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Making sense of big questions that require multiple subjects: preliminary theorisation of an integrative philosophy of knowledge and empirical indications of a lack of subject connection within school curricula

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Abstract

This paper provides theorisation about a novel concept for education: an integrative philosophy of knowledge (IPK). This is proposed for school curricula to relate multiple subjects to big questions of personal and existential importance. Critical contemporary issues such as climate change education require multiple subject contributions but there is little clarity in the English education guidance on this drawing together, beyond the encouragement to do so in priority areas. Leading British thinkers have engaged the idea of the unity of knowledge, not without difficulty and criticism. The paper identifies reasons for a practical approach to consilience in school curricula. In addition to preliminary theorisation, in methodological ‘harmony’, this paper adds tentative empirical findings from a related research project that provides quantitative indications that such multi-subject connection is likely not happening. The findings are not definitive, but the perceptions of three groups of beginning and experienced teachers (secondary Religious Education (RE), secondary science and primary teachers) indicate that school curricula do not reflect an integrative approach to climate change education, and sex and relationships education, despite policy priority. A significant national survey could not detect many signs of connection. The paper speculates that RE could have a key epistemic role for the curriculum as a whole in this regard.

Keywords Integrative philosophy of knowledge (IPK) · Consilience · Unity of knowledge · Science education · Religious education · Personal relationships education · Sustainability · Climate change education

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1 Introduction

Anecdote from one of the authors.

During a research project that provided the data this article draws on, my daughter commented, “we did the Big Bang twice this week; on Monday we did it in Religious Education and on Wednesday we did it in Physics.” I asked whether there had been any coordination. She didn’t think so.

Every college student ought to be able to answer, “What is the relation between science and the humanities and how is it important for human welfare?” (1998, p.11) according to the multi award winning socio-biologist Edward Wilson (1929 – 2021). By extension, the same could be said of teachers in a school. Wilson believed the pursuit of an answer to this question would help the project of consilience, the idea born of science of a unity of knowledge, extended to all of the great branches of learning, resisting the dangers of fragmentation in knowledge. A coherent curriculum in schools which students to ‘some’ degree can hold together, seems in principle to proceed from Wilson’s greater ambition, albeit not in an effort of totalising unity, which remains contested. Such coherence may have significance for the existential questions posed by topics related to the origins of the universe (as in the anecdote), but it also has relevance for immediate concerns of personal and planetary survival, where ethics and science have relevant contributions to make.

This paper emerges from two kinds of knowledge building. Some preliminary theorisation around Wilson’s question, necessary to provide at least some conceptual scaffolding for the key idea at the heart of the paper, and something noticed in a related empirical research project about science religion encounters, including science-ethics encounters, in the classroom (which has been reported extensively in Bowie et al., 2023; Woolley et al., 2022, 2023; and Riordan et al., 2021, 2023). That research found that beginning teachers in primary schools and in secondary science and secondary RE reported teaching lessons about very many topics which drew subject knowledge from the other subject, including climate change and sex and relationships education. Secondary science teachers and RE teachers, are both engaging with these topics in their respective subjects.

Teachers know that many of the topics they teach about rely on multiple subjects. A re-examination and analysis of some empirical data, along with new conceptual structuring, establishes preliminary theorisation for a concept of an integrative philosophy of knowledge (IPK) as a necessary consideration for school education. Such a concept addresses the bringing together of different kinds of knowledge, which students must do practically at the day-to-day level, and for schools to be able to advance a greater theory of knowledge. Critical contemporary issues like climate change education and sex and relationships education, which teachers have reported as drawing on multiple knowledges (Bowie et al. 2023), are both identified in English schools’ education policy as benefitting from multiple subject treatment. The idea that schools do some working of bringing together is not entirely absent and arguably these important subjects require it to be done well. This concern touches the most personal and the most existential of educational matters. Though areas of self-evident importance, the connectivity of subjects in school curriculum should not be assumed. Current Ofsted guidance for schools in England refers to separate subject disciplinary knowledge, not the drawing together of multiple subjects (Ofsted, 2019, 2024). No philosophical organisation of multi-subject

organisation is advanced, suggested or outlined in the policy. Such things are left to schools, teachers and pupils. There is not even a widely understood phrase or concept for this as the curriculum is almost entirely described at subject level.

