

Reconceptualising the school curriculum to address global challenges: Marrying aims-based and 'powerful knowledge' approaches

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Abstract

Today's school students are inheriting complex and harmful global challenges that are potentially irreversible and which they will need to address. The ability to think critically and creatively, to work in interdisciplinary teams and to understand the importance of a healthy planet for all life will be needed for success. Education has a major role in helping humanity achieve this. This article argues that transformations in both curriculum and pedagogy are required. It offers a potential conceptualisation and examples of what learning might look like to achieve these aims, exemplified by school science education as science will need to play a significant role if these global challenges are to be successfully met. This new conceptualisation draws upon Young's (2012, 2013) 'powerful knowledge' and the rather different approach found in Reiss and White's (2013) arguments for an 'aims-based' curriculum to propose curricula and associated pedagogies that can potentially address the global challenges of our times.

KEYWORDS

aims-based curriculum, global challenges, pedagogy, powerful knowledge

INTRODUCTION

Few would dispute that in the 21st century, humanity faces a number of existential crises. Nearly all of us have grown up in a world where nuclear weapons are capable of killing most people and so many have become desensitised to that risk. It is the increasing possibility of

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irreversible anthropogenic climate change and the threats to biodiversity and sustainability that are more evident, not to mention the possibility of post-COVID pandemics. Currently, issues to do with food and water security are as important to many people. In this article, we use the curriculum arguments of Michael Young and Michael Reiss and John White to examine the possibility that reconfigured curricula and associated pedagogies might help in addressing these global challenges. We present an example from science education to illustrate our arguments as most of the existential threats that we face derive from advances in science and associated technologies (Reiss, 2023).

The curriculum arguments of Michael Young and Michael Reiss and John White

Powerful knowledge, as conceptualised by Michael Young and others (Beck, 2012, 2013; Muller, 2009; Muller & Young, 2019; Young, 2009, 2012, 2014; Young & Muller, 2013, 2016), sees knowledge as classified into two key types: knowledge that is non-specialist in the sense that it is learned through our everyday experiences and from our routine encounters with family, friends and elsewhere; and specialist knowledge that we are most likely to acquire, certainly before we become adults, from school teachers who themselves possess specialist knowledge. Young and Muller (2013) reason that we 'intuitively feel that some knowledges are "better" – epistemically, morally, or aesthetically – than others' (p. 230). They argue that specialist or powerful knowledge acquisition provides a key purpose for schools and other educational establishments that broker these types of knowledge and that this type of knowledge cannot be learned anywhere else because it requires specialist teaching. This is not to denigrate everyday knowledge but to claim that educational institutions have a particular responsibility to provide that valuable knowledge which people are otherwise unlikely to acquire.

Young (2013) also argues that this category of knowledge differs from non-specialised knowledge by having a different purpose and structure. In terms of equality, Young (2012) considers that any curriculum must be a basic entitlement for all, which is difficult to argue against. However, the main prerequisites for knowledge to be 'powerful' seem to be consistent with criteria that define the distinctive contributions of specific school subjects (such as science, languages and history). As White (2018) suggests, this ignores the wider legitimate goals of school education, which include dimensions of social, emotional, political and environmental knowledge less restricted to a conventional subject-based curriculum structure.

Young is clear that his conceptualisation of powerful knowledge does not mean that it has a higher cultural value placed upon it; yet, from a different perspective, gaining this powerful knowledge might indeed change an individual's perceptions of their cultural identity. Even if we accept Young's contention that specialised knowledge needs to be independent of social and cultural influence to be reliable and useful, his view does not consider the cultural and social interpretations of this knowledge and how it is applied. For example, STEM (science, technology, engineering and mathematics) knowledge is presently widely perceived as transformational and highly valued, yet this could conceivably change as cultural and social contexts change (Haslanger, 2008).

In contradistinction to Young, Reiss and White (2013) place great emphasis on knowledge that leads to human flourishing. They argue that the school curriculum should be designed not with the acquisition of powerful knowledge as the fundamental aim but with the promotion of human flourishing both for each learner and more widely. While flourishing is often associated with a specifically Aristotelian understanding of human nature, Reiss and White are broader in their analysis. Without eschewing Aristotle, they argue that 'There are many accounts of the flourishing life' (p. 5). After examining a number of these (including hedonism and desire satisfaction), they illustrate a flourishing life as one filled with 'such things as

intimate relationships, meaningful work, making music, scholarly research, gardening, eating good food, watching an excellent film', though it might be argued that this exemplification simply tells us what Reiss and White find fulfilling. Unlike Michael Young, Reiss and White do not explicitly refer to social justice. However, if we adopt a standard understanding of social justice—one that refers to a fair and equitable distribution of opportunities and resources among people—there is ample evidence that societies that are socially more just are characterised by higher levels of human flourishing (Wilkinson & Pickett, 2018).

