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# Equipping society for everyday lives: risk experts' priorities for risk education in secondary schools

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## ABSTRACT

Risk experts and government agencies have long advocated for the inclusion of risk education as part of formal schooling; however, questions remain as to what risk education is and how it should be taught. Drawing on interviews with eleven risk experts based in scientific institutions and universities, we explored their views and priorities regarding secondary school-based risk education. Analysis of these expert interviews highlighted varied conceptualisations of the nature and purpose of risk education. Priorities for risk education included equipping young people for the risks and uncertainties they will experience as part of their lives. Furthermore, risk experts frequently prioritised probability and uncertainty as topics within risk education but deemed judgement and decision-making as more important to include in risk education. Most risk experts valued schools as a place for risk education, although a minority expressed reservations about the ability of teachers to adequately cover more complex risk material. Future research might helpfully investigate how risk concepts are taught in schools and how teachers believe these concepts can be taught effectively.

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## KEYWORDS

Risk experts; risk education; risk science; risk literacy; secondary schools; expert elicitation

## 1. Introduction

Risk analysis is extremely broad and multi-disciplinary field, taught in academic settings across statistics, economics, psychology, political science, history, medicine, geography and communication, to name a few (Jasanoff 1993; Althaus 2005; van Kessenich and Geerts 2017). van Kessenich and Geerts (2017) suggest that such academic breadth translates to difficulty in 'pigeonholing' risk education into an existing (category of) subjects taught in schools. It is in this context that experts and government agencies have argued for at least fifty years, that risk education should be introduced into school curricula in general and secondary school curricula in particular<sup>1</sup> (Kahneman 2012b; Institute for Occupational Safety and Health 2010; Aven and van Kessenich 2020, Lofstedt 2011b). Given that across the field of risk definitions are contested (Aven and Renn 2009), it is perhaps unsurprising that the content of what risk education might comprise is understood differently and still evolving (Beyth-Marom et al. 2012; Aven and van

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Kessenich 2020). The work of Beyth-Marom et al. (2012) focuses on psychological theories concerning decision making, with the educational aim to equip young people to understand decision making of themselves and others and enhance their own decision-making capacity. Drawing on empirical research involving children and young people in the Netherlands, Aven and van Kessenich (2020, 559) conceptualise risk education as teaching, ‘children and youths how to properly understand and manage risk’ and as such, this requires a curriculum which enables them to develop their understanding of risk analysis knowledge, drawing on the four scientific pillars outlined by MacInnis (2011). Even given this prior literature, including important school-based research from the Dutch context, recommendations for risk education continue primarily continue as broad statements of intent, rather than detailed and specific curricula for implementation in the secondary school classroom. The secondary school classroom is an important context, and, consistent with previous research (e.g. Aven and van Kessenich 2020) and much of the wider literature on risk education (Kahneman 2012b; Institute for Occupational Safety and Health 2010; Aven and van Kessenich 2020; Lofstedt 2011b), this new study focuses on risk education for secondary school age groups. Building on previous research, and responding to continued calls for secondary schools to contribute to risk education, this study aims to provide new understandings of what risk education in secondary schools in England could and should be: What should a curriculum include? How could such a curriculum be taught and, whether and how should it be assessed? As a starting point, this research draws on the insights of risk experts to better understand their views as to the priorities, place and purpose of risk education in secondary schools. In so doing we provide new insights as to how risk experts understand the role of school education in equipping young people to engage with risk as part of their everyday lives. We begin by considering further the nature and purpose of risk education as understood in the literature.

## 2. A Brief history of risk education

The purpose of this section is to provide a brief overview of ideas and conceptualisations of risk education, including themes of: (1) judgement and decision making, (2) probability, and (3) understanding hazards. These ideas of what risk education frequently integrate the ‘case’ for risk education. For example, if risk education is about judgement and decision making, the case is frequently made that these are important concepts and skills for children and young people to develop as part of their schooling. Therefore, we consider both what risk education is, and the case for risk education throughout the following themes.

### 2.1. Risk education and judgement and decision making

There have been many proposals for risk education which have predominantly focused on secondary school education. In the early 1970s, Daniel Kahneman and Seymour Fox assembled a team of educators and scientists to create a curriculum for the Israeli Ministry of Education to teach *judgement and decision-making* in high schools (also described as secondary schools in the UK) (Kahneman 2012b, 2012a). In his book, ‘Thinking, Fast and Slow’, Kahneman (2012b) remembers,

The book was eventually completed eight (!) years later. By that time I was no longer living in Israel and had long since ceased to be part of the team, which completed the task after many unpredictable vicissitudes. The initial enthusiasm for the idea in the Ministry of Education had waned by the time the text was delivered and it was never used.

The textbook that Kahneman refers to is ‘Thinking Under Uncertainty’. A version of the textbook was translated into English and adapted to suit an American adult audience (Beyth-Marom and

Dekel 1985) In the translated version, 'An Elementary Approach to Thinking Under Uncertainty' mentions that the original Hebrew version has been used in a course taught to Israeli fourteen-year-olds (which is the equivalent of the third or fourth year of secondary school in the UK). This course seems to have been trialled after Kahneman left the project. The textbook itself focuses on decision making through uncertainty and thinking skills, including probability assessments (Beyth-Marom and Dekel 1985). Simultaneously, a decision-making course for decision-making under stress, referred to as the GOFER course, was trialled in Australia (Mann, Power, et al. 1988; Beyth-Marom et al. 2012). However, the creators of this course acknowledged that it was difficult to test its effectiveness (Mann, Harmoni, et al. 1988). In parallel, *probability* continued to be taught as part of core mathematics subjects around the world (Batanero et al. 2016; Borovcnik 2011). Spiegelhalter and Gage (2015) have highlighted that there is a potential to learn from and integrate real world risk and risk communication into probability teaching. Therefore, we now consider risk probability in the context of risk education.

