Science Curriculum in the Market Liberal Society of the 21st Century: ‘Re-visioning’ the idea of Science for All

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Abstract
The period since the 1960s has seen dramatic change in the nature and practice of science, science education and secondary school education itself. This paper examines changes in the Science for All movement, setting these changes in the context of the societal shift towards market liberalism and the advancement of a new style of individualism. We argue that the climate of today requires a re-focusing of the priorities of secondary school science education, with a new emphasis on what Science for All implies for the education of those who will go on to be our scientific elite.
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Introduction
The period since the 1960s has seen dramatic change in the nature and practice of science and science education. The impact of rapid technological innovation together with an increased expectation that all children would complete secondary education lead to rethinking the goals and processes of science education in secondary schools. The rethinking was undertaken under the slogans of three emblematic international movements in science education: Science Technology and Society (STS), Science for All and its successor, ‘scientific literacy’. Recent years have seen a fourth slogan emerge (or, perhaps, re-emerge, although we think there are significant differences between the old and new forms): Science for the Citizen (see, for instance, Cross & Fensham, 2000; Hogben, 1938).

In this paper we consider the implications of our market liberal society for the idea of Science for All. Market liberalism has had a significant impact on our ability to see that a person can only become an individual in the context of a society. We argue that the market liberal point of view exacerbates dualistic thinking; however, using a framework that we call ‘the new contractualism’ (after Yeatman, 1995, 1997, 1998b, 2000), we show that there are productive and powerful ways to ‘re-vision’ the idea of Science for All.

The Societal Context that facilitated Science for All

science for all: A belief that meaningful learning of science can be extended to all students and citizens, not just those with interests in science related careers. (Fensham, 2005, p.541)

The idea of Science for All arose in the newly crowded classrooms of the late 1970s and early 1980s. Fensham (1992) provides an overview of the changes in emphasis and perceived purpose in Science curricula in the decades following the second World War, until the 1980s. He identifies five significant influences on science curriculum in the 1950s and 1960s: concerned science teachers; academic scientists; political and economic comparisons between countries; psychological theories of teaching and learning; and philosophical ideas about science and science education. The 1980s saw a proliferation of new influences; Fensham identifies an additional seven influences that were powerful by this time: science educators and their research; new groups of learners; evaluations of the 1950/1960s curricula; historical and sociological analyses of curriculum; measurements of educational achievements and science education; major social changes and international movements; and the introduction of new technologies for learning. It would be reasonable to add increased involvement from parental groups to the list.

Perhaps the most significant influence on science curricula at this time was the presence in secondary schools of new groups of learners. These new groups brought pressure to bear
from two perspectives: firstly, with more students in science classes it was no longer possible to believe that they would all become research scientists, and secondly, these students were significantly different in their aspirations and preferred styles of learning from those that had been in the science classrooms of the 1950s and 1960s.

This was a time when movements such as the environmental movement were gaining public acceptance; perceptions of the link between science and the military were altering the public face of science in ways that made research science less appealing as a career choice. The worth of the enculturation into science that had seemed self evident was now in question. Social movements such as the movement for social responsibility in science, the environmental movement and the women’s movement gained prominence in the 1970s and had a major impact on science curriculum in the 1980s. Historical and sociological analyses of the curriculum had problematized the whole enterprise of secondary schooling, and, in particular, had made streaming or other forms of selective grouping unacceptable.

Malcolm (2003) characterises Science for All as primarily a plea for access to Science education for the diverse group of students who were now remaining in school. This inclusive impulse makes the Science for All movement distinct from the Science Technology Society movement that also operated during the 1980s and 1990s. Although the recommendations of the two movements overlapped, STS could be characterised as one way of achieving the broad goals of Science for All.

**Policy responses to the idea of school science for all students**

The pressures for a new style of Science education in schools saw policy responses in the 1980s, with governments and quasi-governmental and international organizations convening conferences and producing reports which affirmed that science should be taught to all children throughout primary and secondary school, and that the form of this education should be away from a narrow, formal system geared for future scientists and towards a broader, socially relevant education. However, there was some disagreement as to whether this broad, socially relevant education should be made available as the only offering, or in parallel with the narrower formal system. This second formulation would see intending scientists continue with their preparation for further study while the ‘lay-person’ would take the Science for All courses.