In any event, the argument of Reiss and White is one that considers issues that need to be addressed before one gets to White's argument. White is a philosopher of education and Reiss an educator, whereas Young is a sociologist, though, like Reiss, he spent some time teaching secondary school science. White has always been interested in fundamental questions about education. Indeed, in his first book, *Towards a Compulsory Curriculum* (White, 1973), he argued in favour of child-centred education, writing 'the child must be at the centre of all he learns; education cannot be "subject-centred" in this sense' (White, 1973, p. 51). Subsequently, Reiss (2015) aligned himself with White's espousal of child-centred learning, maintaining that education (both curriculum design and pedagogy) should start not with subjects but with the needs of children. The positions of Reiss and White can therefore be contrasted with that of Young who writes '... curriculum theory must begin not from the learner but from the learner's entitlement to knowledge' (Young, 2013, p. 101).

Perhaps the question that needs, then, to be asked, is what knowledge has worth and when does knowledge become important to individuals and to society and, furthermore, to our planet's well-being? Certainly, Reiss and White (2013) do not discuss in much detail what subject knowledge they consider important and from this one might conclude that, if appropriate in leading a person towards a flourishing life, Young's powerful knowledge arguments could contribute significantly to learning. Indeed, in Reiss' and White's one attempt to flesh out in more detail what their arguments might mean for a specific school subject, they write about school science (Reiss & White, 2014) in a way that looks not that dissimilar to what one would imagine that an advocate of Young would argue. We must also recognise that what is considered as powerful knowledge may vary over time and is likely to be influenced by the views of those deciding curriculum content and by the current global, national and local contexts. While the two of us write from a UK perspective, our hope is that our arguments apply more generally.

As Young (2014) points out, it is important to provide students with the fundamental ideas presented by specialist knowledge; after all, how would a student know whether they wanted to pursue a subject further without a knowledge of what it is and how it could be used? Although Young (2014) argues that a curriculum should not be focused to too great an extent on helping young people get jobs, the knowledge that young people gain in education is often criticised by employers, which suggests that current curricula may need some attention from this perspective. Young (2014) argues that offering opportunities to learn academic knowledge through disciplined study can improve social justice. There are merits to this position as knowledge can be valuable in leading to better life chances for us all. However, it is as important that we understand how this powerful knowledge is used in society and how it impacts upon us (Reiss & White, 2013) and how individuals' development and understanding are established through complex relationships across society (Lim, 2015). There are some unanswered questions, limitations and potential alternative ideas that need to be explored in order to create a forward-looking curriculum and associated pedagogies (cf. Deng, 2021).

The response of the curriculum to today's global challenges

Taking into consideration the global challenges we face, such as climate change, water and food security and a range of threats to sustainability, we need to recognise that curriculum

change in our schools is an imperative if we want to change perceptions in society towards the environment and our use of resources. High-profile decisions are being made by world governments and others to address the many global issues we are facing (Dormido et al., 2022; UN, 2017) and so it is important that school students are given the opportunity to develop their agency to help them to engage with these discussions and are enabled to gain the knowledge and skills to find solutions to the challenges they will inevitably face. Having an educational aim that has the interests of the learner as its focus is consistent with both Young's and Reiss and White's curriculum visions. However, what is fundamentally important in this curriculum construction is determining what knowledge and skills are most effective in preparing learners for successful, meaningful and flourishing lives. A curriculum must equip learners with the knowledge they will need to engage with the global issues of their time.

This article therefore asks whether the curriculum approaches of Young and Reiss and White are essentially complementary and when considered together could create rich, cohesive and effective learning experiences that are and will be needed, and manifest clear environmental, social, political and culturally awareness in order to address such things as the Sustainability Development Goals set by UN (2017).

