.montclair.edu/iapc/).

[3] In the editorial introduction to the first issue of this journal (Matthews 1992a) and its lead article (Matthews 1992b) Michael Matthews charts some of this history. The rise of this journal and the formation of the International History, Philosophy & Science Teaching Group further attest to this enthusiasm for meta-science (including philosophy of science) within science education stopped

[4] I have in mind here such pieces of knowledge as that:
- choosing what scientific research to prioritise and how (or even whether) to apply such research findings is value-judgemental and it is not clear how we could know what is right or wrong;
- although the justification of scientific claims involved appeal to observational and experimental claims, is unclear how much justification is provided by them;
- much of the scientific theory that is most powerful in providing explanations of our world appeals to putative entities and processes that are far removed from ordinary observation and not easily understandable as descriptive of how the universe is;
- science frequently employs idealisations in the expression of its general claims;
and so on.
Of course, lists vary and this might be awkward for this option's viability. On this point, see Bell and Lederman, 2003, Eflin *et al.*, 1999, Lederman, 1992 and 1995, Lederman *et al.*, 2002, Munby, 1982, Sloep and van der Steen, 1988 and Sutching, 1995.

[5] One controversy concerns the extent to which there is any legitimate requirement for philosophical hypotheses about theory justification to be consistent with the practice of science or with the history of science. I have wrestled with this in the past; see my 1990c
and, more tangentially, my 2002.

[6] See, for instance, Carey, 1985, Gazzard, 1993, Hinton, 2003, Lipman, 1993, Lipman and Sharp, 1994, Morehouse, 1995, Splitter and Sharp, 1995, Sprod, 2001, Vetterling-Braggin, 1993 and Wilks, 1995.

[7] For those who doubt that the average secondary schools student could engage in anything but, say, a passive, "Nature of Science"-style, sense a) introduction to philosophy of science, I imagine that active meta-philosophy of science would be the activity from my list that they would be most pessimistic about. It does, however, seem to me that some issues are plausibly discussable. Take the epistemic issue of justification of belief in a scientific theory. One, currently popular, meta-philosophical theory about what standards of justification should be used suggests that the task of an epistemologist of science is simply to correctly capture the epistemic practices of scientists. An opposing view, less popular at this point, is that philosophy of science is not an *a posteriori* exercise of that sort but an *a priori* exercise in which positions might be held which conflict with the practice of scientists and which have normative status in criticism and reform of that practice. It is not all that hard to get students to engage with this issue by discussing the history of science and changing epistemic practices on the part of scientists. Again, I reiterate that I don't expect the philosophical richness of such conversations to be that of a postgraduate seminar but, although not present to the same *degree* of sophistication, school students' conversations can be of the same *kind*. My support for these claims is again the vast experience of those in the so called Philosophy for Children movement (founded by Matthew Lipman) in engaging schools students with abstract issues. In any event, the argument of this paper is subjunctive: even were such activity to be possible to some extent, it would not be worthwhile enough to outweigh the loss of freedom involved.

[8] Just what that sense is, is not something that I wish to pursue; the philosophical literature remains divided on the matter and it is irrelevant to my purposes to pursue disputes between, say, libertarians, who insist on so-called contra causal freedom as a precondition of moral agency and compatibilists (or soft-determinists) who contend that a person's actions can be both determined and free in a sense appropriate for moral agency. (See, for instance, Berovsky, 1987, Flew and Vesy, 1987) Note also that

I say 'necessary', not 'sufficient'. There may be grounds for deeming someone who has free will to, nonetheless, *not* be moral agent.

[9] Again, controversy continues as to what those principles should be with a major division within normative ethics being that between consequentialists who judge rightness and wrongness of actions in terms of their consequences and deontologists who judge them in terms of the nature of the action itself, regardless of its consequences. Generally speaking, my discussion appeals to considerations of former sort.

[10] What I have in mind here with my talk of free choice is what is usually called "freedom from" or "negative freedom". To have negative freedom to act is to have no externally imposed constraints or forces determining what one does. (It is usually contrasted with "freedom to" or "positive freedom", which is best thought of as one's capacity or ability to do something. To illustrate, I have negative freedom to jump to the moon, no one is stopping me, but I am unable to do it.) The distinction was introduced by Isaiah Berlin, see his 1953 and for some discussion of the distinction see Levin and Young, 1986.