## 2.2. Risk education and probability

Probabilistic reasoning and decision-making under uncertainty is regularly paired with the teaching of probability, as not all risks can be 'meaningfully captured by mathematical formulations' (Aven and van Kessenich 2020). Uncertainty—where probabilities cannot be assigned—is treated as a problem to be solved, rather than a given (van Kessenich and Geerts 2017; Spiegelhalter 2011). When it comes to uncertainty, people often revert to using their intuition or 'common sense'. Exclusive focus on the probability/consequence calculation may lead to students using such faulty intuitions for important components of a risk decision. Beyth-Marom and Dekel (1985) give practice exercises for students to use to identify and understand how intuitions can lead people astray and they provide techniques for thinking clearly in situations where decisions need to be made under uncertainty.

Understanding probability, what Gal (2012) calls 'probability literacy', is core to understanding risk. They define it as 'the ability to access, use, interpret, and communicate probability-related information and ideas, in order to engage and effectively manage the demands of real-world roles and tasks involving uncertainty and risk'. Batanero (2014) argues that 'in order to become a probability literate citizen, a student should understand the use of probability in decision-making'. Both these authors refer to the use of probability in the 'real world' (Gal 2012) or its use in decision-making (Batanero 2014; Batanero et al. 2016). In their textbook for secondary school students *Teaching Probability* (2016), Gage and Spiegelhalter also focus on probability in relation to real-world risk and uncertainty, including aspects of behavioural economics and Bayes' theorem. The book also focuses on the language around uncertainty and the impact of media stories on our perceptions of probability. In an earlier paper (Spiegelhalter and Gage 2015) they emphasise that 'current [theoretical] approaches in communicating risk and uncertainty can contribute substantially to educational practice' in relation to teaching about risk. 'Risk literacy' is another term used for understanding and dealing with real world risks and uncertainty (Gigerenzer 2012; Riechard 1993; Till 2014). Risk literacy in the population as a whole can be strengthened when informed by broader risk science and foundational concepts in risk analysis (Aven 2024). If the general public are going to be involved in the discourse of risk evaluations, it is arguably necessary that education equips people to have a better understanding of both personal and societal risk. We now, consider risk education from the perspective of understanding hazards.

## 2.2. Risk education and understanding hazards

Occupational health and safety bodies in the UK have also advocated for risk education, but introducing a third lens—that of risk as *understanding hazards*. In 2000, the Health and Safety

Executive (HSE) in the United Kingdom set up a Risk Education Programme 'to identify and influence the degree to which risk management techniques are taught in schools and other educational establishments, including universities'. This was said to be mostly focused on preparing people for design and engineering professions, rather than for general secondary or tertiary students.

Six research reports produced under the Health and Safety Executive (HSE) Risk Education Program revealed that teachers felt uncomfortable teaching students about risk and had difficulty with terms including 'risk education' and 'risk concepts' (Health and Safety Executive 2000). These reports also argued that while pupils were being taught about particular risks and hazards in specific contexts, risk itself and principles of risk management are not taught, even though they are fundamental to health and safety (Health and Safety Executive 2000). The Institution of Occupational Health and Safety (IOSH) subsequently released a health and safety manifesto focused on 'improving people's health and safety, quality of life, and future performance' (2010). One of the focus areas included the aim of making health and safety part of the basic education system which they believe will create a 'risk intelligent society'.

In a review into health and safety legislation in the UK, Lofstedt (2011a) endorses both HSE's risk education program and the IOSH aim to create a risk intelligent society. Lofstedt (2011a) then argued for 'a wider debate within society about risk' and recommended that the House of Lords set up a committee to 'consider how to engage society in a discussion about risk'. As part of a discussion on regulatory decision-making in relation to risk versus hazard, Lofstedt (2011b) recommended that risk assessment be taught as part of the secondary school science curriculum. More recently, the European Food Safety Authority (EFSA) et al. (2021) released a report which focused on the field of risk communication and recommended more teaching of risk and hazards in the last years of secondary school education and in universities. The report advocated using concepts similar to those designed by Oyarzabal and Rowe (2017) on food safety, which focused on teaching the principles of risk and hazard in the context of Hazard Analysis and Critical Control Points (HACCP).

Not only could risk education prepare students for decision-making in their personal lives, but if effective, would better prepare them to participate as citizens in considering complex issues of public policy. Better understanding of the impact of risk perception and decision-making biases on evaluation of risks could lead to more considered legislation, the regulation of hazards and to safer workplaces. The explosion of information available through the internet increases the importance for citizens to evaluate risks in a rigorous way. Risk education is one strategy to address these realities and help individuals and communities better understand risks and thus make better personal and political/societal decisions. If ineffective, however, risk education could potentially crowd out other useful subjects in school and university curricula and discredit these approaches to better public decision-making. Having considered the history of the nature and purpose of risk education, we turn to the materials and methods of this present study.