Historical perspectives on the effects of school curricula

Historically, it can be argued that educational structures have too often been employed to perpetuate social stratification between those who expect and often do hold power and influence in society and those who do not hold power and will be unlikely ever to have much influence (Mann, 1987; Robinson & Harris, 2000). Bourdieu (1977) argued that the school curriculum and pedagogies legitimate the dominant culture by normalising it. The cultural capital of the dominant class is a feature that is so pervasive in society it becomes the focus for all (Bourdieu, 1977), even though it is unattainable for many and should possibly be called a pseudo-cultural capital aspiration for most. Both Reiss and White (2013) and Young and Muller (2013) are attempting to change this situation towards an emancipatory curriculum, yet from philosophically quite distinct positions. Understanding the relationship between education and society is fundamental for educational transformation (Apple, 1982). Accordingly, the re-thinking of curricula is critical for influencing the knowledge with which learners engage to support them in transforming their understanding of self in relation to others, including those in the dominant societal groups, and so, one would hope, help move society towards greater social justice.

In many countries, schools have become increasingly market-led. Although the manifestations of these influences on education are highly contextualised, in principle all are driven by a desire to build human capital that can better contribute towards economic productivity from early childhood (Savage, 2011). To ensure that these economic needs are met, both curricula and pedagogies are typically tightly controlled as evidenced by the increased performative nature of educational systems in many countries, a commodity that aims to produce a desired workforce product (Saunders & Ramirez, 2017; Tyler, 2015). In curriculum design, it is important to reflect on how our educational policies are causally related to the global challenges we now face. One might argue that our current curricula are already subject-focused and have clear aims, yet not those that Reiss and White (2013) advocate.

Young's approach to the curriculum does little in itself to identify or challenge inequality, which is often derived from the social divide with sustained social privilege and affluence being intimately connected to social and political processes in society (Anderson, 2020). It is therefore difficult to see how truly effective such a curriculum (one based on powerful knowledge alone) would be in improving social justice in any society that is so steeped in

social division. To argue that providing opportunities to learn specialist subjects such as science and mathematics will ultimately reduce social injustice seems disconnected from the reality of who has 'real' societal power and influence. Certainly, people may earn more by improving their education, and potentially enjoy a higher social status too, yet it is unlikely that many will hold power and influence. Power and influence so often tend to be a birth right and have little to do with the acquisition of powerful knowledge. It is also incorrect to assume that access to powerful knowledge always leads to better careers and greater prosperity than other career routes. Anderson (2020) highlights the limitations of the over-emphasis placed upon knowledge acquisition being seen as the key factor in reducing inequality and suggests that a wider appreciation of the highly complex social and political factors that operate in schools and society more generally is needed. An interesting take on the role that powerful knowledge might play in ensuring social justice is provided by Wrigley (2018) who argues that a socially just curriculum needs to draw upon the vernacular (i.e. 'everyday' in Young's terminology) knowledge of marginalised groups as well as the canonical knowledge of academic disciplines (i.e. that which Young advocates) to produce truly powerful knowledge and a curriculum for social justice.

Young's ideas might be taken as meaning that academic knowledge is superior to vocational or skills-based knowledge, a position which would certainly not be conducive towards equity for all. However, this would be to misread Young, who has, in fact, written extensively about how both academic and vocational education might be strengthened (e.g. Young, 2004), while there is a growing literature on how Young sees knowledge as being important for vocational education as well as for academic education (Guile et al., 2018). Creating a hierarchy of knowledge in which academic knowledge always sits above vocational knowledge is unhelpful. Wheelahan (2018) points out that powerful knowledge is needed for successful vocational education and argues that we need institutional conditions for the development, elaboration, codification and institutionalisation of theoretical knowledge in vocational education.

Young and Muller (2016) maintain that STEM knowledge is the current driver for change in society, and in many respects this seems to be correct, as evidenced by the emphasis being placed on STEM education (e.g. Archer et al., 2013; Bertram, 2014; CBI, 2015; Croak, 2018; Kennedy & Odell, 2014). However, as Young points out, there is a difference between knowledge that can be powerful for an individual's academic progress and knowledge of the powerful (i.e. of those who are powerful). A curriculum that provides opportunities for all to flourish and prosper may indeed need to provide, and one might argue should offer access to, powerful knowledge, yet in terms of influence in society, powerful knowledge acquisition may be something of a 'red herring'. Actual power in society, as Young (2012) suggests, derives from 'knowledge of the powerful' which helps to keep the ruling elite in their dominant positions.