[11] For an account of one such school see Neill, 1968.

[12] Such arguments constitute an exercise in what is normally called 'practical reason'. There is a considerable and longstanding literature on this (see, for instance, Audi, 1989, Clarke, 1985, Raz, 1975 and Thomas, 1981) and, concerning extended reasoning on such matters, see my *Reason and Professional Ethics*, Ashgate Publishing, forthcoming 2007 and the ReasonAble project mentioned in van Gelder *et al*., 2004. As for discussions of student freedom, again the literature is longstanding; see, for instance: Barrow, 1975 and 1978, Barrow and Woods, 1982, Dworkin, 1986, Entwhistle, 1976, Hirst and Peters, 1970, Holt, 1972, Neill, 1968, Noll, 1985, Peters, 1973, Strike and Egan, 1978, White, J., 1973 and 1982, White, P.,1973 and Wringe, 1981 and 1988.

[13] For instance, those of a more theistic persuasion than me might have a general moral principle that one should always do what some deity or other commands which, together with a quasi-empirical claim that that deity has commanded that secondary school science students be introduced to philosophy of science, would provide a warrant for restriction upon such students' freedom which would be satisfactory to such theists.

[14] So, then, the normative ethical principles that I will be appealing to as motivating premises in the arguments that I will consider as putatively warranting the restriction of student autonomy are, roughly speaking, three. They are:

1) It is legitimate to prevent someone from exercising autonomy if that person is incapable of doing so properly;

2) It is legitimate to prevent someone from exercising autonomy if it is for that person's good to do so; and

3) It is legitimate to prevent someone from exercising autonomy if it is for the group's good to do so.

The issues in principle 1) connect with some of those alluded to in note 8, above. The issue may be conceived of as that, although the person has free will, he or she should not be conceived of as a moral agent in virtue of not being able to properly exercise such agency. Pursuing all of this further would take me away from the central thrust what I'm trying to convey in this paper, hence its place in a note.

[15] What will occur here is a mild unpacking of some elements of arguments within so-called practical reason (see references mentioned in note 12 above).

[16] Note again that the usual answers here, ones that appeal to inexperience or immaturity, are no advance on our current analysis. Experience and maturity are not meritorious in their own right as qualities in a decider; rather, any merit they confer is indirect in virtue of improvement that might thereby be gained in one or more of the three elements I mention.

[17] This distinction looms large in philosophy of education. At one stage, it was even considered that it was conceptually bound up with the notion of education that it be intrinsically valuable (see, for instance, Peters, 1973 and Hirst and Peters, 1970).

[18] It turns out that there is quite a lot of work to be done in getting this causal connection strongly enough worded to do the logical job asked of it in arguments articulating instrumental warrants. The details of this do not matter here (for more on this, see my forthcoming *Reason and Professional Ethics*).

[19] By sufficiently, I mean to enough of an extent to outweigh the loss of freedom.

[20] Needless to say, I am not the first person to consider possible warrants for science education or for philosophy of science within it. In particular, the recent enthusiasm for "Nature of Science"style curricula (number 'a' in the list with which I began the paper) has had associated statements of benefits. For some of this discussion see: Bell and Lederman, 2003, Bell *et al.*, 1988 and 2000,Cobern, 2000,

Jacobs, 2000, Khiske and Abd-El-Khalick, 2002, Lederman, 1992 and 1995, Lederman *et al.*, 2002, McComas *et al.*, 1998 and Robinson 1998/1965.
Any of these extant warrants can be considered as within the framework outlined in the body of the paper.

[21] As with any of the empirical propositions upon which my arguments rest, it may be that there is empirical research to suggest that what I assume to be true is, rather, false. I would, however, be astonished were this to occur in this case.

[22] Of course, as always, I may be wrong in my understanding of the empirical situation and readers may discharge the onus by citing research concerning the attitudes of adults to school philosophy of science.

[23] Perhaps, though, not good enough to belatedly force it upon him *now*. Recall my earlier "double standards" concern.