This paper combines some preliminary theorisation to place the idea under examination in the context of the major twentieth century philosophical debate around the same question alongside some quantitative evidence from beginning and experienced UK teacher survey data indicating a likely lack of an IPK. Important and high priority interdisciplinary areas of the curriculum are not being addressed at a systemic level with a conceptual framework or choice of conceptual frameworks for the interlinking of subjects around big questions and ultimate meaning making. This paper therefore argues from this theorisation and reading of data: (1) important personal and existential educational priorities require conceptual organisation for interdisciplinary treatment and different subject area teachers report coverage of important topic areas; (2) English curriculum policy does not contain organising concepts or frameworks for the combination of knowledge to support teachers and pupils; (3) Empirical evidence indicates poor connection between subjects and departments where good connection would be likely needed for such important topic areas; (4) A more clearly articulated IPK is in principle needed in education policy, and in the habits and practices of school departments and subject teachers.

What follows next is succinct preliminary groundwork for philosophical clarification around the extent of connection, disconnection, integration or dialogue between the disciplines, discussed in relation to school policy and previous related educational research background. It then connects these themes with re-examined data from the research project.

2 Preliminary theorisation: consilience and cooperation in the case for an IPK

The instinct of consilience contains some kind of integrative understanding, a provisional holding together of multiple kinds of knowledge (broadly understood) developed through distinct approaches to knowing. Hope for an integrative philosophy of knowledge is arguably ancient. In the poetry of Lucretius, “nam quamvis funditus omnissumma sit infinita, tamen, parvissima quae sunt, ex infinitis constabunt partibus aequae.” / “for although the whole sum of things be absolutely infinite, yet the bodies which are littlest will equally consist of infinite parts.” (Lucretius, 1924, line 620–622, p. 50–51).

However, an overly definitive theory of everything remains elusive and contested. Midgley (1978, 2003), responding to Wilson’s earlier and later thinking in this area (Wilson, 1978, 1998) warned against a totalising approach, “Science, which has its own magnificent work to do, does not need to rush in and take over extraneous kinds of question (historical, logical, ethical, linguistic or the like) as well.” (Midgley, 2003, p.5–6). One discipline’s animating potency might be marginalised as a result of an overreach or ‘trespass’ (Ballantyne, 2019; Bowie et al., 2023) of another. The navigation of values conflicts could not be undertaken purely through empirical subjects and the connection between facts and values is complex (Midgley 1987). If one danger is a subject over-reaching itself, another is such a desire for disciplinary purity that subjects are entirely segregated. This could lead to the marginalisation of the ethical in a technologically and scientifically driven age (Murdoch, 1993), surely a warning for England’s system of subject silos especially where Science and Mathematics have clear prominence.

Turbulence around the reach and disciplines of knowledge needs to be seen in the context of uncertainty around the constitution of knowledge (Rauch, 2021) and the broader post truth convulsion present in popular culture, politics and in diverging disciplinary patterns in scholarship (Baginni, 2017). Wilson thought the project of consilience was challenged by increasing instability and disorientation as we move closer to the point of intersection between multiple disciplines. The case for the IPK can therefore be construed at the practical level daily tasks of navigating life, drawing on information and understanding gathered from different sources and subjects, all with an awareness of instability. The turbulence at the intersection of subjects needs navigation to address the greatest challenges. Wilson illustrates his point with the question of navigating environmental policy, ethics, social science and biology in addressing the ecological questions of our survival.

Murdoch and Midgley leant towards a metaphor of cooperation between subjects which requires a practical integrative activity or reciprocal exchange that nonetheless respects the bodies of knowledge built by disciplines; a cooperation of knowledge, rather than a unity. An IPK may remain agnostic to the magesteria question common in science religion debates, and be sustained instead by an understanding of the operation of the human brain. Ian McGilchrist's work (2009, 2021), reflecting on science and the humanities and scientific studies in brain damaged patients, spotlights this activity as part of the ordinary functioning of a healthy human brain, which ordinarily combines more analytic, explicit, specific forms of knowing with broader, implicit and contextual forms of knowing (McGilchrist, 2021). McGilchrist's case can be added to earlier philosophers of science such as Polanyi and Prosch (1975), who identified a tacit integration and an indwelling of what they called irreducible personal knowing that draws on multiple knowledge types in embodied experience.

There is, then, a practical case in principle for an IPK; a conceptual organisation which carefully avoids the dangers of epistemic trespass and discipline marginalisation to retain the animating potency of discreet disciplines and the value of knowledge cooperation, especially when tackling complex problems. It need not resolve the question of whether there is an overarching single subject of distinct magesteria. An IPK might aid with the navigation of the turbulence created by the intersection of the different disciplines. Measuring economic benefits, navigating ethical concerns, balancing different values interests, and maintaining accurate empirical and theoretical information requires conceptual awareness. This is both a task for multi-disciplinary teams of experts trying to address the ultimate questions of reality and breach the divide between Lucretius' macro and the micro, and for everyday navigation of life (Polanyi and Prosh, 1975) which means it is a concern for education.