Social justice and equity for all can be improved by providing equal access to high quality learning. However, we need to be discerning about what knowledge school students are asked to learn and why. Young's 'powerful knowledge' curriculum is one, arguably very important, solution that has been offered, yet it seems to be geared towards the more academically minded learner, and so it is unclear how it can eradicate current social and economic stratification. Surely, adopting an ethical curriculum that considers how social justice can be achieved and creates an educational experience that involves students in dialogue about how they might help to solve some of the global issues is worth pursuing.

Indeed, sound education about the importance of global challenges provides a strong educational aim, and for students to develop individual and indeed collective agency to find solutions to these challenges necessitates the arguments of Reiss and White and of Young being positioned as complementary (cf. Reiss, 2018a). To achieve the fundamental aim of human flourishing, students need powerful knowledge. In this sense, a curriculum

that acknowledges the need to work towards equipping our young people to meet the many global challenges they will face must be an educational goal for all. One way to seed this change would be to include the UN (2017) Sustainability Development Goals within school curricula. The world is facing many anthropogenic challenges and STEM is at the heart of both the causes and potential solutions of many of these. However, an important aspect of societal change requires an understanding of how we change human behaviours and how we got to this situation; accordingly, application of a range of other disciplines, including psychology, sociology, history and geography, must be key drivers of the changes we know are necessary.

Designing a curriculum that works

School curriculum design is a sophisticated process that requires attention to a wide range of complex, often intercorrelated factors. As we have argued, there are merits in both a powerful knowledge and an aims-based curriculum and adopting one would not necessarily preclude the other in principle. However, it could be argued that for specialist knowledge to truly become powerful knowledge it must be applied in a way that responds to individual and societal needs and effects a positive change for all (Lukes, 2008), where the individual, society and planet all benefit. It is therefore proposed that a purposeful and worthwhile curriculum should combine the key ideas from Reiss and White (2013) and Young (2013, 2014). In such a curriculum, there would be space for specialist knowledge to be acquired by all learners and then to be applied to the global challenges faced by humanity (and other organisms). In the case of school science, such a curriculum would provide learners with a secure foundation in disciplinary knowledge and the skills associated with this and support students' understanding of their place within and responsibilities towards society, thus being more likely to result in greater scientific literacy and enhanced social responsibility. As Moss and Hayden (2008) argue, education should be at the heart of creating a healthy and prosperous society, where people can achieve their ambitions, yet these should not be to the detriment of others.

It is also important that a curriculum provides learners with opportunities to develop the ability to think rigorously, drawing on their subject knowledge. Lipman (1988) advocates a curriculum that is focused upon critical thinking because it develops 'skilful, responsible thinking that facilitates good judgment because it relies upon criteria, is self-correcting, and is sensitive to context' (Lipman, 1988, p. 39). Within such an educational framework we argue that learners need to be provided with opportunities to learn the appropriate disciplinary knowledge that ensures deep understanding of and ability to contribute towards solutions to global issues. As important as disciplinary knowledge is, learners must be shown how such knowledge can be critically, creatively and thoughtfully applied to improve the lives of themselves and others.

Gearry and Berch (2016) distinguish between primary or 'folk domains' of knowledge, which we are hard-wired to learn through both social and environments interactions that 'emerge from a combination of inherent cognitive biases and evolutionarily expectant experiences' (p. 219), and secondary knowledge that needs explicit teaching, such as disciplinary knowledge. One of their conclusions (postulates) suggests that learning might be more effective if secondary knowledge has close proximity to an individual's supporting primary systems (schemata). This suggests that learning is most effective when connections between new knowledge and our social, emotional and lived experiences are enabled.

We know that many young people feel very strongly about the social and environmental issues they face and take seriously the decisions they will be required to make, and so there is no better way to engage learners than immerse them in the issues that will impact upon

