# PRE-SERVICE TEACHERS' CONCEPTIONS OF RISK: A PILOT STUDY

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**ABSTRACT:** The purpose of the research was to identify pre-service teachers' understandings of risk, a concept which is being increasingly emphasised in United Kingdom secondary science curricula. Two groups of four secondary pre-service teachers containing a mix of science, mathematics and English specialists were prompted to discuss 'What risk means to you' by watching two short public information film clips loosely associated with risky activities. The teachers' discussions were audio-taped and transcribed and themes derived through grounded theory. Eight statements were extracted and a questionnaire designed to elicit reactions from a further 184 pre-service teachers. Initial analysis of the data indicates teachers hold diverse understandings of risk and that there are differences in conceptions between practitioners in different subject areas, hence subject identity might be an influential factor. Curriculum design should take account of teachers' conceptions of risk, recognising that this is a much more fluid concept than those normally used in science teaching.

**KEY WORDS:** Risk. Pre-service teachers. Socio-scientific issues.

## CONCEPÇÕES DE FUTUROS PROFESSORES SOBRE O RISCO: UM ESTUDO PILOTO

**RESUMO:** O objectivo desta pesquisa consistiu na identificação das interpretações de futuros professores sobre o risco, um conceito ao qual se tem atribuído uma ênfase crescente nos currículos de ciência do ensino secundário do Reino Unido. Dois grupos de quatro futuros professores do ensino secundário, contendo uma mistura de especialistas em ciência, matemática e Inglês, foram convidados a discutir "O que significa risco para você" através da observação de dois curtos videogramas informativos vagamente associados a actividades de risco. As discussões dos professores foram audiogravadas e transcritas e a sua análise efectuada de acordo com a "grounded

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theory". Foram extraídas oito declarações e concebido um questionário destinado a suscitar reacções de mais 184 futuros professores. A análise inicial dos dados indica que os futuros professores possuem concepções distintas do risco e que existem diferenças de concepções entre os especialistas das diferentes áreas disciplinares. O desenvolvimento curricular deve ter em conta as concepções de risco dos futuros professores, reconhecendo que este conceito é muito mais fluido do que outros normalmente utilizados no ensino da ciência.

**PALAVRAS-CHAVE:** Risco. Futuros professores. Questões sócio-científicas.

## INTRODUCTION

Risk has been characterised by Anthony Giddens as an integral part of the discourse of late modern society (GIDDENS 1990). Developments in science and technology have brought untold benefits since the Industrial Revolution in health, manufacturing industry, sewage systems, communications, food distribution and fuel technologies. Contemporary technologies such as nuclear technologies, however, can generate environmental hazards such as radioactive waste; the mass distribution of food requires the large scale use of chemical treatments which can have deleterious effects such as soil contamination, monoculture crops and accompanying habitat threats; high voltage transmission lines and base stations for mobile phones have generated public disquiet about radiation effects (SIEGRIST et al., 2005); increase in possibilities for global travel also come with the potential for epidemics, as reflected in the public anxiety about Sars (SMITH, 2006), and, most recently, swine flu, as well as being implicated in the production of greenhouse gases . In genomics, for example, the opportunity to locate genetic diseases has raised anxieties about conditions which hitherto would have been unknown. The 'healthy have become the 'genetically unwell' (BENNETT, 2006). These hazards accompanying contemporary developments in science and technology are objectively no greater, and arguably far more tolerable, than hazards in the past such as open sewers, lack of state-funded health care and everyday exposure to adverse climates. Citizens in industrialised societies in the twenty first century are more affluent, healthier and longer-living than their antecedents. But reflexive concerns arising from public mistrust of those institutions responsible for regulation and political decision-making (O'NEILL, 2002) have prompted personal anxieties and fears in the so-called 'risk society. (BECK, 1992)

Since the turn of the millennium, and as a result of a greater emphasis on school science for citizenship in the U.K. (MILLAR; OSBORNE, 1998) increased attention has been given to the understanding of risk in the science curriculum, most particularly in the course for 14-16 year olds, *Twenty First Century Science*,

which aims to develop science for the citizen (MILLAR, 2006); understanding of risk has also been incorporated in the *Science and Society* course in England and Wales for post-16 students and is a feature of SEPUP in the United States.