3 Preliminary theorisation: IPK and curricula

To address questions of ultimate importance for humanity and human civilisation, there has been discussion and policy proposals from trans national supra actor to address the need for pupils to work on a theme or topic with competencies drawn from different disciplines (UNESCO, 1986). It is evident that the development of the mastery of domains of knowledge is viewed by as essential in education (Buchanan et al., 2020). It is also the case that key issues of our time require multi-disciplinary engagement to understand and respond (UNESCO MGIEP, 2021). It's advocated that interdisciplinary knowledge helps students transfer big ideas across different disciplines, identify connectedness, and understand how

and when to transfer knowledge from one setting to another (OECD, 2019) but there are long standing questions about ensuring this is carefully attended to. Subjects contribute to one another as certain kinds of knowledge presuppose others of a different kind such as language for the humanities and maths for the sciences; however, idiosyncratic cross-curriculum design might not develop pupils structuring of thinking or ensure they make progress (Pring, 1976). Nonetheless reported research from UK schools indicate many topic areas being taught by teachers that require more than one subject contribution (Bowie et al., 2023).

Recent government school inspectorate guidelines for state funded schools (Ofsted, 2019, 2024) require a curriculum intent expressed in terms that rationalise the systematic and explicit knowledge sequencing within individual subjects. Schools are not expected to articulate a broader integrated picture of knowledge above individual subject level or to show how this is embedded around curriculum design or subject articulation. Curriculum subjects are separated by clear boundaries (Young, 2013; Billingsley, 2013; Kötter & Hammann, 2017; Billingsley & Nassaji, 2020).

Nevertheless, Government policies for schools expect or hope provision will draw on a range of subjects to contribute to pupil personal development. The statutory guidance on Relationships Education, Relationships and Sex Education (RSE) and Health Education (Department for Education, 2021) recognises that these subjects or areas complement several national curriculum subjects including science, computer science, PE, citizenship education and RE. It mentions these in relation to delivery and teaching strategies, and the obvious opportunities for linking knowledge from different subjects. This promotes an understanding that multi-subject cooperation is beneficial in certain instances.

The Department for Education (2022) advocates a policy around sustainability and climate change to provide ‘opportunities to develop a broad knowledge and understanding of the importance of nature, sustainability and the causes and impact of climate change and to translate this knowledge into positive action and solutions’. This policy mentions contributions of different subjects and the overall ambition to inspire collective collaboration to address climate change. Research has identified the role of different environmental, social and economic dimensions in sustainable development education (Corney, 2006; Dale and Newman, 2005; de Haan, 2006; Summers and Childs, 2007; Van den Bergh, 2007). This has led some to argue that such a holistic approach requires the interrelationship between subjects to be addressed with educators particularly interested in the place of spirituality and ethics in sustainability education (Scoffham & Rawlinson, 2022).

Both Sex and Relationships Education and Sustainability and Climate Change Education specifically involve elements of ethics (and potentially many other elements from RE) and the sciences. Overall, schools orchestrate different subjects and advance curricula that inevitably rely on a bringing together, at least in the pupil, of elements of different subjects, including science and RE (this latter subject containing a significant strand of ethics). It is less clear whether or how different knowledge is encouraged to be drawn on or to form part of an integrated experience. How pupils may be expected to make sense in topic areas that receive treatments in different subjects has particular significance for these high priority topics. When and how biological sex is referred to in sex and relationships is, additionally, politically and socially sensitive.

It maybe that in education, the competences and capabilities for connection could be built within a framework of an IPK, but in the absence of any organised or conceptually structured proposal is it likely that subjects, such as science and RE, will be being drawn well together when needed? Whatever the case in terms of subject magisteria, it is nevertheless an assumed good, that pupils will learn from these two subjects, along

with others, and be better able to make sense of things as a result. Pupils must draw meaning from differently generated knowledges, irrespective of whether those knowledges have opposing, incompatible, parallel or compatible epistemological frameworks. They may draw out competing meanings which are unresolved and incompatible. They may reject some subjects in epistemological terms. They may establish an overarching way of making sense that holds many subjects with their quite diverse epistemological frameworks.

In both of the policy identified topic areas, climate change education and sex and relationships education, science and ethics play a key role. Ethics is substantially part of the subject of RE and in the research project questions that the empirical part of this paper draws on, RE was defined to participants as a category that included ethics. Both subjects have a role in making sense of these parts of the curriculum. How should educators think about the coordination of different subjects, with different ways of knowing, across a school curriculum? Rather than propose an integrated curriculum, which would be a major change for the structuring of the English school curriculum, could not an orientation toward knowledge instead be proposed? The question could instead be framed, how might an approach to knowledge be devised that has some explicit orientation towards the unity or cooperation of knowledge? The emphasis this paper is advancing is an *integrative* philosophy of knowledge informing a practical orientation in curriculum design.