their lives (Bentz, 2020; Dunlop et al., 2022; Kirejczyk et al., 2020; UNESCO, 2022). Tackling these issues will require scientists and others to work collaboratively, drawing between them on the work of a range of disciplines. However, there has been hesitation in the curriculum literature as to the benefits of interdisciplinary learning in schools (e.g. Donnelly, 2002). While widely advocated, the evidence in school science that such learning promotes learning is, at best, somewhat thin, though a recent programme of work (the Big Questions in Classrooms initiative <https://www.templetonworldcharity.org/our-priorities/big-questions-classrooms>) suggests that it may be effective (e.g. Pearce et al., 2021). However, for it to be effective requires, at the very least, careful curriculum planning. It also seems likely that the amount of time a school student should spend on interdisciplinary learning would probably be modest compared to the amount of time spent on disciplinary learning, if learning is to be most effective. As a result of a case study of a secondary school where interdisciplinarity was a key component of the school's philosophy, McPhail (2018) concluded 'that curriculum integration should be utilized not as a main means of curricular delivery but as a supplementary opportunity to put disciplinary knowledge to use in certain, well-planned contexts' (p. 56).

A potential learning structure that focuses upon a global issue is presented in Figure 1 to provide an example of how application of disciplinary knowledge within an interdisciplinary context can help to show how knowledge can become powerful knowledge. The illustration shows how a key issue facing the world can be investigated through the application of specialist knowledge, with key decisions processed through integrating knowledge and expertise from different subject areas, such as the humanities, sciences and philosophy. Different issues may require different contributions from subject areas and a complex integration with societal, political and environmental influences. We do not advocate that only fragments of disciplinary knowledge that fit a theme or global problem are selected and learned as this may limit disciplinary rigour and essential progression which can lead to shallow understanding. Rather, disciplinary knowledge should be drawn upon and applied within the context of a topic or theme, in this case global warming. Such a curriculum structure, that is learning disciplinary knowledge within a frame of a global issue to which it can be applied, demonstrates an important purpose for knowledge.

A creatively designed curriculum that provides greater diversity in study, driven by a passion to look after our planet, and one that affords a greater degree of student autonomy is one to aim for. One might argue that a political framework could also be introduced, one that considers how decisions can be politically motivated on the global stage. Certainly, these ideas align with those of Maude (2017) who argues that a curriculum needs to encourage learners to engage with knowledge in a way that develops their world view by critically exploring new and creative ways to solve problems ethically, and in doing so develop abilities to synthesise, analyse and interpret information within social, political and environmental contexts. It has been known for a considerable time that what is examined in schools tends greatly to influence what and how material is taught in schools (Madaus & Keillor, 1988); to drive successful implementation of a new curriculum, high-status assessments need therefore to reflect the changing focus towards sustainability.

Arriving at a society that provides equal opportunities for all individuals and for communities to flourish and prosper (Reiss & White, 2013) requires, in part, an education system that explores the important relationship attributes of honesty, kindness, collaboration, integrity and empathy within an aim of caring for each other and our environments. Without applying these attributes in a mutually beneficial way, specialist or disciplinary knowledge does not become powerful in the sense of enabling positive transformational development for all. Indeed, we would maintain that such attributes are as important as Young's specialist knowledge. Curriculum development, in terms of subject content, should also focus on the inequalities experienced by many in society. Both Young and Reiss and White argue that all school students should have equal access to much the same curriculum. There should be a