While there has been a great deal of research on the teaching and learning of socio-scientific issues in schools relatively little has focused on the specific concept of risk despite its prominence in contemporary socio-scientific discourse. Much more has been published on risk in the Public Understanding of Science literature (POWELL et al., 2007, BLOK et al., 2008), for example, than on school science. Relatively few empirical studies on school students' understandings of risk are available in the literature. Of these Eijklehof's book on risk and ionising radiation (EIJKLEHOF, 1990) and Kolstø's work on students' evaluation of risk in socio-scientific decision-making (KOLSTØ, 2004) focus on the specific nature of risk. While there is empirical research on students' understanding of risk a thorough literature search indicates that no research has been done on teachers' understandings and constructions of risk in socio-scientific issues. Teaching about risk in socio-scientific issues will interact in an unspecified way on teachers' own discourses of risk in life both within schools in their professional lives and in other contexts. How teachers approach this topic is likely to be influenced by their own backgrounds and experiences.

Our contention is that expert and lay understandings of risk are multi-faceted and complex, and that any effective teaching of risk needs to examine the discourses within which teachers have come to construct their own understandings about risk.

## METHODOLOGY OF RESEARCH

The research was run as an exploratory pilot study. To gain an insight into how pre-service secondary teachers understand risk we asked two groups of four pre-service teachers, each group consisting of a mix of science, maths and English specialists, to watch two short public information films, each between one to two minutes long, which incorporated incidents of potential harm, possible benefits and elements of uncertainty. In order to remove pre-conceptions about contemporary notions of risk the two films chosen were about sixty years old. They were comic and rather patronising and used a middle-aged man as the butt of the jokes. The first film explained how to use zebra crossings which had been newly instituted in the 1940s. Hoped-for benefits were being able to cross the road safely at a crossing point recognised by both pedestrians and motorists but this involved preventative action against possible personal harm by remembering to use the crossing safely,

e.g. looking both ways before crossing[1]. The second film explained the importance of using a handkerchief in public places[2]. After watching the film the two groups were asked to discuss the question 'What does risk mean to you?' The researchers did not observe the discussion but audio-recorders were left in the room with the pre-service teachers' permission.

Each discussion lasted approximately twenty minutes at the point when the participants felt they had said what they wanted to say. The conversations were transcribed. The two researchers read the transcripts and identified themes and quotes through grounded theory and iterative coding (FLICK, 2006). These quotes were then incorporated into a questionnaire which was given to maths, English and science pre-service teachers, together with questions on what risk means to you (GOULDING et al., 2003) (see appendix). The purpose was to see to what extent the understandings of the original eight teachers were reflected in the understandings of a larger sample of teachers.

The questionnaires were distributed to 184 teachers and the responses analysed using excel and SPSS.

## RESULTS OF RESEARCH

### Teacher discussion

Three interconnected themes emerged. First, risk was deemed to be connected with events that one had control over, and that a spectrum of intentional behaviours, from calculated thought through to intuitive leaps, could be taken to influence consequences which might be beneficial or harmful. Apprehension of these consequences might be mediated by psychological, cultural or social factors (PIDGEON et al., 1992). The second theme was the close link between the notion of risk and danger which could be influenced by certain actions that lessened or heightened the danger. Thirdly, risk-taking was linked to the affective domain, for example, feeling for others involved an element of risk-taking.

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[1] See http://www.nationalarchives.gov.uk/films/1945to1951/filmpage_pc.htm (last accessed 30th March 2009)

[2] See http://www.nationalarchives.gov.uk/films/1945to1951/filmpage_cas.htm (last accessed 30th March 2009)

## Control

Events over which people can have no control were not thought to come under concepts of risk. Catching a cold was something over which people had no, or minimal, control, it happened through the very process of living while actions of choice which usually involved adventure and personal enjoyment or satisfaction such as bungee-jumping were strongly associated with risk.

> [...] lots more opportunities to do wacky things now, risk-taking behaviour, like space travel, [...] jumping out of things, jumping off things, going to places, trying to push boundaries, trying to be the fastest thing on Earth [...] that's huge now, all these new sports and the excitement [...] (science)[3]

Events that were not necessarily connected with adventure such as children crossing the road were also inherently risky. Risk, as a number of participants asserted, was 'part and parcel of living' although no clear distinction was made between those events as part of living which are under human control and those which are not, hence there was ambivalence as to whether risk was a conscious activity.

