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Towards a whole-school approach to educating for hazard literacy to address the climate and environment emergency

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Upon reasonable request, the datasets of this study can be available from the corresponding author.

Abstract

In this paper, I show how my thinking about how school education should respond to some aspects of the major social and environmental issues facing society has changed over three decades. I conclude that while a radical reappraisal of the school science curriculum is much needed, there is also an urgent need for every school subject to contribute. I outline what contributions a number of subjects might make and suggest that school leaders, text-book writers and curriculum policy makers could stimulate thinking about how these contributions might best be realised. Underpinning the contributions of many of the subjects is an aim to promote much more critical thinking among young people and the teaching of skills such as the ability to evaluate the quality of different sources of evidence. If we can educate young people to be discerning and critical users of a range of media, we may reestablish greater trust in individuals and institutions who are evidence-based and best able to address the climate and environment emergency.

Keywords: hazard literacy, climate and environment emergency, risk, school curriculum, school, subjects

Introduction

Twenty-five years ago, Peter Gill and I, both ex-teachers (mathematics and science respectively) and then colleagues at King's College London, discussed how unsatisfactorily risk was covered in the school curriculum and imagined how it might be taught better in the classroom. A similar concern had been expressed earlier by Briscoe – a US-based academic. In his letter to the editor of *Risk Analysis*, Briscoe opined that "The almost total lack of risk teaching in high school consumer education classes and the minute progress in developing national risk standards are a serious indictment of the government and scientific and educational communities." [1]

Having done some reading and thinking about the issue, we presented our ideas at the Annual Conference of the Association for Science Education (ASE) held at the University of Surrey in January 2001. The feedback that we received from audience members encouraged us to write a paper for *School Science Review*, an ASE publication aimed primarily at teachers and teacher educators. We concluded the paper as follows:

Authors' contributions
The article is prepared by a single author.

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> In the world of the early 21st century the effects of the scientific enterprise on environmental and health issues are of rapidly increasing importance to the individual (see, for example, Beck [2]). An understanding of how risk is dealt with is vital so we, the public, can make informed judgements that will have political effect. Without the necessary knowledge, society is left with the precautionary principle in its simplest form which, as we have argued, could lead to the severe curtailment of scientific research. Few science teachers want that, but to avoid that scenario there needs to be *a radical reappraisal of the school science curriculum* [3]. (italics added)

As we move towards the third decade of the century, not much has changed. Indeed, the COVID-19 pandemic emphasised that only limited proportions of the public understand risk theoretically or practically. The challenge to educators has been made worse by a proliferation of disinformation and misinformation which has eroded public trust in science and scientists. More and more people turn to social media rather than official bodies [4]. The situation is dire; the rise in the number of deaths due to measles in the US, for example, is both tragic and totally avoidable. Julie Millican, the vice-president of Media Matters for America, a media watchdog, has observed that "information and disinformation spreads faster than you can check it. It takes a lot longer to factcheck something than it does for it go viral", adding, "factchecking can backfire. People so distrust institutions that factchecking can validate the misinformation in their minds and make them more inclined to believe the lie they believed in the first place." [4].

In this paper, I advocate for a much broader response to the climate and environment emergency than simply changing the science curriculum. I also discuss how schools might respond to the loss of trust in science, scientists and other key institutions.

Hazard Communication and Hazard Literacy

Some years before Peter and I wrote our paper, Mark Bailey had written a doctoral thesis entitled *"The social process of hazard communication. A case study of worker right-to-know"* [5]. According to his obituary, Bailey "researched, developed and implemented worker hazard training for the Oil, Chemical and Atomic Workers Union" [6]. In a section headed, 'The limits of science in dealing with risk', Bailey wrote: "Even if workers are adequately literate, a complete understanding of many hazards requires "hazard literacy" involving expert scientific and technical knowledge" [5]. Bailey used the term "hazard literacy" just once in the three-hundred pages of his thesis but, as far as I can tell, he was the first person to do so. His focus on reading skills is, arguably, too narrow when thinking about hazard literacy three decades later, as I will discuss below.

One of the subordinate questions in Bailey's thesis is "What is risk?" and he identified two positions taken up by protagonists in his case study: "risk is a determination of science" and "risk is a social construction". Bailey favoured the latter conceptualisation and concluded that "all parties potentially affected by the risk — including scientists, policy makers as well as target audience — are responsible for risk assessment and management" [5]. That is to say that the public have a key role in deciding just how much of a risk something is – which is why education about hazards and risks is so important for all members of society not just for scientists and policymakers.