UNESCO recommended the first, more inclusive form:

“Science for All” is not an alternative lower status science education in the formal system. It is an essential and core component of primary and secondary science. The content of “Science for All” courses should be related to real-life applications in different societies and should also form a suitable base for those students (the minority) who will need a more rigorous, academic, subject-oriented science at a later stage. (UNESCO, 1983, p.21)

In the United Kingdom, the Royal Society recommended that a ‘proper’ fully funded and resourced science education should be made available to all students up to the age of 16 and that after the age of 16 the study of science should still be available and encouraged. It did so for reasons that have become very familiar: personal decisions in everyday life are aided by an understanding of science and a properly educated community is essential as a support for the institution of Science. The Royal Society’s recommendation seemed to be that all students should take the same science courses, but in its recommendation school science was still seen as it had always been:
All pupils should follow a broad, co-ordinated science curriculum embracing the three traditional branches (physics, chemistry and biology) and their interactions, as well as other sciences such as Earth sciences. (The Royal Society, 1985, p.17),

and academic scientists and their institutions (such as the Royal Society) were seen as the arbiters of what counted as science:

… those closest to science have both the warmest appreciation of its value and the clearest understanding of its limitations. (The Royal Society, 1985, p.14)

The Science Council for Canada set forth four objectives for school science:

1. Develop citizens able to participate fully in political and social choices facing a technological society
2. Train those with special interest in science and technology education for further study
3. Provide an appropriate preparation for modern fields of work
4. Stimulate intellectual and moral growth of students. (Fensham, 1992, p.797)

Fensham describes the first two objectives as explicitly identifying the two target groups of science education; the third acknowledges the increasing importance of science and technology in many fields of work, while the fourth objective provides “a link between the qualities in individuals and their corporate actions referred to in the first objective” (Fensham, 1992, p.797). In doing so he makes the identification that has become commonplace in science education: the intellectual and moral growth of students is seen as an inextricable aspect of their development into citizens of a participatory democracy. However, although this formulation leaves open the possibility that those students “with special interest in science and technology education” should also be seen as “citizens able to participate fully in political and social choices facing a technological society”, it is possible also to interpret this formulation in ways that separate the participating citizen from the future scientist.

An Australian formulation of Science for All

Fensham (see, in particular, 1985) was a powerful influence in framing Science for All in Australia. He identified the trend that had developed in the 1960s and 1970s for secondary school science courses to cater only for those students who intended to continue with science. All of secondary school science was, as a result, focused on the need to provide “specialist manpower (sic) so that societies and economies [could] keep pace in a world where scientific knowledge and technology [was] being exploited in a rapidly increasing way” (Fensham, 1985, p.416). Operating in parallel with this imperative, however, was the demand that schools should make some provision for the increasing number of students who would not go on to work in Science but who needed some knowledge and understanding of science for a variety of reasons:

… the demand for a more scientifically literate citizenry, i.e. science education should produce more members of the society who will be able to benefit from the personal and social applications of science and will be prepared to support the changes of a scientific and technological kind that are needed for a good balance between development and environmental concerns. It is this second demand that now has as its slogan, ‘Science for All’. But these two demands are … conflicting and not complementary … (Fensham, 1985, p.417)
Here, in the paper that came to be crucial for the Australian framing of Science for All, we have a separation of Science for All from science for the future specialist. The reasons Fensham gives for desiring a “more scientifically literate citizenry” (Fensham, 1985, p.417) are those of private benefit and public good. We will, with hindsight, examine the validity of these claims below. Also, in this extract, we see the conflation of scientific literacy with Science for All. These two movements are not the same, but there is a particular style of scientific literacy that can be regarded as a Science for All approach. However, the form of scientific literacy that gained precedence under the regime of outcomes-based education that prevailed in Victoria in the 1990s and largely continues today is not in that style (see Smith, 2006, for detailed discussion of this point).

Fensham concluded that there was “no likelihood of major changes in the manner whereby school systems (particularly secondary schools) meet this national need for scientific and technological manpower” (Fensham, 1985, p.420, emphasis removed) but that “it might be possible to maintain the success of this type of elite science education and still optimise the chance that there can be an effective Science for All” (Fensham, 1985, p.420). He offered three possible strategies for this; courses intended for training elite scientists could be ‘contained’ within the final years of schooling; rich Science for All courses should be offered in the preparatory years while pre-vocational science courses intended for the elite, also offered in the preparatory years, should be clearly identified as such; and Science for All alternatives should be offered in parallel with pre-vocational courses even above the “containment-level” (Fensham, 1985, p.425).

Fensham’s assessment that forms of science education different from ‘valid science’ (Ziman, 1980) would find it difficult to gain acceptance has been shown to be accurate. Elite science education remains largely uncontested; the goals and methods of this elite education are determined largely by academic scientists. Through the late 1980s and early 1990s, proponents of Science for All, appropriately, were preoccupied with providing access to a relevant and accessible secondary school science education for the vast majority of students; however, because they were seen as separate from the preparation of future specialists, Science for All style courses struggled for status. The struggle for General Science in the Victorian Certificate of Education (Fensham, 1998) provides a vivid illustration of the perceived lower status of a Science for All course in the senior levels of secondary school. In addition, the perceived need to ensure access to these elite courses in the senior levels impacted upon the content and presentation of general science courses below the “containment-level”.