> 'Every aspect of life whether decisions are conscious or not involve an aspect of risk' (maths)
> 'When we take risks for ourselves we make the decisions unconsciously really – I'm not sure how much we actually think about it'. (English)

While risky events came along with adventure and hoped-for benefits there was always a probability of harmful outcomes such as injury or death, and again human agency could control the likelihood of harmful consequences taking place; thought and calculation were conceived as instruments in minimising harmful impacts.

> If you're a risk-taker you take a calculated risk which suggests that you calculate that there's a lot more to be gained than you lose.' (maths)
> you don't know it's dangerous until you have statistics come in'. (English)

As one participant pointed out with an example related to the use of cycle helmets, risk calculations could overturn commonsense assumptions.

[3] Indicates subject specialism of the pre-service teacher.

> I looked up on the Internet about a cycle helmet and there was a lot about these probability statistics. You're more likely to have a head injury as a pedestrian and more likely to have a head injury as a car passenger. Some people are trying to make helmets compulsory for every cyclist but if you look at the risks involved you're much better off making every pedestrian wear a crash helmet. Some of the statistics showed you're more likely to have a serious head injury as a result of wearing a crash helmet so this whole idea of risk just turned convention on its head. . . It struck me how important risk is and analyzing risk in normal everyday situations.' (maths)

Yet others remained unconvinced that risk could be quantified, as witnessed by this interchange.

> Is risk always to do with numbers or can it be quite subjective as well?' (science)
> It's rarely about numbers, it's nearly always about your own intuition.' (maths)

The centrality of control in relation to risk had resonances with sociological research which demonstrates personal autonomy in risk-taking situations (LUPTON; TULLOCH, 2002) and contrasts with Beck's characterisation of a more passive society, subject to changes beyond their control.

### Risk as hazard

There were strong associations between risk and danger, harm or hazard and the terms were frequently used synonymously.

> when you say that's a risky thing to do it probably hints that you shouldn't do it because there's an element of danger'. (science)

Science teachers referred to risk assessments in practical sessions and out of this the conversation revolved around an unnecessary pre-occupation with risk and legislation to lessen it. Sometimes the legislation seemed counter-productive.

> Health and Safety laws these days are ridiculous, you wouldn't do very much if you were to follow it strictly. Is that good? Can kids learn? (science)
> When I think of risk I always associate it with danger. We always have to do risk assessments before practicals and that's what I always associate risk with ,so in labs giving kids a pair of scissors is not risky but you have risk assessments for chemicals. But kids are more likely to cut themselves with a pair of scissors than blowing themselves up with chemicals. (science)

This reflected teachers' views of a risk-averse society. But risky situations for one individual were not deemed at all risky for another: risk was seen as a highly subjective and culturally-loaded concept as a Nigerian pre-service science teacher noted in relation to a maths teacher's fears about contracting malaria. In this exchange the maths teacher presents his assessment first.

> I was planning a holiday to Africa. Just before we were due to go we heard the malaria risk was much higher because there had been a lot of rainfall and my family decided to stay behind and I went on my own in the end. I suppose that's recognizing some sort of threshold of risk that I might have actually passed.. . . I had no figures to work on, no percentage risks for example, you just felt not a good feeling about this. (maths)
>
> To you that's quite a risky thing to do. For someone like me who grew up in Africa and had malaria like about three times, saying the level of malaria has increased, well, I've had it three times so it doesn't seem that much of a big deal. (science)

Teachers agreed that human subjectivities underpinned perceptions but there was a counter-feeling that quantification was in some way connected with risk estimation. Individual teachers emphasized in one context that risk was about making calculations about possible outcomes and levels of hazard and at other times believed risk was intuitive and calculations were irrelevant to proposed action.

### Affective domain

There are three main sub-themes which linked risk-taking to emotional reactions. Perceptions of fear from children and adults often provoked disproportionate worries to the probability of danger.

> Lots of people fear things where they are less likely to have an accident than crossing the road. Some people are not at all happy about going on planes who wouldn't mind crossing the road but the actual chance of you being involved in a plane crash is much less than the chance of you being knocked over. (English)

The chances of being hit by an asteroid are very rare but the riskiest thing, being hit by a car children don't see. Yes, that's what risk means to me, and when I'm taking my children across the road I point out to them that this is more dangerous than a shark because actually this is what you're most likely to be killed by, not a shark and not a Martian.' (maths)

Slovic et al. have demonstrated that one way of estimating risk is to base it on perceptions of dread-not dread, observable-non observable effects and a combination of number of people exposed to the hazard and likelihood of personal exposure, hence the release of nerve gas in a confined area would have a high dread rating, be unobservable with potentially a large number exposed but low likelihood of personal exposure; a car accident would have a low dread rating and be observable, involve relatively few people but for most people in industrialised countries have a high likelihood of occurrence. (SLOVIC et al., 1980).