### **3. Materials and methods**

This research aims to understand how risk experts conceptualise risk education, as the views of experts is a previously under-researched area. After establishing how experts conceptualise risk education, we then explore experts' views on the effective enactment of risk education in schools including when and how risk should be taught and assessed and the key concepts and priorities for risk education.

#### **3.1. Participants and procedure**

A 'purposive sampling' approach (Campbell et al. 2020) was used to identify key participants with knowledge or experience of risk education. Participants were identified by authors one

and two as experts or key informants (Patton 1990) as they had authored published reports or academic papers which included the topics of risk and education. This established their status as experts or key informants and was a central inclusion criterion in the pool of participants. At the same time, many of these potential participants were part of the professional network of author two who had themselves also authored a published report which included recommendations regarding risk education. As such, the study benefited from a context of professional trust and engagement from potential participants which might not have been otherwise the case. To mitigate against potential bias a 'snowball' (Patton 1990; Berndt 2020) recruitment process followed by asking participants to suggest experts not included in the initial round of invitations. In total, 17 experts were approached, with 11 agreeing to participate.

Consistent with the approach of Frewer et al. (2003) the research was conducted through a series of semi-structured interviews with experts because this allows for detailed and nuanced conversations which are guided by an interview schedule which is responsive rather than restrictive. The 11 risk experts were interviewed online, each interview lasting approximately 40-60 min, and all were recorded with the consent of the participants. To ensure that the interviews were spaces for open and frank discussion about the priorities and challenges for risk education, all interviews were conducted by author one, who had not previously published a report or academic paper regarding risk education and participants were encouraged to share their views and expertise freely. Interviews included questions about the professional background and interests of the participants and also included the following indicative questions:

- How would you describe and define risk?
- How would you define risk education?
- What aspects of risk should be taught in schools?
- What are the priority areas for school-based risk education?
- What age groups should be taught risk as part of school-based risk education?
- How should risk be taught in schools?
- How should risk be assessed in school-based risk education?

Each interview was transcribed and three transcripts (Professor of Risk (1) and (2) and Professor of Psychology) were anonymised as requested by the experts who did not wish to be identified.

A limitation of this sample is that the group of experts are mainly drawn from social science, psychology and judgement and decision-making fields of risk as opposed to statistics, engineering, toxicology etc. These latter fields make major contributions to risk studies and may have expressed different views or nominated different priorities for risk education. Also, the current sample, as they themselves highlighted, are not experts in secondary education. Furthermore, given the purposive rather than systematic sampling approach, and given the focus on English language publications, it is highly likely that there is risk education expertise that was not included in this study.

### **3.2. Ethical considerations**

Institutional ethical approval was obtained at the outset of the study (MRSP-21/22-28869). As part of the informed consent process, participants were given the opportunity to contribute anonymously, using a pseudonym or to be fully identifiable, including all research outputs. This informed consent was obtained both through written consent forms and an additional verbal confirmation as part of the interview process. Of the eleven participants, three elected to be anonymous and agreed the format of their professional role namely, Professor of Psychology and Professor of Risk (1) and Professor of Risk (2) (Table 1). Tilley and Woodthorpe (2011) argue that the ethical principle of anonymity can create issues with contextualizing and disseminating research findings. Risk experts were identified based on their experience and previous

**Table 1.** Risk experts with who contributed to the study, and their expertise and/or contribution.

Name	Current role	Link to risk education
Joe Árvai	Dana and David Dornsife Chair, Wrigley Institute Director, Professor of Psychology and Biological Sciences,University of Southern California	Interested in risk education—recommended by another interviewee
Julie Downs	Professor of Social Psychology,Carnegie Mellon University	Developed a number of evidence-based educational interventions for teenagers
Baruch Fischhoff	Professor of Engineering and Public Policy, Carnegie Mellon University	Authored papers on adolescent decision-making
Ragnar Löfstedt	Professor of Risk, Director of King's Centre for Risk Management, King's College London	Recommended risk education in Löfstedt report
Peter Shearn	Senior Technical Analyst, National Institute for Health and Care Excellence	Co-authored a report on risk education in schools for the Health and Safety Executive
Paul Slovic	Professor of Psychology, University of Oregon	Interested in risk education—recommended by another interviewee
David Spiegelhalter	President of Decision Research Emeritus Professor of Statistics in the Statistical Laboratory, University of Cambridge	Co-authored a textbook on teaching probability
Andrew Weyman	Reader in Psychology, University of Bath	Co-authored a report on risk education in schools for the Health and Safety Executive
Professor of Psychology	University	Interested in risk education
Professor of Risk (1)	University	Interested in risk education
Professor of Risk (2)	University	Interested in risk education—recommended by another interviewee

publications on risk education so the context of who was chosen and why matters. Achieving anonymity in practical research is often challenging, as removing context to protect identities can diminish the meaning of the findings (Van den Hoonaard 2003; Ellersgaard, Ditlevsen, and Larsen 2022). Jerolmack and Murphy (2019) suggest that masking identities hinders the development of cumulative social science, as it prevents researchers from replicating or revisiting previous studies, therefore, depending on the context and with appropriate informed consent in place, using real names can enhance transparency in qualitative research (Reyes 2018). Therefore, the remaining eight participants who are named throughout this article all agreed to be identified in this way and at the end of the interview participants were asked again whether they consented to be named. In line with *Journal of Risk Research* ethical requirements, identifiable participants were emailed the quotes being attributed to them in this research project and were given the opportunity to give consent to adjusting anonymity.