[24] Again, I would be more sanguine about a worthwhile result were the school curriculum to be more comprehensively philosophically inclined. See note 7 above concerning the Philosophy for Children program.

[25] See note 7, above.

[26] There is some controversy about the extent to which critical thinking is applicable across domains of inquiry and even if it is, some evidence to suggest that students taught the skills in one domain don't tend to apply them in a distinct domain. For some of the issues see Bailin, 2002, Ennis, 1989, Norris 1992a and 1992b, McPeck, 1990, Sadler, 1994 and vanGelder *et al.*, 2004.

[27] It is also, as noted elsewhere, generally speaking absent from the Philosophy for Children program.

[28] Defeasibly so in various circumstances but such complications caused by clashing values are beside the present point.

[29] On this, see: Gess-Newcombe, 2002, Lederman, 1992 and Tobin and McRobbie, 1997.

[30] This would especially be so if philosophy of science were to be squeezed in as a part of the science curriculum - whether integrated in as an aspect of treating regular science topics or given dedicated discrete curricular space by itself.

[31] This is not to say that there may not be more, perhaps even sufficient, merit in people being able to philosophise about other philosophical issues apart from those arising from the pursuit of science.

[32] Some preliminary work has been done by Bell and Lederman (2002) on the related issue of the effect of NOS knowledge on later decision making. The results were pessimistic but one should be cautious about transferring this relatively passive knowledge scenario across to an active philosophising scenario. More closely relevant is the Philosophy for Children program's experience. However there are a few matters that advise caution in transferring that experience across to the present proposal. One is that that program has generally concerned itself with issues that do not include philosophy of science (just snippets here and there and not a lot concerning the ethics of science). The second is that (probably due to greater teacher autonomy) the major level at which P4C has been implemented is that of elementary/primary school. Usually this has involved discrete lessons and usually the analytical/reasoning/inquiry skills fostered in those lessons can be reinforced by the same teacher throughout other areas of the curriculum. In short, students get a fairly robust introduction to active philosophising - more robust than seems plausibly attainable within science education at secondary school. Finally, ethical issues of a more personally engaging sort than the ethics of science are certainly covered within the program. However, experience is generally positive concerning students' capacity to engage in the *kind* of philosophising about them that might occur in an undergraduate applied ethics course, though not, as already emphasised, to the same degree as would be carried out by a more academically selective, more experienced undergraduate group. The last point is promising but that promise is alloyed by the point that preceded it.

[33] Again, as far as I know there is simply no longitudinal empirical research concerning this. Certainly within the Philosophy for Children literature with which I am most familiar, I know of no such study. My suspicion would be that, given the generally greater embedment and retention of material that students actively craft rather than passively receive, P4C might enjoy greater long-term retention than standard Nature of Science material embedded in school science lessons but that is pure speculation on my part. It certainly does seem to me that there is an interesting research gap here.

[34] Or constructed by them in some sense held by pedagogical constructivists. My discussion is neutral as to the merits or otherwise of Constructivism. This journal has already a robust representation of the debate concerning Constructivism; for my own thoughts see my 1999.

[35] Munby (1982, p.31) quoted by Bell and Lederman, p.353 - my insertions. I must say that this seems to be a somewhat optimistic outcome from mere Nature of Science instruction.

[36] Some time ago, Peter Sloep and Wim van der Steen wrote a paper (Sloep and van der Steen, 1988) in which they advocated something like this for undergraduate science students. That issue of that journal was associated with the first conference of the International History and Philosophy of Science in Science Teaching group in Florida in 1989. At it, I presented a response (see my 1990a) in which my concerns were not so much that it was not achievable but that much more of what I have called an active sort of philosophising should be aimed at. At the same conference, Sloep presented a rejoinder. It is curious that I am now coming around more to his way of thinking. Mind you, the educational *level* under current discussion is different to that discussed by Sloep and van der Steen.

[37] Perhaps more first order science would be in order - a suggestion welcome to many, although contrary to the sentiments of my 1994 and the feelings of many in this group.

[38] See, for instance, the works cited in note 6. I would also encourage readers do find out where Philosophy for Children is occurring in a school close to them (probably a primary/elementary school) and see if they can arrange to witness some classes.