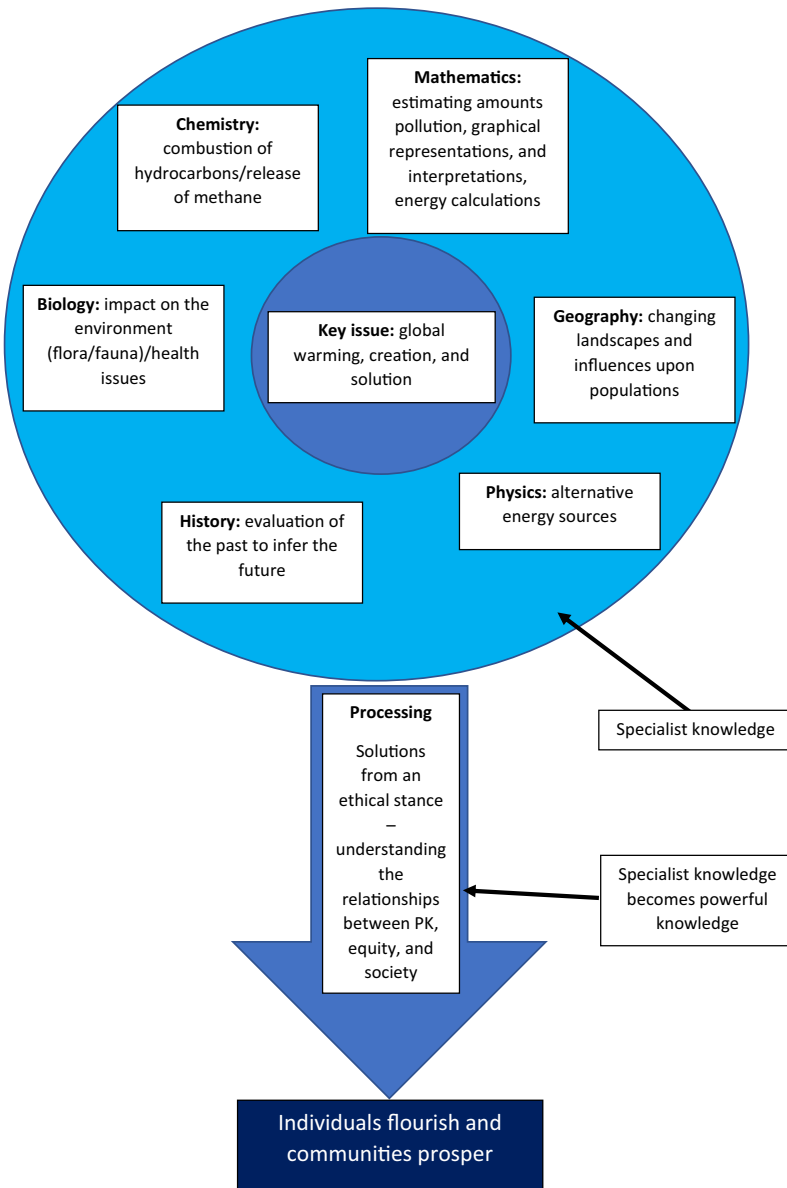


FIGURE 1 Illustration of how interdisciplinary learning can help develop 'powerful knowledge'.

moral imperative to improve social justice awareness, for without this how can society even recognise the need for change? There are numerous ways in which this might be envisaged. Figure 2 illustrates a social justice approach to one standard school science topic, sex determination, that has been tried-and-tested by the first author. It looks at the impressive contributions to our understanding of sex determination that Nettie Stevens (1861–1912) made, despite the disadvantages experienced at the time by women who wanted a career in science.

Table 1 provides some suggestions related to Figure 2 that might support socially informed learning through school science. Students would learn about X and Y chromosomes within the wider topic of genetics by engaging with specialist knowledge. Advances in our understanding of genetics since Nettie Stevens' time mean that students can be taught a