Fensham offered the hope that “… [i]f some of these other forms of science education are also mandatory for the elite training group, the possibility that these other forms of science education will gain acceptance, meaning, and likelihood of success, would be enhanced” (p.422). This suggestion shows a fine grasp of the realpolitik, or, in Blades’ (1994) terms, the educo-politics of curriculum development but it perpetuated the view that the success of Science for All courses could be judged in terms of their acceptability to the scientific establishment.

In the Australian state of Victoria, the Science Framework (Malcolm, Cole, Hogendoorn, O’Keeffe, & Reid, 1987; a framework to guide school science curriculum for all years to Year 10) was written from a position of Science for All using a framework that acknowledged and extended STS. The Science Framework provided a vision for a context driven, community responsive general science curriculum for the compulsory years of education. It was replaced by the Curriculum and Standards Framework or CSF (Board of Studies, 1995) which provided a very different vision for what counted as an appropriate science education for both
the intending scientist and the future citizen; in the CSF science curriculum was linked with the establishment and assessment of very narrowly defined and easily testable standards, while the broader purposes for education were framed as separate from curriculum. We argue below that such a syllabus does not constitute an appropriate preparation in science for the future citizen, whether or not he or she intends to become a professional scientist.

In what follows we unpick the various justifications given for Science for All. We argue that the demand that good science and good learning should be culturally embedded requires that we radically rethink our education of future scientists.

The arguments for a Science for All curriculum

Two broad justifications were widely used to justify the new prominence that science, as Science for All, was given in primary and secondary education through the 1980s and 1990s. The first, which we call pragmatic (after Fensham, 2002, unpublished) is the assertion that, because societies everywhere are permeated with science and technology, citizens will be better able to cope if they have some knowledge and confidence about science. A variation on this idea is that a scientifically competent workforce will improve economic outcomes for a country and enhance employment opportunities for individuals. The pragmatic approach appeals to instrumental values: science is included for what it will do in the future rather than for its intrinsic value.

The second broad justification is the democratic assumption (also after Fensham, 2002) that quality science education is needed to enable citizens to fully participate in social and technical decision-making processes. Another form of the argument in support of the democratic form has been made by, for example, Snow (1993), Chapman (1991) and Solomon (1997): science is a cultural activity and thus should form part of the general education of everyone. We choose to offer this as a form of the democratic assumption, although most proponents of the democratic argument seem more concerned with the need to ‘keep the scientists honest’ than with the sheer joy of scientific theory or practice. Essentially, science education under the democratic assumption is either of instrumental or intrinsic value depending upon how one frames the terms of the democratic assumption.

Wellington (2001) identifies five tensions that operate in determining science curriculum today. The first is a tension between scientific knowledge for its own sake (in the sense that it is a product of our culture and therefore of intrinsic value to learn) and science education for its utility value (the idea of utility value encompasses Fensham’s pragmatic sense as well as many meanings of the democratic assumption). The other four tensions cited by Wellington are: between preparing future scientists and teaching science ‘for life’; between teaching science as a body of knowledge and teaching its processes, skills, and methods; between science education taught for itself (what we would call ‘valid science’) and science education taught through its applications and its moral, social, and environmental consequences; and between science education that is academic (high-status) and vocational science education that is more ‘relevant’ (lower status). These last four, as Wellington himself acknowledges, are forms of the first: certainly taken together they present a picture of the strong dichotomies that are characteristic of the science education debate today.

Problems with the pragmatic rationale for Science for All

To begin with we will consider the pragmatic rationale that citizens will be better able to cope with life in today’s technological society if they have some knowledge and confidence about science. The distinction between this form of the pragmatic rationale and the instrumental democratic rationale that that quality science education is needed to enable citizens to fully
participate in social and technical decision-making processes is frequently blurred. The lists of content necessary for coping in society seem to be very long: if all of this science knowledge is essential in order to cope with life in today’s world it becomes difficult to understand how adults who have not learned these things manage to live so very successfully.

Atkin and Helms (1992) strongly refuted the pragmatic arguments being made in favour of scientific literacy. Their case, we think, applies equally to the pragmatic rationale for Science for All.

Ordinary, intelligent human beings can get along perfectly well without a knowledge of Newton’s Laws, an understanding of the atomic nature of matter, or even how everyday consumer devices (like TV sets or automobiles) operate. They do it all the time. That is not to say that people are not benefited by such information, of course. But to claim a major place for science education in the schools on the basis of its essentiality in personal and social functioning - as by likening its centrality to reading or calculating - is an exaggeration that misleads the teacher, the student, and the public. (Atkin and Helms, 1992, p.4)

In the context of the United Kingdom, the pragmatic rationale was refuted by Bryan Chapman in 1991. Chapman’s (1991) chief aim was to argue against a “monolithic” compulsory science programme mandated by the English National Curriculum, but the points he made regarding the pragmatic rationale - although he did not, of course, use Fensham’s terminology - are pertinent in a wider context.