**3.3. Analytical process**

Data were analysed by the authors using a conventional approach to qualitative content analysis (Hsieh and Shannon 2005) as this approach is appropriate for teams working across a shared dataset. The transcribed interviews were distributed to the researchers for independent phases of analysis and then the team discussed and refined the codes and themes collaboratively through iterative phases of analysis. Author one led the data collection and analysis. Author two held a dual role in this research as both a risk expert interviewee, and part of the analytical team, with extensive knowledge of the research context and participants, and part of the analytical team. Due to the familiarity of both author one and two with the research context and participants there is the potential that this knowledge may have overly influenced their engagement during data analysis. Therefore, the inclusion of author three at this stage of the research process, who had no prior engagement with the general field of risk, or the research participants provided an analytical perspective that was ‘at arm’s length’ from the data and reduced the

potential for bias. Prior to data analysis discussions the authors agreed that should there be conflicts in our interpretations or analysis we would return to the key questions to consider when reviewing themes as outlined by Braun and Clarke (2012) as a framework for our decision making.

## 4. Findings and discussion

In the following we explore risk experts' conceptualisation of risk and risk education, and their views on the effective teaching of risk in schools.

### 4.1. Risk experts' conceptualisation of risk

There was consensus amongst many of the participants regarding the central role of probability and consequence in defining risk. The integration of these two factors was unanimously regarded as a core element of risk. However, a number of participants emphasised the necessity of incorporating uncertainty into the conceptualisation of risk, recognizing the inherent unpredictability and variability associated with risk.

I only tend to use it completely generically to apply to any situation about where there are uncertain outcomes and things might turn out well and they might turn out badly. And I think that's actually how most people do use it conversationally. So I've adapted, rather than trying to force people to use a technical definition, I've just given up and gone over to a loose definition. (Spiegelhalter)

The quantitative approach inherent in probability-consequence views of risk, even augmented by considerations of uncertainty, was seen as an incomplete approach to risk and that when conceptualising risk one must take affect and intuition into account.

You need to think about probability and uncertainty and consequences. But one has to realize that the discussion and the assessment of probabilities and consequences and how they feed into what we would call risk is governed most of the time within us by our feelings. (Slovic)

Yeah, so I very much think of it as a function of probability and consequence. So, I think that's sort of the classic definition that a lot of folks use. I think I've been conditioned to use it to think of risk that way I do ascribe a bit to the whole risk as feelings construct. So, kind of affect and intuitive senses of risk. But to me I view that as a way for people to calibrate the consequence side of the probability and consequence equation. (Árvai)

I would say when we're talking about just assessing levels of risk, you need to consider the probability and the consequences. But I think that it's important to have a broader sense of what people mean when they're thinking about risks. Because risk can be really multifaceted and sort of distinguishing this is maybe just semantics between a hazard, like some situation or threat that you might encounter in the world versus what's the level of risk posed by that hazard. And I do tend to slip into saying risk when what I really mean is a hazard. (Downs)

One participant suggested that risk should not be defined at all. This suggests that a diverse range of viewpoints exists within the expert community as to how the fundamental nature of risk is understood and conceptualised.

### 4.2. Risk experts' conceptualisations of risk education

Some participants identified the inclusion of risk as feelings (Slovic 2010; Slovic et al. 2005) and the subjective nature of risk as key areas to be included when defining risk and drew on this definition of risk when reflecting on risk education. For example, Slovic, while acknowledging the value of the probability-consequence formulation, argued for the importance of including an emotional component based on feelings toward risk.

I should also say that that risk goes hand in hand with decision-making and behavior [...] while we can try to understand risk as an intellectual endeavour and a concept, and I think that there's a place for that, maybe even at the higher levels in terms of philosophy even [...] for young people, I think we should look towards the practicality and the way in which if they understood risk better, it would enhance their lives, their wellbeing, and the wellbeing of people around them [...] One has to realize that the discussion and the assessment of probabilities and consequences and how they feed into what we would call risk is governed most of the time within us by our feelings[...] our feelings are incredibly sophisticated risk assessment mechanisms that have been wired into our brains through the course of evolution in order to help us survive in a world where there's a lot of dangerous things for human beings [...] So I would hope that somewhere in the educational domain that would be taught how we rely on our feelings, but we need to learn when we can trust them and when we need to pause and think more carefully and bring in and be more analytic or bring in experts to help us with these decisions. (Slovic)

Through this contribution, Slovic moves beyond simply defining a risk as a concept, he also identifies that educating young people about risk requires bringing together both conceptual knowledge (such as the probability-consequence formulation) with the affective domain (positive and negative emotions) with the aim of enabling young people to develop capabilities which equip them for their future lives. This is consistent with what have been described as 'new curriculum' models, which focus on the capabilities or capacities which school education aims to develop in children and young people rather than outcomes which emphasise learning of propositional knowledge (Priestley and Biesta 2013; Humes and Priestley 2021).

Looking across the contributions, three prominent concepts were identified as integral to an effective risk education curriculum. Firstly, experts emphasised the significance of cultivating judgement and decision-making skills, as these skills were seen as integral to effectively assessing and managing risks. Secondly, the understanding of probability and uncertainty was highlighted as a fundamental component of risk education, enabling students to grasp the unpredictability and uncertainty of risk. Finally, the role of risk perception emerged as a key area of focus, with experts stressing the importance of individuals' awareness and comprehension of the subjective factors that shape their perception and evaluation of risks.