Integration of knowledge is crucial in the everyday life of current global citizens. Understanding complex issues and dealing with a variety of societal issues requires an integrated knowledge base (Wraga, 1993). In practice students and teachers must integrate their different components of learning in specific topics. Some kind of an IPK happens in everyday education in schools, even if it is simply in the making sense pupils do themselves when drawing on different things they have learnt in different subjects. An IPK could advance the broad epistemic and inter-disciplinary dimensions helping pupil awareness of these. English schooling at the level of government policy does not have a clearly articulated IPK. It is not present in curriculum guidance on subjects beyond the general aims of education. An IPK is not synonymous with an integrated curriculum of the type that removes individual subjects or visible disciplinary ways of knowing and restructures disciplines around topic areas.

The research team developed a way of trying to capture the nature of the dialogue between subjects and departments in schools (summarised below) drawing on a typology Barbour (1998) developed for making sense of science religion dialogue and applying it to school contexts (Woolley et al., 2023). Barbour's typology, very widely used in the field of science and religion is a classification describing the nature of the relationship between science and religion in terms of 'conflict', 'independence', 'dialogue', and 'integration' and the research team added 'collaboration' after the term was mentioned in pilot focus groups. This typology matches many of the conceptual lines present in the debates referred to in this section, with integrated, cooperative, and dialogic possibilities for imagining an IPK.

Science and religion debates raise questions about enquiry, reasoning and how conclusions are reached. An IPK can refer to guidance, habits of practice, principles and opportunities for the development of the effective handling of different subjects and disciplines, with their distinctive epistemological integrities, when more than one is required for instances of problem solving or sense making at micro or macro levels. Such is required at the level of the good working of multidisciplinary teams dealing with complex specific challenges. It is also required at the general level of navigating life through challenges that ordinarily require that insight is drawn from multiple disciplines. Just as a discipline develops its own habits and ways of knowing, so, at a broader level, some pattern of how the

different insights are drawn together to navigate complex matters requires its own habits of practice and surely pupils need curriculum space to exercise these habits.

In recent years several studies have pointed to a lack of integration in the science and RE curriculum (Erduran et al., 2019; Guilfoyle et al., 2021). Billingsley and Nassaji (2020) found that students from church schools often view science and religion as conflicting. Guilfoyle et al. (2021) found science and RE teachers more generally view their different subjects not as conflicting, but instead could mention ‘areas of convergence and common purpose’ aiming for ‘coherence across the whole school curriculum’ (p. 201).

An IPK is arguably of general interest to all schools offering a broad curriculum but in the state-funded English schooling sector, a prioritization of IPK is less obvious at a general policy level. An IPK is of relevance to the whole education system in so far as various policies that call on multi subject cooperation are concerned. The UK government implies some sense of the value of an overarching vision that some integration is assumed or even advocated for English schools. How this is to be resolved is left to those schools. The absence of the philosophy of knowledge more generally leaves pupils alone to develop any epistemic insight, that is, their ‘knowledge about knowledge’ (Billingsley & Nassaji, 2020, p. 154).

4 Empirical work: method, data collection and procedure for the associated research project

A large multi component research project produced the data which was subsequently reanalysed and reinterpreted for this paper. Different aspects of that project have been reported elsewhere. For clarity some general information is given here before turning to the new interpretation of findings and its relevance for this paper.

Empirical research drawn on in the present paper comes from *The beginning teacher in the science/religion encounter: Building confidence for an integrated vision of knowledge (SRE)*, led by NICER, a research centre at Canterbury Christ Church University. This project sought to “understand the extent and nature of the experience of beginning teachers as to how knowledge works in ‘science/religion encounters’ in the classroom and how this impacts their confidence and competence” (TWCF0375). This project had a different focus from the aim of this paper, but findings in the project informed thinking in the paper.

Participants were recruited from six universities and through use of social media, subject associations and other teacher education contacts (see also Woolley et al., 2022, 2023). An ethics application was approved by Canterbury Christ Church University in 2019 (19/EDU/015) following the BERA ethics guidelines (2018). The participants agreed they had read an online information sheet about how data would be used, stored and reported. Initial pilot focus groups of beginning teachers were conducted with questions developed from a literature review, and from the findings of these pilots and the prior literature in the area, a survey was designed. On completion of the online survey, participants could choose to be entered into a draw to win vouchers, which was an incentive intended to publicise the survey in a period when teachers were under pressure due to the pandemic lockdown.

The survey was accessed by a total of $N=949$ participants over a period of 13 weeks, from 12 March 2021 to 14 June 2021. The survey was aimed at early career teachers of science and RE, defined as either in pre-service training or in their first two years post-qualification. As the survey was advertised through professional contacts and social media

groups, a number of experienced teachers, more than two years teaching post-qualification, also completed the survey.