Chapman scrutinised in turn each of the arguments being made for the compulsory inclusion of science in the school curriculum: that the sciences were of direct employment relevance; that industry required scientifically competent school leavers; that compulsory science in the preparatory years would increase participation in post-compulsory science and hence increase the output of scientifically and technologically competent graduates entering industry; the establishment of a more favourable environment for scientific and technological enterprise; that science had a particular role in preparing young people for life in a technological society; that education in science develops skills which have applications in many other areas; and that compulsory education in the sciences would encourage more young women to take up careers in science and technology. He concluded that none of these factors provided a convincing reason for the compulsory inclusion of science in a school curriculum in the form proposed by the National Curriculum. In particular:

Education aimed at providing competence in the sciences only makes sense for those who have the potential, and the curiosity to become the originators of the future. Perhaps, for the others, there are more important priorities. (Chapman, 1991, p.55)

In other words, ordinary citizens do not, in the course of their ordinary lives, need the detailed knowledge of science that science curricula, for approximately the past decade, have been trying to instil.

There is another form of the pragmatic rationale that should be considered – the idea that a scientifically competent workforce will improve economic outcomes for a country and enhance employment opportunities for individuals. We deal with this aspect of the pragmatic rationale in what follows.

Chapman acknowledged that the cultural argument for teaching science in schools (that education in the sciences is a vital component of everybody’s general education) was difficult...
to refute. This argument can, however, be made for everything taught in a school: it does not
accord special status to science unless science has some special place in culture. From this
point of view science in the form proposed by the National Curriculum need not have been
compulsory nor be allocated such a significant proportion of the curriculum. Chapman also
considered the ‘science for citizenship’ argument, and pointed out that such a priority would
require a very different approach to science education from that proposed for the National
Curriculum. The democratic rationale requires a different approach from the pragmatic one.

Problems with the democratic rationale for Science for All

The instrumental form of the democratic rationale for Science for All is usually framed as the
idea that each individual citizen needs enough science to participate in social decision making
on scientific and technological issues: a ‘just in case’ approach. We see significant problems
with this approach. Firstly, the sheer volume of such knowledge is daunting, secondly, we
cannot always predict which knowledge will be needed in the future, and, thirdly, the
approach adopted is often framed in a scientist’s terms and does not meet the needs of the
‘layperson’.

For example, Solomon (2002) estimates that in the lifetime of any one individual the total
agreed scientific knowledge may increase by 100% and perhaps 50% of what was learned in
school may have become dated. In addition, the science needed for an understanding may be
so recent as to post-date the school years of most adults: for example, this was the case with
the recent BSE (mad cow disease) controversy. If we teach young people the science they
need to understand a current-day issue, it is very likely that the scientific knowledge involved
will last them for a very few years after leaving school: either the science will be dated or the
controversy will be overtaken.

This is not an argument against teaching the science needed to understand current issues - as a
simple example, the science of motion can be very effectively taught in the context of its
implications for traffic and safety. It is, rather, an argument against establishing lists of
content for secondary schools on the basis that these will give a student the knowledge they
will need to ‘handle’ socio-scientific issues for the rest of their lives. A contextual approach,
properly handled, can give a student two important attributes. The first is the capacity to
learn; the second is an understanding of the habits of science that should enable them to gain
the knowledge that they need in the future. At its best, a contextual approach can give
citizens the skills they will need to ‘handle’ the experts in any particular area of need: however, it is both unrealistic and unreasonable to expect that every citizen will be able to
handle every issue. Yet, if it is the case that science syllabuses are driven by this form of the
democratic rationale, and if we take the endless lists of content in science syllabuses as a
guide to what knowledge is considered essential for each citizen, then we are left with this
impression – it seems necessary that each citizen learn rather a lot of science.

Socio-scientific issues may only appear with hindsight. This may be because it takes a
disaster to bring home to us the import of what we (as a society) have done or have had done
on our behalf. Or, it may be that the science required to understand an event is secret, either
militarily or commercially ‘in confidence’. Or, it may be that the science is well known but
has only recently become an issue. For example, in the weeks after a catastrophic tsunami
generated by the slippage of tectonic plates in the Indian Ocean, plate tectonics and the study
of energy transfer by very large waves suddenly gained an extraordinary immediacy, with the
production of a large number of articles, interviews and web sites which provided very good
explanations of what happened. This calls to mind another aspect of the science of socio-
scientific issues; often this science is best learned as an adult from the popular press, because such articles, if well written, frame the science in ways that directly address the relevant issue.