Another sub-theme in the affective domain was the importance of adventure, the adrenaline factor and impulsive emotional factors which would make life dull if they were not present.

> One thing about those extreme sports is that they give us an adrenaline rush to make up for the fact that our own lives are so comfortable. (science)

Finally risk was a factor in relationships.

> you can't go through life not taking risks, if it was always comfortable and not risky then what would you do, you wouldn't feel for anybody particularly. (science)

## Questionnaires

Statements from the focus group discussions were used to construct a survey instrument containing authentic statements about risk to which the sample of pre-service teachers being surveyed could respond (GOULDING et al., 2003). The survey instrument was designed to elicit immediate responses about the notion of risk rather than views they may have rehearsed beforehand or felt that they ought to hold. (While this designation is impossible to check, the duration time of the survey and the nature of the responses would suggest these were largely spontaneous). To this end we started with a prompt asking what 'risk' meant to the respondent and then asking for a response to statements that were verbatim extracts from the group discussions. There were then three response prompts: (1) to offer an opportunity to explain why the respondent totally dis/agreed with a particular statement; (2) to relate risk to teaching; and (3) to enquire if there were other points the pre-service teacher wanted to make. Parts 2 and 3 are not discussed in this paper. (See appendix for a copy of the survey instrument).

## Analysis of questionnaires

### Instantaneous responses

Most of the responses associated risk either with danger, or with the probability that something harmful or hazardous could take place. Only one respondent linked the probability of an event to its impact. A minority of respondents identified hoped-for benefits which always had to be weighed against possible harm or 'cons'.

As a result of the analysis we separated responses to the statements into four groups (see figures 1 – 4):

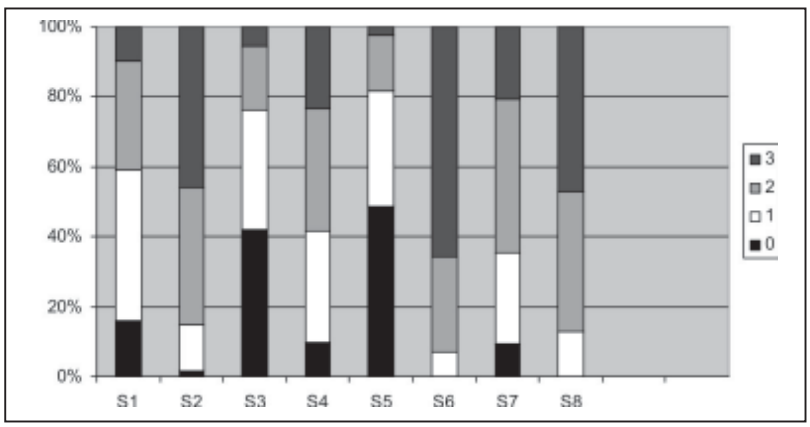


**Fig. 1** - Percentage of levels of agreement of responses to each statement (see appendix) All teachers (n = 184)

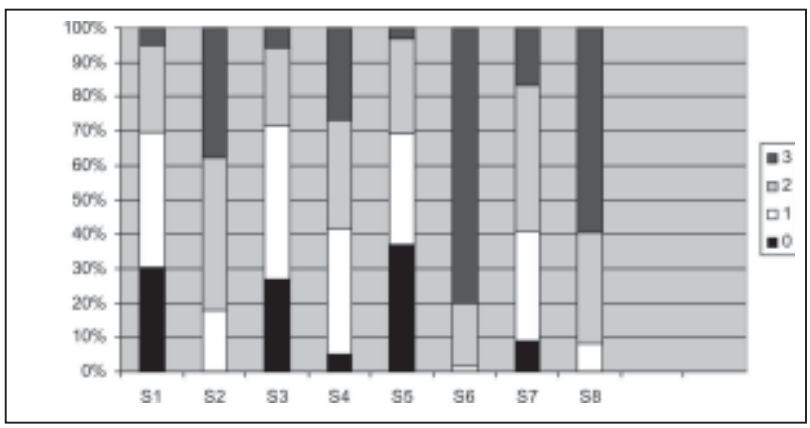


**Fig. 2** - Percentage of levels of agreement of responses to each statement (see appendix) Teachers of English (n = 63)