#### ***4.2.1. Judgement and decision-making***

A number of participants discussed the teaching of concepts relating to judgement and decision-making. This included mentions of making decisions, heuristics, biases, intuitive ways of making decisions, and automatic ways of thinking about danger. The Professor of Psychology affirms Slovic's concern about biases in judgement and decision-making, particularly for adolescents:

I think it actually would be quite useful for [...] teens, to understand some of what we've discovered in risk education, around, in the risk sphere, around optimistic bias. How we can be also [influenced by], the confidence, overconfidence biases. I think a lot of those automatic ways of thinking about danger are good to reflect on. (Professor of Psychology)

The need to equip students with conceptual tools from the judgement and decision-making literature while maintaining risk education as firmly linked to everyday experiences of risks was a recurring theme in these expert responses.

#### ***4.2.2. Probability and uncertainty***

Slovic recounts that his early work (Slovic, Lichtenstein, and Edwards 1965; Slovic, Fischhoff, and Lichtenstein 1981) was motivated by the realisation that "life is a gamble". This approach enabled quantification of uncertainty while maintaining the concrete experience of gambling:

[T]here's many different ways and you can think about educating people to think, to be sophisticated about thinking about probability and uncertainty [...] So it could be an extension of some of the current

teaching in how to think quantitatively about things. But when you get away from the abstract probability and consequence notion that life is a gamble, it has probabilities and consequences, that's the way I started. We started studying gambles in the abstract because you could manipulate the probability of gain and loss and the amount of gain and loss. And you can do that very precisely and then see how people react when you change the probabilities a certain way when you change the number of outcomes, the mix of gains and losses. (Slovic)

Spiegelhalter picks up this theme and explains how the experiential nature of uncertainty interacts with the way that uncertainty is discussed and measured in mathematics:

[W]hat makes risk and uncertainty different from other areas of sort of mathematical work is that they use terms and concepts that have got a much more general, fluid human perspective rather than if you think about angles and algebra and geometry, everyone knows what you're talking about, but that's not the case in risk or even probability. And I think there's a good reason for that in that probability doesn't actually exist. It's not a measurable thing. You can't take out a ruler and measure it. It's a much more fluid concept and which is what makes it so exciting. But it makes it a challenge to, I think, teach in schools. But I think I've always found it deeply restrictive that when teaching probability in schools, people just is, or traditional, to use it to force it into a narrow mathematical framework, which is not part of people's experience. And so in our book and our approach, we try to, as much as possible, make probability, expectation, uncertainty, to match people's actual experience as much as possible. (Spiegelhalter)

Perhaps due to the timing of the interviews, which were conducted during the Covid-19 pandemic, risk perception was a frequent reference point for risk experts. Weyman, for example, used vaccination risks, including the modern MMR or Covid vaccine, to illustrate the importance of risk communication, and Spiegelhalter had published widely on Covid-19.

I mean the work we did was really, we're looking at the kinds of attempts that were being made years ago now into trying to find ways to communicate risk to young people [...] [Including] to try and give people an understanding of risk in the sense of trying to get to accept certain kinds of risks that you typically get public opposition to. So modern MMR or covid vaccine will be an example. (Weyman)

While experts broadly agreed on the content of risk education, their priority and emphasis on content areas differed, often reflecting personal experiences and insights into the nature of risk.

#### **4.3. Risk experts' views on effective risk education in schools**

Some risk experts' ambivalence to or uncertainty regarding the specific mechanisms of how risk education would be administered was underlined in their deference to education experts and teachers:

I have no clue, but I'd ask a teacher. (Löfstedt)

I would leave this to the teachers. I'll take the easy way out. (Slovic)

However, this was not a universal response. Downs argues that fidelity of the content should be prioritised using video or written material that could be used without relying on teacher confidence or specific knowledge of the concepts:

If you had risk experts teaching risk, go for it, right? That's fantastic. But if you're talking about schools where teachers who are also teaching geography and math and reading and spelling, and now you want them to teach risk [...] it's not going to be cost effective, time effective, and they're not going to want to become risk experts. What I would do if I were approaching that is try and make as many materials as I can that sort of contain the content. So maybe it would be, it wouldn't have to be in a video, but certainly a teacher could show a video, but there's lots of other ways you could do that. But rather than having a teacher explain these very tricky concepts, I would try to integrate those into some kind of materials that the student is getting the real detailed, nuanced content directly from the materials [...] I mean it could be something printed that they're reading and asking each other questions. But especially

the things that people have misconceptions about. We of course know a long list of things people have misconceptions about risk that we really would make that stuff crystal clear that trying to get to zero risk is sort of a red herring and stuff like that. I would really have that be integral in something that doesn't rely on the teacher understanding it to convey it to the students. So, it's really something solid there that will have fidelity. (Downs)

Responses on the content of teaching were closely linked to questions of where risk education might sit in the secondary school curriculum: as a separate single subject, or as segments across discipline areas with questions of how such multidisciplinary risk education would be coordinated.

#### 4.3.1. *Single subject vs multidisciplinary*

In response to the question of how risk should be taught in schools, participants nominated a range of subjects, including Personal Social Health Economic (PSHE), mathematics and geography as obvious places where key concepts could be taught, but acknowledged that single disciplines could not encompass the breadth of risk education.