Bailey would probably have been in sympathy with the views of Ulrich Beck whose book "*Risk society. Towards a new modernity*" was published in 1992. This work is not cited by Bailey

but the two authors have overlapping views. Indeed, Beck writes "In contrast to all earlier epochs (including industrial society), the risk society is characterized essentially by a lack: the impossibility of an external attribution of hazards. In other words, risks depend on decisions, they are industrially produced and in this sense politically reflexive" [6] should be [2] echoing Bailey's argument that everyone has a responsibility for the social construction of risk.

Peter and I, in our 2001 paper, noted that "The whole problem with risk is that it is a mix of hard science and mathematics, sociology, psychology and politics" [3]. To fully understand risk in the context of our post-industrial age, students require knowledge and skills from a number of disciplines and an awareness of how values, culture and politics impact on risk assessment and management.

Writing in the US context a few years earlier, Briscoe had argued for something much less ambitious but certainly an improvement on what he saw being taught in schools:

> Public education should introduce the concept of risk (perhaps with gambling theory), provide an understanding of utility theory, and help the student to understand the various risk perception factors and to apply these concepts to the purchase of various types of insurance and to the use of safety devices such as smoke detectors and seat belts [1].

These everyday examples of risk education would provide the groundwork for something more appropriate to the needs of students in the future. However, I believe that we need a much wider curriculum response to hazard literacy education if society is to adequately respond to the growing challenges facing it.

Hazards, Risk and Soft Disasters

The majority of the public are aware of at least some of the hazards surrounding them in everyday life even if they do not fully understand them. People of my age have lived through Chernobyl, HIVAIDS, bovine spongiform encephalopathy (BSE), COVID-19, the introduction of genetically-modified crops, acid rain, the hole in the ozone layer, urban air pollution, etc. More recently, anthropomorphic climate change has become the dominant 'wicked problem'. We are increasingly aware that climate change is exacerbating the frequency and the extent of natural disasters such as floods, forest fires and catastrophic heat waves [7]. Indeed, one might argue that, as a species, we have been particularly effective at hastening our own demise.

Few, if any, of us can be experts in the range of subjects needed to understand all the hazards facing us. What we need is some understanding of cause and effect, a critical appreciation of the interrelationship between economics, industry, politics and society, enough numeracy to understand data presented to us through the media, and the ability to judge the veracity of sources of information. Without them, we are likely to fail to make wise judgements which could dramatically impact on our lives. Indeed, numerous examples of people dying through ignoring advice related to their health are reported in the media every day.

Many of the hazards that I listed above can be defined as controversial – and, thus, liable to be subject to disinformation and misinformation. The resulting undermining of trust in experts, governments and institutions has been characterised as a 'soft disaster', that is, an example of "environmental and political crises that emerge only slowly but at high cost to society" [7]. Soft disasters can include the loss of public trust and confidence in industry, scientists and decision-makers. I would argue that the oversimplification of complex issues by a predominantly right-

leaning media simply adds to the damage caused. Thus, any education for hazard literacy needs to incorporate some awareness raising about how the media can be used for promoting political views that do not necessarily benefit the whole of society – so that students can disentangle what is actually controversial and form their own informed position. To aid in this process, students need to learn how scientists and science work and appreciate that we make knowledge in many ways of which science is but one (albeit very powerful).

There is a caveat here, of course. Learning how people make knowledge and what checks and balances are put in place, does not imply that scientific knowledge should be treated as infallible or that learned institutions must always be respected. Recent events in the US are beginning to cast doubt on a number of government-funded institutions who, until now, maintained due diligence and high levels of objectivity.

The Current State of Risk Education in England

Having started the paper with reflections on the state of risk education in England, twenty-five years ago, I will now turn to look at what the current situation is before discussing what the future might hold. This section is somewhat speculative because we are awaiting the result of a review of the curriculum and assessment carried out on behalf of the Department for Education.

A recent study by Duckett et al. found that the national curriculum in England does make reference to "some aspects of risk" [8]. The authors, who used textual analysis and semi-structured interviews with teachers and teacher-educators, as well as other experts in education, concluded that:

> Despite the commonly held view that risk education does not exist in secondary school curricula, it is, in fact, taught across a range of subject areas. What is missing from this picture, however, is system-wide integration of risk concepts into those subjects. Such a systematic approach would include better preparation of teachers in the relevant subject areas, incorporation of risk concepts in assessment of those areas, and creation of teaching resources to build the confidence of teachers [8].

These recommendations might be perceived as worthy but somewhat unrealistic. There is not enough time in teacher education courses to cover everything that is needed to be a competent teacher – hoping to squeeze in another important topic is not going to happen overnight and may never happen at all.