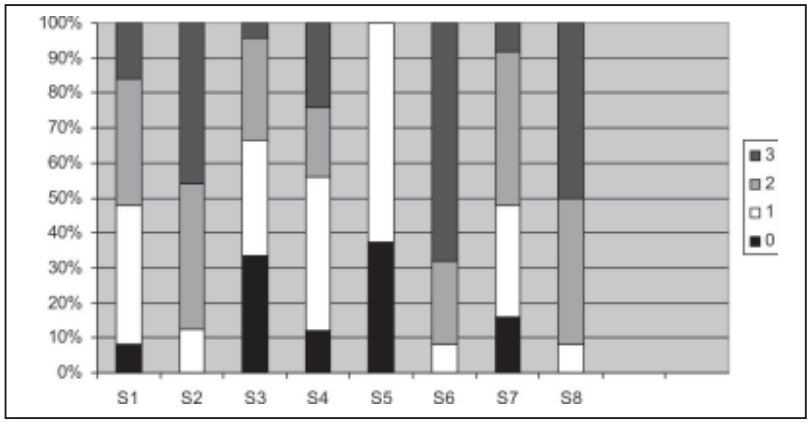


**Fig. 3** - Percentage of levels of agreement of responses to each statement (see appendix) Teachers of mathematics (n = 25)

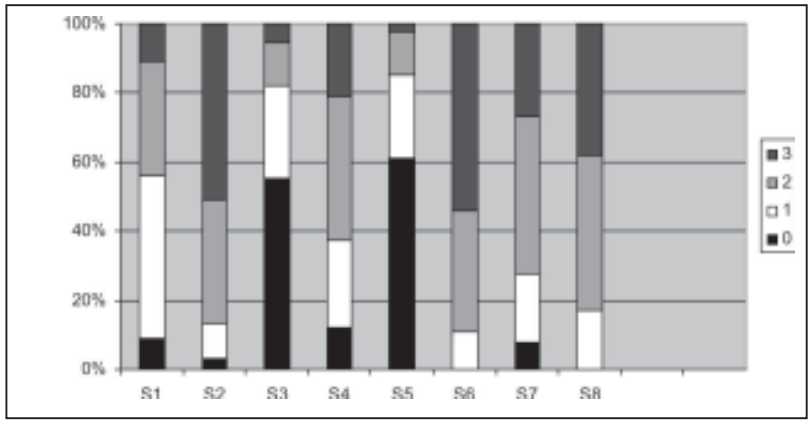


**Fig. 4** - Percentage of levels of agreement of responses to each statement (see appendix) Teachers of science (n = 96)

- statements which resulted in strong disagreement;
- statements which resulted in substantial agreement;
- polarity of viewpoints with a range of views in between.

## Statements which resulted in strong disagreement

Statements 3 and 5 resulted in the greatest disagreement for all teachers. Statement 3 which stated 'the most risky thing is exposing your feelings' was largely interpreted as something which ought not to be the case rather than a

reflection of people experiencing considerable uncertainty when exposing their feelings, hence 'exposing your feelings can be positive, it allows and encourages deeper and less superficial relationships ... (maths)'. However, others who strongly disagreed thought that exposing one's feelings was a way of reducing risk and uncertainty because it 'helps others to act appropriately, and indeed yourself, thereby reducing risk' (English). But there were also responses which suggested that physical acts were inherently more dangerous than emotional acts. In the few cases where there was strong agreement with this statement risky acts were seen as involving feelings rather than demonstrating feelings as necessarily being risk.

Overall there was no refutation of the linkage between risky acts and feelings, rather scepticism as to whether demonstrating feelings exacerbated risk. Statement 5 was frequently interpreted literally with many respondents noting that most risky acts had impacts which did not involve death as an outcome.

### Statements which resulted in substantial agreement

A large majority agreed substantially or totally with the statement S2 that 'risk involves thought and decision', for example, 'to think about a particular risk will reduce its impact' (maths). This statement is consistent with the perception of risk as being under the control of human volition, that human agency is active in reducing elements of risk rather than risk promoting anxiety and passivity. There was a tendency to agreement about S4, that 'risk is synonymous with danger' but this was tempered by the idea that these dangers could be controlled and that dangers often accompanied hoped-for benefits. There was very strong agreement that 'risk for one person in a particular situation may not be the same for another person in the same situation' (S6) and therefore that risk was subjectively perceived rather than an entity which could be objectively quantified. There was also emphatic agreement with S8 that 'decisions about what risks to take depend on whether it is just me involved or others'.