I think it's actually a good trend [to have it across subjects] rather than having a risk course [...] Now the question is how much these different subjects in an ideal world, [...] [would] do the link. For example, a geography teacher could say, oh yeah, I know you've learned that in maths, you've learned about these probabilities [...] if some schools work through some kind of theme, they can mobilise these in different subjects under different classes. So, I don't know if that happens, but that could be interesting. (Professor of Risk 1)

So I would prefer to have it taught across the curriculum. (Fischhoff)

The Professor of Psychology took a different approach, suggesting a 'framework' for teaching risk as part of specifically one subject: Personal Social Health Economic education, a current subject taught in schools in England (Formby et al. 2011).

[A]s part of PSHE. So, something where it's not very formulaic. I mean I suppose one could have a bit of a curriculum that comes into PSHE, but I wonder if those subjects seem to be at the discretion of those who teach them. But I'm not sure, maybe there is something more structured. I mean I know they teach wellbeing, do they teach it according to a curriculum or according to how they perceive wellbeing? [...] So it might be useful to have a sort of framework [...] that we might suggest for PSHE. But I think it PSHE is generally one of these looser subjects where the kids feed in a lot and so on. It's not pedagogical, it's not like you get the information and it's not like with maths that after this year you have to be at this level and after that year you have to be at that level. (Professor of Psychology)

Shearn also identified the subject PSHE, formerly known as Personal and Social Education (PSE) (Willis, Clague, and Coldwell 2013), as a place for risk education.

I went around to all these schools and I was talking to teaching staff and I was going there with my sort of background in sociology and psychology and trying to get to understand where they were with some of the concepts that academics and risk education boffins [...] And of course they don't use that language and in some of the concepts they may be familiar with [...] But for the most part I think teaching staff probably have a great insight into educational concepts but this sort of Venn diagram of safety and risk and educational concepts, there's not a great deal of overlap in their understanding. So I think teaching staff [are] focused on practical life skills [...] I think PSE curriculum's come a long way and that was the primary driving force for education and safety and life skills if you like [...] I think most of the teaching staff were focused on what kids need to know and what are the practical courses we teach them. (Shearn)

The consensus amongst those raising the issue was that multidisciplinary teaching was best suited for risk education, but they had no clear way of resolving gaps and overlaps in teaching across different disciplines.

### 4.3.2. *Student age*

Most experts noted the importance of age-appropriate approaches to teaching risk concepts regardless of the age of the student. For some, including Downs and Spiegelhalter, there was enthusiasm for risk education beginning very young, even with pre-school age children:

I think you can start with very little kids. They understand that something doesn't always happen [...]. And so it's this concept of risk being probabilistic and outcomes being stochastic like that, is a concept I think you can start very young just to be thinking about this general idea of there's some uncertainty in what's going to happen, but predictability and how we can make change the odds by our behaviors. But I think that can start before school and certainly in grade school. (Downs)

Two upwards basically, because very small children can grasp the idea of picking at random, so can grasp the idea of fairness. And I believe is one of the first things that children develop is this idea of fairness and the idea of picking at random as being exemplifying fairness is an extraordinarily early experience that people have got. And I think that's very powerful. Very powerful indeed. And that simple act of getting a child to pick something at random and taking the consequences of that action in terms of deciding which piece of cake they're getting or which prize again, which birthday present as an is wonderful. It's [an] enormously powerful idea. It's risk taking at its most basic. And I think that those ideas can be built on then in education from a very early age. (Spiegelhalter)

Whereas, others, including Fischhoff and Professor of Risk 2, stressed the complexity of some concepts, concluding these should be taught when it was developmentally appropriate, which was likely later in the students' school career:

[T]he cognitive part of this is just any other higher order skills [...] So, the basic capabilities are pretty much there by age 15 and 16. [...] So I think that there's no particular reason why you couldn't teach this as well as you could teach, as you could teach anything else that was developmentally appropriate. [...] I think one needs to understand the kids in order to do it. And I think people who study decision-making don't know that. And I think conversely, people who are in developmental psychology typically don't know decision science in a way that would help them to analyze the decisions from the kids' perspectives. So, they look really the kids are doing what they want and it takes an insightful teacher to say, "Yeah, yeah, she's taking risks, but that's developmentally appropriate. (Fischhoff)

That is all quite high-level material that goes beyond the kind of simple idea that there's no such thing as zero risk and all those kind of slightly trite slogans isn't it? It really seems to me to be most appropriate to fairly advanced level study. (Professor of Risk 2)

Here, the broad consensus is that risk education should take place in ways which are developmentally appropriate, with divergence on what age this might occur.

### 4.3.3. *Assessment*

While acknowledging the necessity of student assessment, participants were ambivalent about how this might be done to assess student understanding of risk concepts. Some experts understood the question as assessment of individual attainment, while others saw assessment as a policy tool, i.e. have we achieved societal goals in educating young people about risk?