The previous UK government published a sustainability and climate change strategy for England [9]. As is the way with these sort of documents, they contain aspirational, almost hyperbolic, language: "World class teaching will ensure all children and young people get the best possible climate education". World class teaching would be ensured through "world class training and development opportunities" for every teacher. Not surprisingly, perhaps, neither that government nor its successor, has got very far in achieving the aspiration.

The current government did follow through on one if its pre-election pledges. Shortly after the election in 2024, the DfE commissioned Professor Becky Francis to chair a panel of experts to conduct a Curriculum and Assessment Review (CAR). The review was set up to deliver, *inter alia*: "A curriculum that ensures children and young people leave compulsory education ready for life and ready for work, building the knowledge, skills and attributes young people need to thrive" [10].

The committee produced an interim report in March 2025 [11]. There are some positive indications that the intense lobbying that climate, nature and sustainability groups and their supporters had had some influence. Early in the report, the committee stated that "global social and environmental challenges require attention to scientific and cultural knowledge and skills that can equip young people to meet the challenges of the future" [11]. Near the end, the report states that "Rapid social, environmental and technological change necessitates that the curriculum keep pace; including a renewed focus on digital and media literacy, and a greater focus on sustainability and climate science" [11]. The Panel acknowledges that "society is rapidly changing, and bringing new opportunities and challenges, including those presented by artificial intelligence (AI), and those relating to global political developments and climate change". All these statements have been taken as signalling that the CAR might lead to much-needed change in the educational provision in the country.

However, realistically, the CAR is unlikely to lead to a substantive change in the content and delivery of the national curriculum. Accompanying the interim report was a "conceptual position paper" written by Zongyi Deng, a colleague at the UCL Institute of Education, in which the panel's philosophical position is outlined:

> Theory-instigated reform, often driven by elite elements in society, involves crafting an ideal curriculum at the policy level, out of touch with the realities of schools and classrooms, ignoring what has worked and what hasn't in the system. Indeed, a significant body of research has repeatedly shown that radical, theory (vision)-driven reforms have little to no impact on the work and practice of schools and classrooms [12].

So, Duckett et al.'s "system-wide integration of risk concepts into those subjects" [8] will need to be achieved through tinkering with the system rather than the radical reappraisal of the school science curriculum that Peter and I suggested earlier (see, also [13]).

Lessons from Scientific Literacy

In this section, I draw lessons from the history of scientific literacy to inform what changes might be needed to increase society's hazard literacy. Lee et al. argue that hazard literacy should be considered "as part of the broader concept of scientific literacy, which refers to the knowledge and understanding of scientific concepts and processes necessary for personal decision-making, participating in civic and sociocultural discourse, and engaging in economic productivity" [14]. However, the phrase "broader concept of scientific literacy" needs some unpacking here. I have noted elsewhere [15] that since the term was first used over 60 years ago, it has morphed substantially and while McEneaney [16] claimed that it had acquired a 'worldwide cachet' through the work of the Organisation for Economic Co-operation and Development's (OECD) Programme for International Student Assessment (PISA), Laugksch (2000) dismissed it as "an ill-defined and diffuse concept' [17].

Osborne and Allchin "seek to salvage scientific literacy from such vagueness and lack of clarity" [18] by outlining specific outcomes such that students become "competent outsiders" – that is, people who, while not being experts, have sufficient knowledge of, and about science, to evaluate the credibility of sources of science-related information (see, also [19]). Implicit in this view is a notion of an action-oriented public able to address science-related challenges – a point with which I would fully concur.

By contrast, Lee at al.'s view of hazard literacy might appear quite narrow with its focus on

knowledge: "Hazard literacy for hurricanes thus involves knowledge and understanding of hurricane-related science concepts, the methods used to investigate and forecast them, and the socioeconomic impacts they may cause" [14]. They do, though, take a more action-oriented approach to describing what students would be able to do as a result of their education: "Hurricane hazard-literate individuals and communities are expected to make productive decisions while anticipating and mitigating potential impacts and increasing preparedness for protection". However, their view that hazard literacy should be seen simply as part of scientific literacy is one that I fundamentally disagree with.

If we are to avoid hazard literacy suffering from the "vagueness and lack of clarity" that has befallen science literacy, then we might follow Allchin and Osborne's advice to identify some specific outcomes. Lee et al. have made a start by identifying knowledge and understanding of hurricane-related science concepts, the methods used to investigate and forecast them, and the socioeconomic impacts they may cause coupled with the ability to make productive decisions, anticipating and mitigating potential impacts and increasing preparedness for protection. Osborne and Allchin advocate knowledge of, and about science to make evaluative judgements of credibility. But that approach still seems rather narrow.