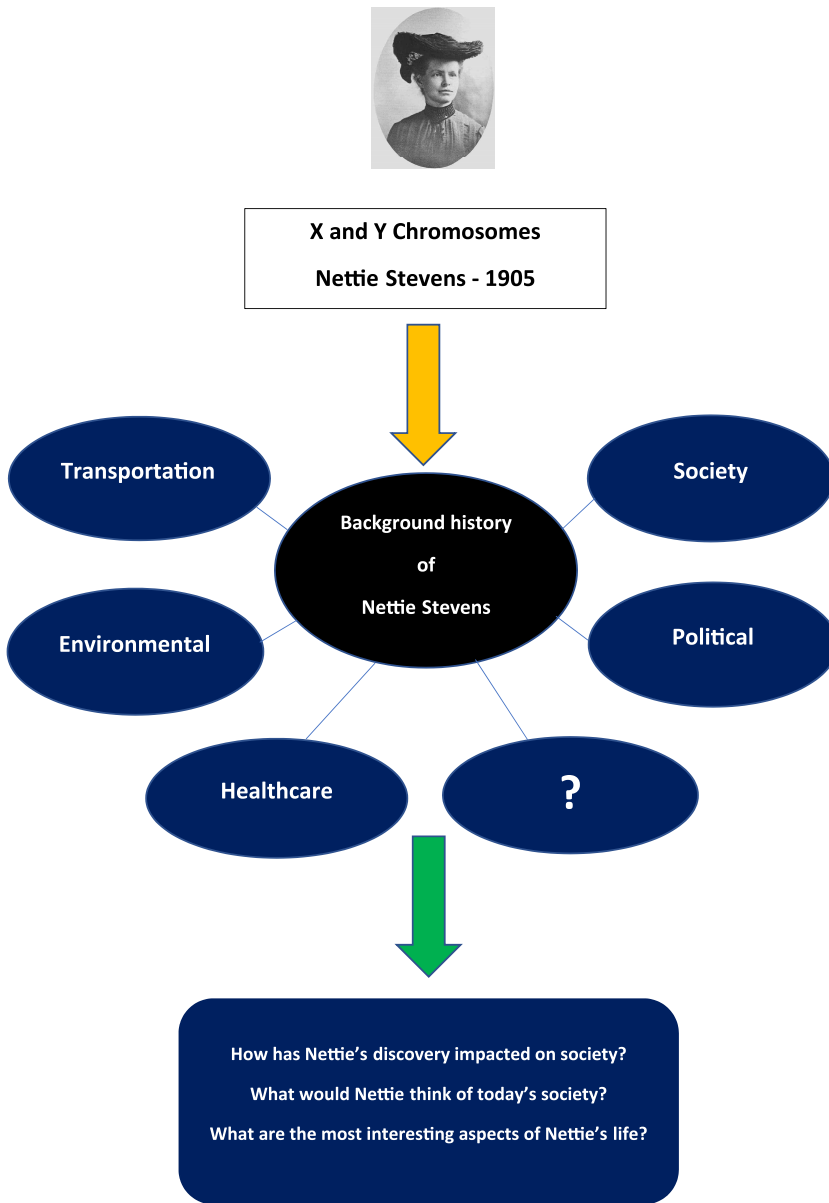


FIGURE 2 An example of how learning might be organised. The photograph of Nettie Stevens is taken from https://en.wikipedia.org/wiki/Nettie_Stevens#/media/File:Nettie_Stevens.jpg.

less essentialist version of human sex determination. While the XX (female) and XY (male) distinction holds for most humans, sex determination is the result of chromosomes, hormones, life experiences and human autonomy interacting in ways that are still not entirely understood (Reiss, 2018b). The net result, including individuals who are intersex, is that it is difficult to defend the notion that human sex is entirely binary. This could be further developed to draw students into ethical discussions about the way our knowledge of genetics (whether in regard to human sex determination or more generally) is applied throughout the world and in different societies. Who decides what should be used and for what purposes? Learning experiences should be introduced flexibly and entail the utilisation of a range of creative and dynamic ways to engage students and facilitate learning, so as to help them

TABLE 1 Suggested questions in relation to [Figure 2](#) to support learning and the development of ideas through school science.

Focus	Possible questions and ideas
Nettie's life	Explore Nettie's life from her birth to her death. How hard was it for Nettie to demonstrate her abilities in science? Whom did she work with? What other discoveries was she involved in?
Society	Place yourself in the society of Nettie's time. What would your life be like? What would your diet be like? What education would you receive? What are the new scientific discoveries in Nettie's day? What didn't people know? What couldn't people do?
Transportation	How did people get around? Choose another country. How would you get there today? How long would it take? How would you travel to this country in Nettie's time? How long would it take?
Political	Who was the government of the day? Who could vote? What laws were being passed during Nettie's lifetime?
Environmental	What are the main changes to our environment since Nettie's time? What has happened to the number of trees? How many species have become extinct in this time? How many new species have been discovered? What has happened to the air quality? This might be a local investigation.
Healthcare	What healthcare would you have received in Nettie's time if you had a very sore throat? What about a broken leg? If you were seriously ill with cancer, how would you be treated? How is this different to today?
Ethical appreciation	Debating whether genetic manipulation/engineering is ethical can be very motivational for students as it impacts upon their own lives
Other	What else do you want to find out about in Nettie's time?

acquire powerful knowledge and enable flourishing, both for themselves and for others. Such considerations begin to move the argument towards a consideration of pedagogy, considered in the next section.

So, what of pedagogy?

The material in [Table 1](#) and [Figure 2](#) indicates how pedagogy might be used to populate a particular topic in the science curriculum. The material manifests a range of approaches, collectively intended to develop a contextualised knowledge and sets of skills that increase awareness of past and present political, social, environmental and cultural dimensions of life. This teaching approach could enhance critical thought and provide learners with opportunities to engage with science through social, political and environmental lenses, as discussed by such science educators as Reiss (2019), in the context of sex and sexuality, and Guerrero and Torres-Olave (2022) more generally. Lambert (2018) explains that curriculum and pedagogy, although generally considered as distinct entities, 'merge into one highly practical set of operations' (p. 358). He argues that Young and Muller (2016) explain in detail the why of what should be taught, yet do less well with the how, the pedagogy. Much the same criticism might be made of Reiss and White as they, like Young and his colleagues, focus on matters of curriculum design. Yet, pedagogy is crucial. The best curriculum in the world is of little value if a teacher fails to understand the thinking behind it and is incapable of teaching it well. Equally, a great teacher can bring a poor curriculum alive and help develop in their student knowledge and understanding and a wide range of skills from subject-specific ones

to more generic ones like critical thinking, teamwork and bringing together learning from different parts of the curriculum.