The length of the survey led to variation in the percentages of completion reached. Of all the responses recorded ($N=949$), $n=584$ completed the questionnaire to the end, though here still missing cases were reported. A total of $n=68$ completed between 100% and 50% of the questions in the questionnaire, and $n=297$ had less than 50% completion. It was decided to include only participants who completed at least 50% of the survey questions ($n=652$) to avoid systematic missing cases and completion bias. This $n=652$ included 12.3% missing data on relevant items as SRE relationships, and experience in teaching generally. This resulted in a valid total $N=572$ (see Table 1), of which $n=65$ early career secondary science teachers, $n=76$ early career secondary RE, $n=292$ beginning primary teachers, $n=85$ experienced RE teachers, $n=18$ experienced science teachers and $n=36$ experienced primary teachers. As the number of experienced science teachers is comparatively low ($n=18$), only tentative claims can be made from this set of data.

5 Empirical findings: the key question and how it could measure an integrative philosophy of knowledge

One item, towards the end of the survey, asked participants to describe the relationship between the science and RE department in their school. The research team applied the well-known typology of Barbour (1998) an important historian of science and religion. Based on this widely used typology, the study conceptualized and explored teachers' perceptions of 'connection' and 'disconnection' (the felt sense of a culture of integration) between science/religion subjects and departments in primary and secondary schools, among beginning and experienced teachers. This was a single question in a lengthy questionnaire.

Barbour's typology (1998) was used with the option of 'collaboration' added (Woolley et al. 2023). Drawing on qualitative data from focus groups and the quantitative data used in this study, Woolley et al. (2023) found good reasons to use this typology for exploring the perceived relationships between science and RE departments in secondary schools. Earlier, Bagdonas and Silva (2015) adopted Barbour's model amongst pre-service teachers 'to discuss the science and religion relationship' in science education, whilst Reiss has "adapted the categories for the context of science education" (Reiss, 2007, 2008). If a

Table 1 Sample beginning and experienced teachers per type teacher training

Teacher group	<i>N</i>
<i>Beginning teachers</i>	433
<i>Teacher training</i>	
1. Secondary RE	76
2. Secondary Science	65
3. Primary	292
<i>Experienced teachers</i>	139
<i>Teacher training</i>	
1. Secondary RE	85
2. Secondary Science	18
3. Primary	36
Total	572

school has an philosophy of curriculum that explicitly brings subjects together to address complex problems, we might have expected to see signs of that.

Five choices were provided in alphabetical order so as not to suggest a hierarchy: collaboration, conflict, dialogue, independence and integration. Barbour did not apply his typology in this way, but the research team deemed the terms useful in representing a range of levels of interdisciplinarity between science and RE departments (see Woolley et al. 2023).

We subsequently focussed on results from this question to understand whether teachers perceive some form of IPK. Data from this question was re-examined through a refined conceptual framework looking at the data not as an indication of encounters, but rather as indicative of the degree of connection between departments. To what extent do teachers perceive subject connection or disconnection between science and RE, as a proxy for the perceived degree of IPK in schools? In England, RE is the main subject where studies related to religion, ethics and philosophy takes place in schools. We believe a measure of subject connection or disconnection is indicative of the extent of a culture of some degree of integration. We believe the results above show that the measure indicates such a culture is currently lacking albeit there are signs of some dialogue.

Woolley et al. (2023) found no qualitative data for the category ‘integration’ among secondary RE and science teachers. Therefore, to explore a presence of an IPK, Barbour’s categories of ‘collaboration’, ‘dialogue’ and ‘integration’ are conceptually viewed as resonating with an integrated vision on education, which here are signified by *connection*. Barbour’s categories ‘conflict’ and ‘independence’ are considered as reflecting a lack of an awareness of an integrative philosophy of knowledge in education, which here are signified by *disconnection*. These two overarching terms give more credence than a reliance on precise meanings of Barbour’s words due to the potential of divergent respondent interpretation.

This data is explored by examining the science-religion relationship as *connected* or *disconnected*: scores on the taxonomical categories of dialogue, integration and collaboration are understood as science and religion being perceived as *connected* (representing an integrative philosophy of knowledge) and scores on the taxonomical categories of conflict and independence are understood as science and religion being perceived as *disconnected* (representing a lack of an integrative philosophy of knowledge). One limitation of this data is that we cannot be certain how teacher respondents interpreted Barbour’s terms. Further qualitative data, based on focus groups in the same research project, can be used to further examine this. That will be addressed in a separate paper.