[39] As an entirely personal observation, I consider there to be great merit in having students "walked through" the argument from pain and suffering as a ground for rejecting the existence of the Christian God and through the inadequacies of various theodicies advanced in response to it. But perhaps I overestimate the deleterious effects of thoughtless theism upon a person's happiness (better a fool satisfied..... again?).

[40] And having it so *is* something that I do consider to be connectable to intrinsic goods such as society's happiness, capacity to achieve its goals and so forth. Of course this is again empirical speculation on my part and again I doubt that anyone has ever carried out empirical research on these links.

[41] Note that this pessimism is not particularly age related; such intellectual sophistication to any great degree is beyond most citizens as the grade spread in any undergraduate philosophy course in which met philosophical disputes are addressed would attest.

[42] If any thing. One might hope that commitment to reasoned argument and conceptual clarity might be uncontroversially considered part of the business of philosophising but that would seem to rule out most post-modernist philosophy.

[43] Note that none of this is to make any comment about the worth or otherwise of subsets of society apart from academic philosophers having meta-philosophical skill and knowledge - notably as informing active philosophising about science. Scientists themselves come to mind (see my 2004) as do teachers of science (see, for instance, Gess-Newcombe, 2002 and my 1994).

[44] It is perhaps worth re-emphasis that I don't take such active philosophising to be "developmentally inappropriate". The experience of the Philosophy for Children movement is that it can occur from quite an early age. It is, however, here considered as an isolated curricular exercise within compulsory school science education. Given such restrictions, it is not plausible that results across-the-board would be at all philosophically robust.

[45] It is interesting to note in this context that Bell and Lederman, in their 2002 paper, having become pessimistic about the influence of knowledge of be nature of science upon intellectual agents' decisions on science and technology issues, muse at the end of their paper (p. 370) that 'Perhaps citizens could make better decisions on science and technology based issues if, as students, they were taught to apply current understandings of the nature of science to their decision-making.'. The authors had passive philosophy of science in mind but the point applies that is one thing to have knowledge or skill and another thing to deploy it. I suggest that it would be quite a redeployment of curricular time to have such critical thought about such issues (deploying knowledge of the nature of science as premises in ones thinking) occurring to any reliable extent. Critical thinking seems to require sustained expert coaching in order for it to become part of the student's repertoire (see van Gelder *et al.*, 2004).

[46] Although see Tobin and McRobbie, 1997 for some concerns about teachers' own understanding impacting on their teaching.

[47] As will be apparent philosophical readers, I am appealing here to a crude hedonistic utilitarian rationale. This is not the only version of consequentialism that might be deployed but parallel points would be made about others as well.

[48] Again, distinguish the current suggestion from one where it would be advocated that it is extrinsically good for the group to contain such knowledge as part of its collective intellectual resources yet have that occur in virtue of expert members of the group in having such knowledge and making it available to others much in the manner of the consultant expert.

[49] This "piggyback" turn of phrase was one used by one of this journal's anonymous referees. Curiously, is one that I have employed myself - see my 1998b.

[50] Which, contrary to the views of many, I would advocate as a pedagogical style were one to wish such activity to occur at all - at least for active forms of introduction. Philosophising is a complex suite of

skills which require dedicated coaching (again, see van Gelder et al., 2004). It is hard to do that coaching mixed in around other agenda items as part of first-order science instruction. If one was really concerned to have students philosophise about science, my recommendation would be separate philosophy of science instruction followed up by philosophically enriched conversations within the first-order science lessons in which those skills were applied on the subject matter being dealt with. Still, all of this is an aside to the main thrust of my paper. And nothing in it hangs on whether I am right or wrong about this.

[51] For philosophical readers, I note that I'm skipping over debates about semantic holism and so forth. I do not think that the meaning of anything is semantically connected to everything else but that is hardly something I can pursue here. Some of my thoughts on the matter are in my 1998, Chapter 6.

[52] Which I am not at all sure of - see my 1994.

[53] See my 1994; quickly put, my suggestion there was that much of the time-consuming detail that formed the content of science education was a waste of time and thus, with its excision, time in the curriculum would be available for more worthwhile intellectual endeavours. Mind you, at the time I had in mind philosophy of science as the more worthwhile thing.

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