I'd teach probability as part of maths. And it's that assessed in the same standard where math absolutely right/wrong answers obviously with working and things like that. [...] [But] it's amazing how much you can do with say, with multiple choice questions when you're exploring people's understanding of concepts and topics. So actually, you could do with that in that way, but this is not then part of math. The moment you stop being able to quantify things, it stops being part of math. (Spiegelhalter)

We have an obligation to assess educational attainment, who knows how well we're doing. But the ways which you test attainment tend to be, it's really hard to do it in a way that isn't divorced from actual understanding. It is actually an impediment to understanding. [...] So I would say yes, we should have an assessment but we're have to do work, which perhaps you'll get the chance to do in figuring out what is the proper test [...] So you might look at this high school curriculum as a way of looking at does it improve substantive understanding, which is what we really want. Does it improve kids' cognitive abilities,

which reduces, as you probably know, a problem with testing is teaching to the curriculum. So anyway, that would be, those are some first thoughts on how to do the assessment. (Fischhoff)

Well I think you know, can certainly examine in a traditional sense core competencies, understanding how probability works and how consequences get incorporated into a risk calculation using very cut and dried examples. You could also explore in that kind of setting just basic definitions around risk, which I think would be really valuable. And then ultimately, as I think a student becomes more learned and mature, expanding evaluation into more reflective pieces I think is probably the way to go. So, essays and thought pieces. (Árvai)

Some respondents did not support individual student assessments, citing what they considered to be an over-emphasis on assessment in other areas of the curriculum. This was underpinned by scepticism that suitable assessment strategies could be developed, and/or by enthusiasm for alternative teaching strategies such as gaming.

I probably just wouldn't assess risk understanding. I think they've got enough assessments as it is, but there might be some sort of clever game, a games day or what you would want to know is they could think through things. So I probably sort of, either some sort of challenge day where you saw, had maybe hypothetical scenarios like a city gets hit by a hypothetical illness, what should people be thinking about? So then my answer would be the aspects over which they could control, aspects they couldn't control, in terms of what they could control, how to keep low levels of anxiety, but high levels of activity around that sphere, et cetera like that. (Professor of Psychology)

We have under the, I think I say after the Iraq war, the Bush administration's greatest damage to humanity was probably ramping up the testing in schools, which probably set us back by half a standard deviation in our national intelligence. So I think, I suspect it could be done, I think it's not trivial and I would hesitate to rush to set standards, to prematurely develop standards. (Fischhoff)

In the final part of the interview, participants were invited to reflect on their priorities for risk education. Many incorporated concepts related to a potential risk curriculum outlined above, however, media literacy and the social amplification of risk framework were also highlighted as important to be taught in schools. We now explore the priorities identified by the experts in turn.

#### **4.3.4. Priority 1: equipping students for real life**

When discussing what concepts should be taught, participants went beyond theoretical concepts and also suggested that there is a need to prepare students for real life and teach to some of the specific hazards they will face. Again, this is consistent with broader understandings of the nature of curriculum which place greater emphasis on skills and capabilities which are developed through student-centred pedagogies, and where teachers have active roles as curriculum makers rather than adherents to an authorised text (Humes and Priestley 2021). Areas which experts drew on to illustrate the need for risk education to meaningfully equip young people included wellbeing and sex and relationships education:

[I]t needs to be practical, meaningful really. So just in terms of the evidence-based approaches, like the whole school approaches keep coming up. Apply things to real life situations, tied, tailored to the age groups or culture. And I think a lot of PSE [Personal and Social Education] topics properly encourage discussion, perhaps debate. I think those are ways for learning about yourself in society. (Shearn)

Experts identified the importance of incorporating findings from emerging research focused on risk perception and the communication of risk into a risk curriculum. Incorporating risk perception could better enable young people to understand that people perceive and experience risk differently and this could contribute to improving students' wellbeing:

[I]f people understood more how people perceive risks, that'd be very helpful. Explain how people, why people could show us some risk more than others. And then, and if you can rationalise that and put that in people's, you know, mindset, then I think there'd be much less anxiety out there. (Löfstedt)

#### 4.3.5. Priority 2: probability and uncertainty

Risk experts frequently prioritised probability and uncertainty as topics within risk education, but deemed it less important in comparison to judgement and decision-making.

[B]asic understanding of probabilities. I mean, again, I don't want to restrict it too narrowly to probability times consequence, but there is a lot of understanding that, or at least let's put it differently. There's a lack of discussion about these aspects in many everyday life occurrences[...] [W]e know from the work of Kahneman, Tversky and others that people are not very good at dealing with probabilities[...] So a lot is about, okay, how can we understand and convey more meaningful or helpful information about how probabilities work and make it understandable to people again so that they can use that to their benefit. (Professor of Risk 1)

Both Slovic and Spiegelhalter emphasised the *personal* as well as the *societal* benefits for students of teaching about uncertainty and probability:

I think [students] need to understand how to think about probability, how to think about risk as in a way that links to the goals of a decision situation, whether it be health or safety or social satisfactions, financial matters, decisions that they're making involving their own financial situation and budgeting and things like that. Being financially secure. To think about how sometimes we have to make trade-offs between accepting risk and other benefits. (Slovic)

[T]o realize that in principle this thing can be broken down into a list of possible futures of possible things that might happen and some idea of likelihood of them happening because otherwise risk, they're psychologically, they just get, we know these are just merged into a single caution or anxiety about something and that none of that separation is happening. So, I think that although I don't believe one can ever do it fully, I think as an exercise in saying that's what we're actually, it's unbelievably valuable[...] trying to envisage possible futures, that scenario development is a fantastically valuable mental exercise and challenging what might happen, what are the possibilities? And then to realise, whoa, they're not all equally likely in some of our possible futures. There are more possible futures that will lead to one than the other. And I think this for me is an enormously valuable mental tool [...] So it is a mental model, it's a way of thinking about things that I suppose tries to bring the decision analysis or whatever technical tools when thinking about into a concrete framework for people to help them in their own lives. (Spiegelhalter)

Professor of Risk 2 cautions that such teaching should emphasise the limits of decision-analysis and other probability and uncertainty approaches:

I'd also say though that there's some humility probably in the sense of what you can communicate as well lies, damned lies and statistics on that kind of theme. People need to understand that there are limits to what experts can tell us. Knowledge is uncertain, how do you deal with that? We often don't know very much about the problems that we really worry about and no one does. So critical evaluation of the assumptions that underlie that kind of risk assessments[...]. Turns out sometimes the world is quite a scary place. (Professor of Risk 2)

#### 4.3.6. Priority 3: tools, models and frameworks

Teaching students about tools for judgement and decision-making was a priority for most risk experts:

I think being able to structure decisions [...] it's so intuitive once people know it, but people don't develop it by themselves[...] Benjamin Franklin's Prudential Logic where he says write the pluses and minuses of your different options on a piece of paper. And it's pretty straightforward [...] decision trees, influence diagrams. Those are the basic three, basic kinds of things. And I think that their experience in doing them will go a long way. (Fischhoff)

Árvai takes the judgement and decision-making (JDM) tools further, suggesting they may be taught as a form of inoculation against manipulation by conventional and social media:

I think JDM, I mean it is my area, but it is how we work, how we process or fail to process information. How we make or seldom, fail to make trade-offs. How we are at the mercy of these different social constructs and in particular how those can be weaponized against us. That to me is so quintessentially

important in this day and age where in particular in a hyper-concentrated media environment we lose our agency at the hands of people who know what they're doing[...]I've been doing this long enough that I can with relative ease, manipulate people and if I can do it and that's not my profession, I shudder to think what true professionals who are using those tools for their own ends are able to do. So, I think that to me is above and beyond anything the most important thing we should be teaching. (Árvai)

Another aspect would be also from a risk communication perspective, how to exchange information about risk, how to understand the best ways to help conduct that discussion. It's not by, for example, instructing people to do such and such that you often achieve very good results. The notion of behavioural change doesn't necessarily work so well. So, you have to devise other strategies to understand perceptions to interact[...]for example, the mental model approach, which helps to start from comparison of expert, non-expert. So, part of risk education would also be to help and again, a different level of, at different age groups, you will not do it the same way[...] Understanding again, all the probability aspects and understanding all the perception communication aspects. (Professor of Risk 1)

The social amplification of risk framework (SARF) was nominated as a priority for risk education by many of the experts interviewed here. Ensuring that students could evaluate the importance of an issue of risk as separate from the public interest/attention it attracts was seen as a useful skill to be taught:

I think social amplification of risk is really useful because if you were teaching that you could actually prioritise with the kids, actually give them a sense of what it is really. And once you understand that certain risks because of a whole media ripple are constructed as very dangerous where they aren't actually of massive threat. (Professor of Psychology)

I think some of the media insights from SARF and the related literatures is probably in some respects the more useful thing to do. Cause perhaps alerts people to something which is less obvious. (Weyman)

Emphasising the importance and usefulness of risk concepts, the experts endorsed a number of tools and models, ranging from Franklin's eighteenth century Prudential Logic to the more recent insights from SARF.

## 5. Conclusion

This study analysed risk experts' views about risk education. Interviews with these 11 academic leaders showed that there was broad agreement that risk education should prepare students for the risks and uncertainties they will face in real life. Most risk experts valued schools as a place for risk education, although a minority expressed reservations about the ability of teachers to adequately cover more complex risk material. Several said that having risk experts teach would be their ideal answer, but acknowledged this was probably not feasible in most schools.

There was also broad agreement that such teaching be 'age appropriate' but with some contention about which ages are appropriate for teaching about risk. Some argued that key risk concepts are intuitive and could be taught from pre-primary school, while others felt that some concepts were too complex and therefore should be reserved for late secondary or even tertiary classrooms. Experts with research in schools or adolescent risk understanding expressed confidence that the child development literature could guide curriculum design appropriately.

The contentious nature of the definition of risk was reflected in responses. Experts agreed with the use of the probability/consequences approach as well as the notion of 'risk as feeling'. This was also reflected in responses about the core concepts to be taught. Most mentioned probability and uncertainty along with tools for judgement and decision-making. The notion of Social Amplification of Risk Framework had fewer proponents.

### 5.1. Implications for policy

Risk education in schools has long been advocated, but there has been no previous analysis of what aspects of risk should be included in curricula. This study therefore provides new insights which could inform policy and curriculum development.

1. When developing school-based risk education, real-life aspects need to be considered in relation to curriculum, pedagogy and assessment. What existing approaches to incorporating authentic learning or real-life learning can inform this thinking? For example, are there relevant insights inquiry-based learning (Butler, Schnellert, and MacNeil 2015) or similar which could inform such developments?
2. With a large range of concepts and issues related to risk identified, there will need to be some prioritisation of what aspects of risk should be taught in schools. This might include ascertaining the views of teacher educators and teachers about what can be taught and if the recommended concepts would be appropriate in a classroom setting, and for what age levels. Future research efforts will need to investigate how risk concepts are actually taught in schools and how teachers believe these concepts can be taught effectively.
3. There is an urgent need for professional development and learning opportunities for teachers in relation to risk education and the need for collaborative networks which bring together risk experts with teachers, teacher educators and policy makers to realise high-quality and effective risk education in schools.

Given that these novel insights on the nature, purpose and practice of risk education have been identified from the insights of risk experts, an important aim for future research could be to establish the views of education experts as to whether and how risk is taught in secondary schools in England, and opportunities to further strengthen and develop this.

## Note

1. In the UK school education for young people aged 11-18 years is commonly described as secondary school.

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