This aspect addresses the third, and we think the most significant, objection to a ‘just in case’ approach to teaching science to future citizens in a participatory democracy. Often the scientists’ framing of such science is very technical and unnecessarily complicated. If we try to give a technical account of this science to our students, in what way does the account we give the future layperson differ from the account we give the future scientist? At present, science education’s response to this dilemma has been to provide for the future layperson a technical scientific education remarkably similar to that provided for the future scientist.

To some extent this has happened because, today, in Australia at any rate, science curriculum is represented as a list of science skills and topics, usually accompanied by similarly detailed and presented standards. It does not have to be this way. As someone who was consulted in the process of development of the Victorian Years 11 and 12 (VCE) Physics Study Design one author, at least, knows that it is possible to specify a Physics course not by the physics topics but in terms of the contexts in which the physics must be learned (Hart, 1995; 2001 provides a salutary account of what can happen to such a visionary course). However, given the power of academic scientists to determine what counts as school science it is difficult to maintain a vision that a science course could and should be about much more than “valid science” (Ziman, 1980).

Curriculum change in school science is a conservative process. Studying science in the senior years of high school is still seen as preparation for the further study of science at the tertiary level. This, in turn, has an impact on the extent and the nature of the change that is possible in the middle school. Our vision for the scientifically literate citizen has become restricted to that of a participant in a scientifically literate workforce, and our vision for that workforce is largely framed by the needs of academic scientists. It is our contention that this vision must change, and that we must see the democratic rationale for Science for All in a new way: our focus should be on examining the implications of our practice for the next generation of expert scientists.

The need for a new vision for the ‘expert scientist’

The iconic movements of science education, STS, Science for All and scientific literacy all have tended to exempt the best science students from ‘General Science’ by seeing the Science for All/STS courses as being for non-specialists only. Certainly, future specialists have not generally been considered in any justification for such approaches, which have rather tended to do as Ziman (1980) does, and recommend “General science for the general public” (p.138) in lower and middle schooling but general studies in parallel with ‘valid science’ for future specialists. Where future specialists have been embraced in discussion of Science for All/STS approaches it has tended to be in support of the inadequacies of such approaches. In doing this the movements have largely transferred the responsibility for science in society from the expert scientist to each individual citizen.

The rhetoric of science education for participatory democracy can too easily be read as a demand that that professional scientist and client become equal in terms of expertise. Why else should we try to teach so much ‘valid science’ to students who will rarely, if ever, in their future lives need to understand this science in this form? In addition, the responsible citizen has been asked to understand the interaction of science with society; to think of science as a human enterprise that may be as flawed as the humans who engage in it; to appreciate that scientific truth is not absolute (in the terms of constructivists, socially constructed) but that the findings of science have validity yet. As Solomon (2002) points out, they are often taught
this science in a context that is connected with personal disasters, a situation that does not make a good setting for learning. We have asked much less of our future scientists. For them we have reserved the specialised science courses that teach ‘valid science’: a much less problematic entity. (PLON in the Netherlands is an exception here).

Almost from its inception the Science for All movement was adamant that the needs of the ‘layperson’ were different from those of the intending scientist. Then, there were good reasons for this dichotomy. Fensham (1985) alludes to a shortage of the technological and scientific manpower needed for the social, economic and defence needs of all countries. Also, the 1950s and 1960s had seen extraordinary effort and expenditure on curriculum development aimed at capturing the imagination of ‘the best’ students for science. If Science for All was to make provision for the other students it would have to clearly assert its difference from courses such as PSSC Physics and BSCS Biology, but not impede the good work such courses were doing.

Our understanding that science must be seen in its context as a product of society has developed over the past twenty years. Both the usefulness of science to society and the disciplinary well being of science itself may be compromised if we continue to treat future scientists as a separate group. In addition, society has changed. It may have been possible to assume through the 1980s that those students intending to continue with science would be the recipients of the type of broad general education that would remind them of their place in society: as we argue below, there is no such guarantee today.

Societal Context in the 1990s and 2000s in Australia

Our Australian home state, Victoria, has a recent history in education policy that has been common around the industrialised world. The 1990s and early 2000s has been the era in which market-liberal thinking, which privileges market forces and valorises the rights of the individual above the needs of the community, has held sway. Initially, this trend was made evident with the election in 1992 of the Kennett State government that instituted dramatic changes to public secondary education. However, it is important to note that the market-liberal philosophy that drove the reforms of the Victorian State government referred to above was not uniquely that of the Liberal/National party then in power. Indeed, a similar trend in tertiary education was, at the same time, although much less dramatically implemented, being presided over at the Federal level by a Labor government. Market-liberalism is a trend that transcends party politics and which has transformed the ways in which we are able to discuss the purposes that a community might have in undertaking the education of its children. By 2000 the political landscape in Victoria had changed dramatically; the Kennett Coalition government that had driven the school closures and restructuring of the 1990s was out of office, but even under a Labor State government the drive that the Kennett Government had initiated remained. Marketisation has come to be seen as the natural order of things in most spheres, including education.