Taking another approach, in critiquing current approaches to disaster and hazard education, Park notes that they "are frequently shaped by economic and technocratic values" [20]. While he recognises that "minimizing economic loss and ensuring personal safety are undeniably important", Park argues that if these outcomes drive education, then the focus is on short- and mid-term outcomes which stops people seeing "the sociopolitical and systemic factors that enable hazards to escalate into disasters". Park advocates an educational approach that focuses on "disaster vulnerability and justice-centered science, technology, engineering, and mathematics (STEM) education". Based on his analysis of the 2023 Türkiye-Syria earthquakes, Park advocates "a shift in the purpose of disaster and hazard education: from minimising economic losses to cultivating democratic citizens who understand the social roots of disasters and actively work to challenge injustice and transform society". This sounds promising as an overall aim – but if we believe Zeng's point, above: "radical, theory (vision)-driven reforms have little to no impact on the work and practice of schools and classrooms", we might question to what extent Park's shift is achievable. In the next section, I continue the journey towards trying to find an approach to teaching hazard literacy that would result in appropriate outcomes yet would be feasible to implement.

A Whole-School approach to Teaching Hazard Literacy in the Context of Climate Change

As I noted above, Peter Gill and I advocated "knowledge and skills from a number of disciplines and an awareness of how values, culture and politics impact on risk assessment and management" [3]. So, if we look across the curriculum, just what contributions might subjects make to hazard literacy? In the UK as in many other countries, climate change education is addressed in Science and Geography. Only Science is compulsory up to the age of 16 which means that most students get an incomplete education about climate change. In actuality, all school subjects can contribute to a much more rounded understanding of the climate and environment emergency.

I was recently involved in identifying how subject associations and learned societies in the UK saw their key contributions to climate change and sustainability education [21]. Representatives

from over 20 school subjects responded. Together, they make a compelling case for a cross-curriculum approach to climate change education.

I have already suggested that school mathematics makes an essential contribution to climate change education. In this new document, the Joint Mathematical Council of the UK's statement identifies a number of topics that are relevant:

> School mathematics provides the underpinning knowledge, numerical skills and understanding of the key concepts needed in order to critically evaluate and influence the important decisions affecting sustainability and climate change. These concepts include, but are not limited to, probability, risk and uncertainty, statistics, rates of change, analysis of data and data communication. Without these skills, the next generation will struggle to make optimal decisions for themselves as individuals or as part of the families, the communities, the workplaces and the organisations in which they operate… [21].

This statement identifies its key outcome as students being able to influence important decisions affecting sustainability and climate change. Representatives from organisations representing English teachers provided a joint statement that reflects their opinion of the contribution of the subject towards a similar goal:

> English education fosters critical thinking, empathy, and communication skills, which are essential for understanding and addressing sustainability and climate change. Through critical engagement with diverse literary and non-literary texts and other discourse, students learn to analyse arguments, identify bias, and evaluate sources. Young people also encounter different relationships between peoples, animals and environments, across cultures and histories, and can imagine alternative futures, question dominant narratives, and appreciate the power of storytelling. English education builds confidence in written and spoken expression, enabling meaningful participation in global debates. It empowers young people to advocate persuasively for sustainable actions and to understand the human dimensions of environmental challenges [21].

A final example, from a subject that might not immediately be seen as offering much to climate change education, is the statement from organisations representing teachers of art and design:

> Art, craft and design provides a safe space to explore difficult concepts, fostering autonomy, original thinking and innovation. Learners can be empowered to engage with climate change and sustainability through meaningful and personal creative exploration, critical and contextual analysis, developing design behaviours and material literacy. The freedom of a curriculum that is concept rather than content driven provides the opportunity to nurture nature connectedness, explore socially engaged practice, and deliberate on the meaning of citizenship. Art, craft and design equips learners to not only solve, but identify problems with agency, harnessing the power of imagination, creativity and design thinking [21].

In Table 1, I have extracted key outcomes from the document which relate to hazard literacy.