### Statements which produced a polarity of viewpoints with a range of views in between

Statements 1, 4 and 7 provoked polarised viewpoints although the majority of respondents were equivocal. 'Risk is a mathematical thing' prompted responses suggesting that risk 'is a human construct involving non-mathematical ideas' although there was also agreement that even in subjective perceptions quantification might be possible, for example it might be possible to estimate the probability of

an event but more difficult to quantify impact. In S1 there was a marked difference between subject area specialists with just over 30% of teachers of English not agreeing at all that risk is a mathematical thing whereas this was the case for 8% of both mathematics and science teachers. While most respondents agreed, as stated earlier, that risk is synonymous with danger, there was some polarity of viewpoints although a higher proportion agreed with the statement. Where there was disagreement it was suggested that risk is strongly associated with uncertainty rather than danger *per se*. Finally there was limited polarity of viewpoints for statement 7. Those who strongly agreed felt that identifying risks helped to formulate ways to reduce them. Those who disagreed felt that risks were impulsive and talk would have no effect.

## CONCLUSIONS AND DISCUSSION

Risk is not like a scientific concept over which there is agreement about definition, for example force, current, chloroplast, atom or procedures such as prediction, hypothesis or induction. Normative considerations influence meaning and are reflected in a range of discourses; curricular prescription in the teaching of risk in socio-scientific issues, for example, would be problematic because of the wide range of different understandings and experiences, possibly influenced to some extent by subject identity. Pre-service teachers have fluid and markedly diverse perceptions and understandings of risks and the incorporation of risk as a topic of study in science and mathematics curricula needs to be buttressed by a theorised understanding of pedagogy.

The evidence based on pre-service teachers' perceptions strongly suggests an approach which allows researchers to track teachers' thinking when engaging with risk situations which involve decision-making. However decision-making involves taking into account not only standard definitions of risk of probability of a particular event occurring x impact (PIDGEON et al., 1992) but also an opportunity to express and prioritise values and affects. What emerges very strongly is an appreciation of the subjective nature of risk-taking decisions and of their situatedness. Further research on teachers' understandings will therefore need to also expose teachers to a range of both personalistic and policy-making aspects to generate more opportunities for tentative insights and generalisations into teachers' understandings.

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## APPENDIX

**What does RISK mean to you?**

Please write down the first thing that occurred to you

.....

thank you! your response will contribute to our finding out about NQTs' understandings of risk.

Please would you help us further by completing our brief survey? From focus groups of PGCE students (in maths, science or English) discussing their ideas about risk, we have reproduced a selection of statements about **risk** below. Please score your level of agreement with each statement by circling one number only:

0 = I don't agree at all (I don't think this is true)

1 = I agree a bit (there is a bit of truth in this)

2 = I agree substantially (this is substantially true)

3 = I totally agree (this is true)

| | Statement | Agreement level |
|---|---|---|
| 1 | Risk is a mathematical thing | Do you agree? 0 1 2 3 |
| 2 | Risk involves thought and decision | Do you agree? 0 1 2 3 |
| 3 | The most risky thing is exposing your feelings | Do you agree? 0 1 2 3 |
| 4 | Risk is synonymous with danger | Do you agree? 0 1 2 3 |
| 5 | Taking a risk can be like defeating death | Do you agree? 0 1 2 3 |
| 6 | Risk for one person in a particular situation may not be the same for another person in the same situation | Do you agree? 0 1 2 3 |
| 7 | Talking about risk is a way of preventing danger | Do you agree? 0 1 2 3 |
| 8 | Decisions about what risks to take depend on whether it is just me involved or me and others | Do you agree? 0 1 2 3 |

On one of the comments where you have given a 0, please explain why you do not agree at all (if applicable)

.....

On one of the comments where you have given a 3, please explain why you are in agreement (if applicable)

.....

Do you think the notion of risk is relevant to you as a teacher? YES / NO
Please say why:

……

Do you have any views about risk, other than those stated above?

……

Which is your curriculum area? Circle one: **mathematics/English/science**
Please state whether you are: **male/female** (please circle)

Thank you very much for taking part.