In the examples of topics considered above, a teacher might interpret the 'how to teach/learn' in different ways. However, if we are to engage with the conceptual framework provided by this interpretation of curriculum and pedagogy, teachers need to provide students with opportunities in context and to explore these ideas. In this way, learning has a degree of social construction and is more student-led. Duran and Dökme (2016) found that using inquiry-led pedagogies enhanced students' abilities to think critically, and so such pedagogies might be useful when educating for sustainability. There has been a long debate as to the possible role of inquiry-based learning. While many science educators are committed to it, more conservative commentators see it as indicative of an abandonment of proper instruction, replaced by a commitment to a child-centred form of teaching. Christodoulou (2014) identifies 'Projects and activities are the best way to learn' as one of her seven 'Myths about education'. Viilo et al. (2011) explore the crucial role that teachers have in enabling students to undertake collaborate inquiry-led learning practices.

Specifically in relation to school science, inquiry-based science teaching, at its worst, can make unrealistic demands on learners and take up inordinate amounts of time. Indeed, it has long been realised by empirical researchers that minimal guidance is not an effective way of learning science (Kirschner et al., 2006; Kirschner & van Merriënboer, 2013). However, inquiry-based science teaching can be motivating for learners, help them learn science (National Academies of Sciences, Engineering, and Medicine, 2022) and give them a better understanding of how science is undertaken by professional scientists. Mourshed et al. (2017, p. 8) used PISA data to identify what, in terms of performance on PISA science tests, the optimal balance was between the extent of direct instruction and the extent of inquiry-based approaches, concluding that it is the use of teacher-directed instruction in most to all classes and inquiry-based learning in some. A systematic review of the outcomes of Independent Research Projects in school science (characterised by an inquiry-based approach and high levels of learner autonomy) for upper secondary students found that 'Benefits were identified in relation to the learning of science ideas, affective responses to science, views of pursuing careers involving science, and development of a range of skills' (Bennett et al., 2018, p. 1755).

Conclusion

We need an urgent educational reform that formulates and delivers curricula that engage students in acknowledging and exploring current and potential global issues. The curriculum should be enacted through pedagogies that develop skills of creativity and critical thought. This article argues that serious consideration needs to be given to the implementation of an aims-based curriculum focused on environmental, social and political issues, supported by the learning and application of appropriate powerful knowledge.

The learning ideas presented in this article demonstrate the importance of applying specialist knowledge for understanding, yet within contexts that have clear aims derived from both individual and societal perspectives, ensuring that specialist knowledge can truly become 'powerful knowledge'. The underlying approach is predicated on the understanding that an individual's interaction with knowledge should support personal development, and lead to improved social and cultural justice through enhanced and proactive interaction with social, political and economic influences on our planet, our home.

Learning about contextualised science within a framework that takes seriously issues both of social justice and of the pressures on the environment not only demonstrates the

importance of science to all of us, it also makes clear the consequences of applying science inappropriately. Learning can be envisaged as a flexible and rewarding study along routes that offer both vocational and academic learning or even have the potential to integrate both, dependent upon learners' interests and needs.

Scientific literacy, which currently seems somewhat to be in short supply (Jufriada et al., 2019; Prastika et al., 2019), would be improved and so contribute to improving socio-scientific decisions made that affect us all. However, it would be naïve to presume that such learning alone would lead to significantly greater individual or collective efficacy in society or to the attainment of social justice. Nevertheless, the journey towards enabling individuals to see themselves more clearly within societal structures and to have greater autonomy in decisions they personally and collectively make would be enhanced, and this can only be good for the individual, society and for our planet.

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No potential conflict of interest was reported by the authors.

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ETHICAL STATEMENT

No ethical issues arose in the conduct of this research.

GEOLOCATION INFORMATION

The data were collected in the UK.

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