Looking at Table 1, it appears that all subjects have something to offer. This list of possible contributions could be used by school leaders at senior and middle levels to promote discussion among their staff about topics, teaching approaches and desired outcomes for individual subjects and for the whole school curriculum. It could also be used by text-book writers and curriculum

Table 1. The possible contributions of school subjects to hazard literacy in the context of climate justice and social equity

Subject	Outcomes
Art and design	Design and material literacy; nature connectedness; imagination, creativity and design thinking.
Biology	Understanding of environmental interactions, processes and solutions to the climate and nature crises; the ability to make informed choices about the environment.
Business	Ability to design and transform enterprises to meet human needs within planetary boundaries; understand enterprises as powerful system-shapers, capable of fostering resilience, equity and sustainability.
Chemistry	Develop the ability to make decisions about their own lives and critically evaluate scientific developments; become equipped to make informed decisions and contribute to a more resilient future for all.
Citizenship	Understand evidence, explore sustainable solutions and consider multiple perspectives to see climate change in relation to key citizenship concepts such as democracy, law, economy, equity, diversity and human rights; appreciate how individuals, businesses, governments and communities can act ethically and collectively to create practices and policies for living together more sustainably.
Classics (classical civilisation, ancient history, Latin & Greek)	Understand how the environment has contributed to shaping key phases in human history; develop critical thinking and empathy, and reflect on the legacy and modern relevance of other cultures' beliefs and practices.
Computing	Develop critical digital and media literacy in a world of growing data and media use and misuse; develop skills to research about the environment, nature and global inequality.
Dance	Develop physical and mental wellbeing, collaboration and resilience.
Design and technology	Develop the creative and critical thinking skills needed to design solutions that are not only innovative but also environmentally and socially responsible.
Drama	Develop healthy, humane, empathetic, creative and democratic people.
Economics	Possess a critical and ethical awareness of how economic decisions affect people and the planet; posess system thinking skills, question dominant assumptions, imagine and design regenerative economies rooted in care, justice and sufficiency.
English	Be able to analyse arguments, identify bias, and evaluate sources. Be able to communicate persuasively for sustainable actions and to understand the human dimensions of environmental challenges.
Geography	Possess the skills young people will need in order to adapt to and mitigate against a changing climate.
History	inspired with examples of human resilience and adaptability in the past; possess vital perspective when we envision a more sustainable future.
Languages	Appreciate environmental issues, culture and life across the world and the reasons for different ways of living and being.
Mathematics	Demonstrate knowledge and numerical skills; show understanding of probability, risk and uncertainty, statistics, rates of change, analysis of data and data communication.
Music	Strengthened community cohesion and sense of interdependence.
Personal, social, health and economic education	Identify values and attitudes that underpin sustainability and develop the resilience and agency to act on them through everyday behaviours.
Physical education	Understand the importance of physical and mental wellbeing in sustainable lifestyles and how personal health is interconnected with planetary health.
Physics	Understand how to use evidence, reasoning and logic to evaluate and develop arguments relating to potential solutions.
Psychology	Understand denial, disempowerment and social norms; understand why people fail to act with urgency, and why many experience climate-related mental health issues.
Religious education	Understand how traditions and beliefs hinder and inform sustainable living and environmental ethics.

policymakers to promote educational change that responds to the climate and environment emergency.

In any discussion of educational provision, however, it is important to note that one size rarely fits all and individual schools and departments need to choose their own response to the challenges. It is also important to note that it is usually the most disadvantaged young people who benefit least from educational change. On this point, Ronoh et al. note that "Children with disabilities are often excluded from disaster risk reduction (DRR) initiatives and, as a result, can experience amplified physical, psychological, and educational vulnerabilities" [22]. They note the "potential value" of such children "in helping shape inclusive policies in DRR planning". So, any hazard literacy education needs to have some input in its design from young people. Such an approach has been used by the UK organisation, Teach the Future. Their *Tracked Changes* project involved young people working with adults to devise changes to the existing curriculum for many subjects that they hoped would "inspire the integration of climate and nature into the curriculum in the near future" [23].

Conclusion

Hazard literacy is still developing as a concept in academia and in everyday discourse. Unless we are careful, it will end up being as vague and unsatisfying as 'scientific literacy'. In this paper, I have attempted to show how my thinking about the teaching of hazard literacy and, in particular, risk, has evolved over the past twenty-five years. Whereas in the very beginning of the century, I advocated a radical reappraisal of the school science curriculum, I now favour a whole-school approach, recognising that science is just one of the subjects that can contribute to hazard literacy. Either way, though, the outcome has to be a public that can make informed judgements that will have personal and political effect.

Underpinning the contributions of many of the subjects is an aim to promote much more critical thinking among young people and the teaching of skills such as the ability to evaluate the quality of different sources of evidence. If we can educate young people to be discerning and critical users of a range of media, we may reestablish greater trust in individuals and institutions who are evidence-based and best able to address the climate and environment emergency. Time, though, is running out.

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