Marginson (1997) traces the origins of market liberalism back to 1968 and Margaret Thatcher. In a speech to the Conservative Political Centre Party Conference (in England), she outlined her fundamental beliefs. Government should in almost all cases not provide or legislate for anything. People should be encouraged not to rely on the state but to enrich themselves by their own efforts. She argued for freedom for the individual of a type that Marginson (after Hayek, 1978) calls negative freedom (economic freedom, freedom from restraint) rather than positive freedom (democratic freedom, the freedoms of the politically active citizen). Market liberalism was unfashionable in 1968 when Margaret Thatcher made her defining speech but in its form of public choice theory drives political and economic thinking today.
Of particular importance to our thinking has been the manner in which market liberal/public choice theory has defined ideas of the individual and of freedom.

The market liberals … wanted a social order based solely on individuals linked by contract and exchange; and consistent with this objective, the tools they used to explain reality were individualist in nature … There was no such thing as ‘society’ distinct from individuals. Wealth was not created by societies and distributed to its individual members: it was created by individuals, and ‘society’ could only take it away … Individuals were motivated only by self-interest and self-love. (Marginson, 1997, p. 104)

The reading of the individual as oppositional to society has been a deeply damaging aspect of the application of market liberal thinking to public institutions such as education.

The classical liberal individual, patrimonial governance

The social theory that one author (Smith, 2006) argues to be most useful in understanding the impact of market-liberal thinking upon education uses two key concepts, that of status and contract. In the context of justice and legal matters, a person has status because of their positioning within the community. This status is largely acquired through family relationships; in a classical liberal sense a woman has status as her father’s daughter or her husband’s wife while a male, on the other hand, has status as a son until he reaches an age at which he could be deemed to have reached maturity, and a life stage at which he has a degree of economic independence. At this stage he may gain the ability to become a contractual individual. Within classical liberal framing, contract is seen as a free agreement between individuals without respect of status, indeed, status and contract are seen as mutually exclusive; contract is seen as a liberating device that frees the individual from the obligations of status: once contract is in place, status becomes redundant.

Governance that is modelled “along the lines of a patrimonial household, owing care and protection to those who are viewed as both the subjects and dependents of this household” (Yeatman, 2000, p.170) is patrimonial governance. To those within a patrimonial status-driven community, contract becomes attractive because it offers the possibility of an independent position and freedom of choice to those who in the classical, patrimonial, framing of status are relegated to the position of dependent. Patrimonial governance is not restricted to the classical liberal state but is built into the very foundations of liberal democracy. In a very real sense the modern welfare state is also built upon the ideals of patrimonial governance – “The welfare state, as well as the colonial state, were both structured by this conception of state administration as the protection of the weak and needy by a state conceived as though it is a large and independent household.” (Yeatman, 2000, pp. 174-175)

Crucially, the liberal ideal is framed in terms of interactions between individuals. The classical liberal individual may not have been identical to Marginson’s “individualist economic anti-citizen” (1979, p.103) but certainly, he (choice of pronoun intentional) was first and foremost an individual, and society was framed in terms of consenting and contracting individuals. In this conception of individualisation, society is barely relevant. Patrimonial governance is conceived entirely as relationships between individual householders: Yeatman asserts that it was a classical liberal model that Margaret Thatcher reverted to in her insistence that ‘there is no society, only individuals and their families’.
Post patrimonial governance: a neo-liberal individual and the new contractualism

Market liberalism insists that contractual standing must be made available to all individuals. However, the freedom to avail oneself of this standing is dependent on the capacity to form contracts, a capacity that market liberal theory assumes is equally available to all. Availability is more problematic and complex, but this problem is not acknowledged by market liberal theory, although often pointed to by its critics. Market liberal theory takes literally the classical liberal belief that contract and status are mutually exclusive. It sees the individual as only an individual, never as embedded within and supported by society.

Most critiques of market liberalism argue for a return to a form of patrimonial governance that will protect those who are unable to operate as market liberal individuals. Anna Yeatman (1995; 1997; 1998a; 1998b; 2000) takes a different approach: she challenges the stark dichotomy between contract and status and points out that contract does not supplant status but builds upon it and continues to draw upon it. Yeatman rejects a return to patrimonialism and instead proposes a new form of contractualism that recognises the embeddedness of the individual within community and the inseparability of contract from status. Yeatman refers to this way of thinking as 'the new contractualism': it can also be thought of as a post-patrimonial contractualism.

Both neo-liberal contractualism and the new post-patrimonial contractualism see social interactions and obligations as being mediated by individual consent; however, the new contractualism insists that the freedom of operating as a contractual individual must be made available even where the availability is problematic. Post-patrimonial contractualism sees each person as a contractual individual but also recognizes that for many individuals the community must act to enable his or her contractual status. Society not only exists, but it is obliged to support and enable the exercise of this new contractualism.