The scores on Barbour’s categories will be presented first. The combined scores on ‘connected’ or ‘disconnected’ must be understood with caution. The analysis of the data has an explorative nature, in which only percentages for the different groups are compared. In light of the importance of an integrative philosophy of knowledge for future education systems and the initial stage of English education policy system on it, a perceived ‘integrative philosophy of knowledge’ is, where possible, explored for experienced and beginning teachers separately.

6 Empirical findings: the results

The descriptives for the perceived relationship between the subjects (primary teachers) and departments (secondary teachers) of science and RE are presented in Table 2, for beginning and experienced teachers, for secondary RE teachers, secondary science teachers and

Table 2 Descriptives for the perceived science-religion relationships within schools for beginning and experienced secondary RE, secondary science, and primary teachers

	Beginning teachers		Experienced teachers		Total		
	N	%	N	%	N	%	
Secondary RE teachers	Collaboration	5	6.6	13	15.3	18	11.2
	Conflict	2	2.6	1	1.2	3	1.9
	Dialogue	20	26.3	27	31.8	47	29.2
	Independence	47	61.8	44	51.8	91	56.5
	Integration	2	2.6	0	0	2	1.2
	Total	76	100	85	100	161	100
Secondary science teachers	Collaboration	5	7.7	1	5.6	6	7.2
	Conflict	0	0	0	0	0	0
	Dialogue	13	20	6	33.3	19	22.9
	Independence	44	67.7	11	61.1	55	66.3
	Integration	3	4.6	0	0	3	3.6
	Total	65	100	18	100	83	100
Primary teachers	Collaboration	59	20.2	5	13.9	64	19.5
	Conflict	33	11.3	2	5.6	35	10.7
	Dialogue	41	14	13	36.1	54	16.5
	Independence	135	46.2	14	38.9	149	45.4
	Integration	24	8.2	2	5.6	26	7.9
	Total	292	100	36	100	328	100
Total		433	100	139	100	572	100

primary teachers (see also the study by Woolley et al., 2023, reporting on the secondary teacher data only). These data reveal that most of the teachers in all three groups perceive the relationship between the subjects (primary teachers) and departments (secondary teachers) of science and RE as one of *independence*. Amongst secondary RE teachers, 56.5% ($n=91$) perceived the science religion relationship as one of *independence*. Amongst secondary science teachers, 66.3% ($n=55$) perceived the science-religion relationship as one of *independence*. This percentage was slightly less among primary teachers, with 45.4% ($n=149$).

The findings furthermore reveal that the perceived relationship between the subjects (primary teachers) and departments (secondary teachers) of science and RE was least identified as one of *conflict* or one of *integration*. Especially amongst secondary teachers it was almost never perceived as *conflict* nor as *integration*: among secondary RE teachers only 1.9% ($n=3$) perceived the relationship as *conflict* and 1.2% ($n=2$) as *integration*. These secondary RE teachers perceiving it as *integration* are beginning teachers only. Amongst secondary science teachers no teacher perceived the science-religion relationship as *conflict*, whilst 3.6% ($n=3$) perceived it as *integration*. Again, these secondary science teachers perceiving it as *integration* are beginning teachers only. These numbers are slightly different for primary teachers. Among primary teachers a low percentage perceived the relationship as *conflict* (10.7%, $n=35$) and as *integration* (7.9%, $n=26$). Again, more beginning teachers perceive it as *conflict* 11.3% ($n=26$) and *integration* 8.2% ($n=24$), compared to experienced primary teachers, where 5.6% ($n=2$) perceived it as *integration* and 5.6% ($n=2$) as *conflict*.

In the following, these numbers are first further explored. Chi-Square Goodness of Fit Tests were performed to determine whether the different proportions of teachers were equal between the five categories of perception of the science-religion relationship of Barbour's typology. In these Chi-Square Goodness of Fit Tests, the test variable is the perception of science-religion relationship by the five categories of Barbour's typology.

Second, Chi-Square Goodness of Fit Tests were performed to determine whether the different proportions of teachers were equal between the two categories of perception indicative of IPK or not. In these Chi-Square Goodness of Fit Tests, the test variable is an indicative variable of IPK. The data is explored by conducting Chi-square Goodness of Fit tests on these test variables for different groups of teachers, using the option of *Split file*.

6.1 Perceptions science-religion relationship

6.1.1 All teachers

The proportions of teachers significantly differ by category of perception, $X^2(4, 578)=404.388, p=.001$.

6.1.2 Per type of teacher

The proportions of secondary school RE teachers significantly differ by category of perception, $X^2(4, 165)=174.667, p=.001$, as the proportions of secondary school science teachers, $X^2(3, 83)=82.349, p=.001$, and the proportions of primary teachers, $X^2(4, 330)=147.606, p=.001$.

6.1.3 More experienced and beginning teachers

The proportions of both beginning and experienced teachers significantly differ by category of perception, with beginning teachers, $X^2(4, 433)=298.859$, $p<.001$, and experienced teachers, $X^2(4, 139)=121.827$, $p<.001$.

Overall, in all groups, the observed number of teachers to perceive the science-religion in accord with the category of 'Independence' was significantly higher than the expected number of teachers on this category.

6.2 Perception integrative philosophy of knowledge (IPK)

We understood independence and conflict we as indicative of disconnection and therefore suggestive of a lack of IPK, whilst collaboration, dialogue and integration we understood as connection suggestive of IPK.

6.2.1 All teachers

The proportions of primary and secondary teachers significantly differ by category of perceived IPK, with primary teachers, $X^2(1, 330)=4.848$, $p=.028$, and secondary teachers, $X^2(1, 248)=11.758$, $p<.001$. Tested for secondary RE and secondary science teachers separately, the proportions of both groups still significantly differ by category of perceived IPK, for RE teachers, $X^2(1, 165)=4.418$, $p=.036$, and for secondary science teachers, $X^2(1, 83)=8.783$, $p=.003$.

6.2.2 Experienced and beginning teachers

The proportions of beginning teachers did differ by category of perceived IPK, with beginning primary teachers, $X^2(1, 292)=6.630$, $p=.010$, and beginning secondary teachers, $X^2(1, 141)=14.362$, $p<.001$. The proportions of experienced teachers do not differ by category of perceived IPK, with primary teachers, $X^2(1, 36)=0.444$, $p=.505$, and secondary teachers, $X^2(1, 103)=0.786$, $p=.375$.

Overall, in all cases of significant differences, larger proportions of teachers perceived the science-religion relationship as not indicative of an IPK. In all cases of no significant differences, proportions of teachers who perceived the science-religion relationship as not indicative of an IPK, and proportions of teachers who perceived it as indicative of an IPK, were equal. Thus, overall there were no findings of significantly larger numbers that were indicative of a perception of IPK.

6.3 Discerning an integrative philosophy of knowledge in data from an exploration of science and RE subjects and departments

From this subsequent interpretation of part of the data from an original project with a different focus, there are indications of a minimal measure of integrative philosophy thus emerges in the extent to which subjects are perceived as part of a whole, within which there is some sense of connection. This could be at the level of multi-subject investigations, in a less clear sense of a dialogue between different ways of knowing, or in curriculum sequencing where one subject requires development in skills or knowledge in another. Each

would be valuable for the big questions government policy identifies in climate change education and sex and relationships education.

7 Discussion

The secondary analysis of the data from the empirical study did not find a strong presence of connection, as indicative of IPK, overall among teacher perceptions. There are signs of dialogue but far less than independence and we do not over interpret that figure against the general trend. Collaboration and integration is almost entirely absent. If something akin to an IPK exists in secondary schools, and if schools encourage or facilitate cross subject collaboration drawing on science and ethics from RE on matters such as climate change and education or sex and relationships education, then it is not leading to collaboration or integration. It seems to exist in a small proportion of schools in some dialogic way that draws the ethical and religious contributions together with scientific understandings. The tool used for this project either did not pick IPK up or something like it present in schooling.

Primary and secondary science and RE beginning and experienced teachers are likely to experience a lack of an IPK that translates into cooperation. A few may encounter some dialogue. Interestingly, slightly more beginning secondary RE teachers perceive the relationship as 'disconnected' rather than 'connected'. Among experienced secondary RE teachers, slightly more teachers perceive the relationship as 'connected' than as 'disconnected'. Perhaps there is some degree of connection but of a kind that newer teachers, perhaps more centred on their subject development, did not discern. Nonetheless even among experienced teachers the levels reported are low. The general lack of connection may imply there is little attention to content and concept sequencing in curricula, little coordination around topics, and a low measure of professional contact among different teachers in the secondary context. Murdoch's (1993) fear about the marginalisation of ethics is not placated by these findings.

If, as seems likely to the research team, this research has correctly captured something of a gap, then we may question whether the more 'integrative' policies of government around things like sex and relationships education and climate change are resulting in substantive multi-subject contribution.

If the hope of government schooling policy more generally on issues such as personal relationships and sustainability is one where connection and integration would be manifest, for instance in helping to bring together empirical subjects with matters of value and ethics and navigating both well, then those leaders will also be disappointed that the findings of primary, and secondary science teachers with experience of community schools are weak. Education leaders are urged to investigate further the degree to which an IPK is realised and what this may mean for their policy ambitions.