From the perspective of the new contractualism a need for social assistance does not equate to a need for protection. This need can be met in ways that do not automatically cast the person into the role of being dependent upon a patriarchy, but rather in ways that respect the contractual freedom of the person. For example, contemporary anti-discrimination legislation extends the status of contractual personhood to people with disabilities, yet such a person cannot be an autonomous individual without depending on the assistance of others. If this dependency is to enhance rather than undermine the independence of the individual it has to be oriented in this manner: dependence is not perceived as being at odds with a person’s rights to be a contractual individual.

The new contractualism offers a powerful perspective on how we view the individual in the community. In the new contractualism, individuals must be positioned within a community, and must themselves acquire depth of vision: they must see others both as individuals but also as the community that has made the individual possible. The interdependence of contract and status are reflected in another interdependence, that of the individual and the group.

There is no individual apart from a community. We are born into a community and it is through living in this community that we learn how to live. Ironically, it is the imagination we develop while living in a community that allows us to imagine that we might be individuals separated from that community. “The consciousness and capacities that enable us voluntarily to assume obligations are also those that enable us to single out an aspect of this process and imagine that an individual could be completely abstracted from, and separate from, social relationships.” (Pateman, 1979, p.30)
A new vision of Science for All

The implications of the new contractualism for expert scientists

The perspective of the new contractualism has particular relevance when it is brought to bear upon those who expect to lead our community, for example, those who will become our scientists. Every individual comes from a community and continues to depend upon a community for the status that allows them to be an individual. To fail to recognise this is to exploit a relationship, and to jeopardise the contractual status available to all those individuals who aspire to the status of contractual individual. This has particular importance in the context of those who, perhaps, do not obviously need assistance in becoming contractual individuals: for the relationship between client and professional, in particular, in this case, scientist and ‘lay-person’.

… it is impossible for a client to compete with the expertise of a professional, but does this mean that the professional has to exercise the expertise as a paternalistic ‘speaking for’ the client? … [I]f this model is no longer the only one going, and it is possible to think of responding to those who are less able, knowledgeable or expert as individuals who can participate with their own distinct and unique wisdom or sense of self in the relationship, the distinctive inequality of the professional-client relationship can be reconciled with individualised democratic governance. It is not that professional and client become equal in terms of expertise, or even that they are equal in their respective capacities to be individuals, but that the relationship can be governed in such a way as to invite reciprocal respect from each other for their own unique individuality and that of the other. (Yeatman, 2000b, p176)

The implications of this insight for the relationship between the professional scientist and the ‘layperson’ are significant, and central to our arguments about the need to re-vision Science for all:

Both the professional scientist and the client or ‘layperson’ must learn how to engage in relationships that invite “reciprocal respect”. The scientist, as an individual, is positioned in many communities: one of these is the community of science. In this context, we refer to the institution that is Western Science, or, more properly, Research Science. While this institution may have developed in the ‘western world’, it is now an international activity, and there is remarkably similarity across the world, in a wide diversity of cultures, in the type of activity that is funded as Research Science.

Another community in which the future scientist is positioned is the wider community that this scientist will come to serve. In this service role, she or he will have to deal with the range of individuals who need advice, individuals seen as individuals and also as members of the community. The scientist must herself acquire the requisite depth of vision, to see the individual positioned in community and to balance competing interests. This facility will be at least as important as any specialised science knowledge she should have gained. The educated scientist is, and must be acknowledged as a ‘fully fledged citizen’.

Research Science is an institution generated by a community. In a very real sense, what counts as science is negotiated between the institution of Science and the communities within which it is embedded. In addition, society nurtures and educates prospective scientists. It is in the wider community that they gain the imagination and perspective that they will bring to their future work, it is in this community that they learn to be human and citizens. Since the institution of Science is inextricably embedded within this wider community, it is in this
wider community that they learn to be scientists. Any failure of articulation between society and its subculture of Science impoverishes Science – yet the failure of articulation is all too common. Numerous studies within the canon of science education research document a gulf between the formalism of the valid science taught to, and all too frequently practised by, professional scientists and the contextual science needed by citizens faced with a real dilemma (See, for example, Layton, Jenkins, Macgill, & Davey, 1993).

The implications of the new contractualism for Science Education

If we are aiming to generate relationships of interdependence and mutual respect, then it is as irresponsible to educate citizens to blindly trust expert scientists as it is to educate experts to expect blind trust. While science education has grasped its responsibility for the first (by, put simply, seeking to educate citizens to not blindly trust experts), it is, today, still neglecting the second. Science education remains wedded to educating every student to a level from which they could become expert scientists. It is as if science teachers and science curriculum writers believe that the only way a citizen can cope with the requirements of a technological society is to never need to trust the expertise of a professional scientist. At the same time, we do not transmit to our future professional scientists any sense of the complexity and social embeddedness of the work they are about to undertake.

Science education’s attempt to see educated citizens as ‘mini-scientists’ is both futile and self-defeating. Depending on how it is justified, it either draws from a patrimonial view of the autonomous individual that has lost its relevance today or subscribes to a neo-liberal philosophy that denies the existence of community in a manner that problematises the institution of Science (and other communities).

A new vision for Science for All is needed, a vision that demands that we take seriously the education of every scientist as a citizen, and give this education a significantly higher priority than our previous ambition to educate citizens as scientists.

Wellington (2001) offers the following list of things that learners should know: that science has limits - it cannot predict and explain everything and there are other ways of understanding the world; that science is done by people, or by groups and networks of people - it is a human activity and therefore not 100% infallible; that scientific evidence is not always conclusive - decisions are not made on scientific grounds alone but by weighing up benefits, risks, and probabilities; that science does change over time (albeit slowly) and across cultures or nations; and that, above all, science proceeds in a social, moral, spiritual, and cultural context.

This is a list that frames his vision for the scientifically literate person. By implication and in the light of the current assumptions of science education, it is thus a list of what the laity should know. We see it as a list of things that every future scientist should know, and we believe that he or she should learn these things in the company of his or her fellows who will not go on to be scientists. While we agree with Wellington that the minority of students who go on to be scientists should not be forgotten, we do not see that treating them as if they were to be citizens is to neglect them. For us, the neglect would be (even by implication) to allow them to believe that their training exempted them from the common duties of citizenship. Incidentally, from this point of view, the bare minimum pragmatic rationale that science education is necessary for the economic well-being of a country is shown as an impoverished and inadequate base for an educated scientist or citizen.

In the context of this paper we are particularly concerned with the separation that happens when a child is educated to be a scientist. Such an education, which typically begins in secondary school, acts to locate the child in a new community: that of Science. At present, the education that inducts an intending scientist into his or her new community also acts to
remove the child from the responsibilities of an ordinary citizen. We do not claim that this separation is intentional, but we do claim that it happens: it is a consequence of the dualistic thinking that has, at key times, prevailed in science education.

The dualistic thinking that separates the education of future scientists from that of future citizens itself draws from the dualism that sees science as separated from society. From within science education many metaphors have been invoked to describe this separation: indeed the very idea that underpins STS teaching is that Science can in some sense be seen as separated from society. One of the most powerful and widely used of these metaphors is that of cultural border crossing employed by Aikenhead (1996; 2001; Jegede & Aikenhead, 1999).

Solomon (2002) has the following to say about expert knowledge:

There is a problem about expert knowledge. For some two hundred and fifty years, since the time of the Enlightenment, science has pushed ahead with its usual emphasis on abstract thinking. It has always astonished me that the great French philosopher Descartes should have singled out ‘thinking’ as his criterion for ‘being’. Surely sharp bodily pain or paroxysms of love or delight give us far more salient evidence for our existence – ‘I can feel love, therefore I am’? But it cannot be re-written now. Gradually, the situation arose that those with knowledge became a smaller and smaller proportion of the population, but they became more and more difficult to follow. They were an intimidating force of experts, with knowledge so narrow and esoteric that most of the population did not even understand their explanations about scientific matters, and just had to trust them. Normally we give trust only to those in whom we have faith – shamans, priests – and those we love. Anthony Giddens identified this rather grim situation as ‘trust without intimacy’ and suggested that we could lose out if we cheapened trust in this way. (Solomon, 2002, p.28)

Even if we wanted to, it is probably too late to undo the expectation on the part of tertiary educators and, indeed, the community of Research Science, that professional scientists, in order to do their work, must acquire knowledge that is narrow and esoteric. However, this must not be the only knowledge they gain. At the very least they must come to recognise that trust without intimacy is an unreasonable demand to make of the community that supports the smaller community in which they work. In addition, they must come to understand, because they share it, the perspective Jenkins (1997) offers: “[t]he various studies of the ways in which adult members of the lay public engage with science suggest strongly that their interaction is rarely if ever narrowly cognitive” (p.147). We contend that scientists will only gain this perspective if they are taught science from this perspective throughout their primary, secondary and (ideally) tertiary schooling.

A secondary school Science for All education of both future scientists and future non-scientists must adopt a view of science that is more than narrowly cognitive, must acknowledge that science can encourage a perspective that is narrow and esoteric but must ground this narrow view against a wider context. Further, it is imperative, given the narrow and atomistic view propagated by science curriculum documents in the recent past, that our new curriculum documents explicitly acknowledge and frame scientific knowledge in a manner that effectively and explicitly conveys a wider perspective to teachers, their students and the wider community. It is not only “[t]ime to change drivers” (Fensham, 2002, p.9), it is time to reconsider what counts as a road map and to re-vision our destination.
References