There are nuances in the data. Disconnection and connection are constructs of the analysis which we used as these are a way of grouping Barbour's typology to address the question of IPK. No definition for Barbour's terms were given in the survey. As participants' understanding of the different relationships are not confirmed, the application of analytical constructs (connection, disconnection) were used to gain a sense of whether participants perceived an IPK. The consequent larger numbers make the data more robust in one sense, but meaning is deferred by a further step from the original data.

Nevertheless, due to the sample size and the use of the survey tool, we have a novel national picture of a perceived likely lack of IPK in English schooling. This resonates with

findings from studies focussed on secondary school students in church schools, where there is a perception a science-religion relationship as ‘incompatible’ (Billingsley & Nassaji, 2020, p. 171) although there are signs of dialogue in the findings of this project. To a large extent this article treats the presence of an IPK as an assumed good. Of course, this might not be the case if a developed IPK came at the expense of other educational goods within subjects. The most significant limitation comes from the majority of primary and secondary science survey participants being student teachers or early career teachers and that they simply wouldn’t have known much at that stage about the curriculum of the whole school. However, the responses from more the statistically significant group of experienced RE teachers lends strength to a hypothesis that the perceived degree of IPK in English schools is not likely to be different among the teaching body as a whole.

The survey data does not reveal a sense of conflict between science and religion, and nor does it reveal a sense of a strongly integrated curriculum, at least between these two subject areas. In view of Barbour’s (1998) thinking on the typology, which we used in our study, we previously warned against perceptions of a relationship of *independence* (Woolley et al., 2023). We similarly understand that a relationship conceptualised in this study as ‘disconnected’ indicates a likely lack of IPK. This likely lack will not offer either students or teachers the possibility of ‘constructive dialogue and mutual enrichment’ (Barbour, 1998, in Woolley et al., 2023, p.144).

8 Conclusion

This paper has combined knowledge building from theorisation and empirical education research, to explore the case for an IPK, a strategy for consilience in schools, despite the inevitable turbulence which, as Wilson observed, occurs when you bring two ways of knowing together. While greater theorisation is required and more specifically targeted empirical research would provide a clearer picture, there are signs of a policy and policy implementation gap, around big questions of personal and existential significance that matter, and any associated framework, and little to guide how subjects feature in such policy and framework, such as how ethical understandings from RE might join scientific knowledge, for good personal relationships education, or sustainability and climate change education.

It is desirable that teachers have some sense of a practical integrative philosophy of knowledge for education. Different subjects play component parts cooperating with other subjects to achieve general education aims around certain topics. It is likely not yet the case that the preconditions exist for schools in terms of strong cultures of dialogue and cooperation around such areas of learning though there are some indications of a beginning in dialogue. Doubtless there are standout examples of excellent cooperation and collaboration in some schools but there is no significant extant policy covering this area in the English school context and the empirical evidence suggest obstacles may exist.

There may be good examples of collaboration and cooperation between other subjects, maths, science and geography for instance as these are outside the scope of the measure tool. More work would need to be done to detect signs from other cooperating combinations. It is possible that moral contributions are being drawn on outside the subject of RE and if so this would raise questions about the role of subject specialism in the curriculum. However, the connection between the kind of contributions that RE might offer (ethics and social understandings, ideas of sacred earth, the dignity and equality of the human,

commitment, vocation, service and justice) are likely absent from organised connection with insights from science in key topic areas of priority in schools.

Important content areas of education could bring together ethics (from RE) and the sciences, such as climate change and sex and relationships. While there are likely to be excellent examples of good bringing together, currently these are less likely to be met by well-integrated provision, for example bringing ethics, biology, health and geography into cooperation, given the absence of good patterns of dialogue and inter-subject organisation. In the absence of such good bringing together, we might in particular wonder about the connection between science and ethical concerns in the many topic areas that require both to play a part. As a significant part of the secondary data comes from RE teachers contextually, it is important to understand that there are generally accepted concerns about the quality and quantity of provision of RE (a subject that includes ethics) in many English schools, with reports that a significant portion of the sector have very few RE teachers (Tudor, 2024; Lewis & Roberts, 2022).

For practical reasons, it may be that the success of an IPK in a school comes down to a single subject being given responsibility to drive forward the kind of epistemic literacy required for an IPK. The subject of RE could hold this discreet role for the whole curriculum, given the subject's interest in epistemic literacy (Stones & Fraser-Pearce, 2022), attention to meaning making with different organising systems of knowledge (Wright, 2015) navigating different worldviews (Cooling, 2020) and addressing existential education (Sporre, 2023; Hannam and Biesta, 2019). Put another way, RE could be reinterpreted to offer an epistemological service to the whole school curriculum. More generally, the condition of dialogue in schools between the ways of meaning in the different subjects, suggest they are a long way from Wilson's dream of a project of consilience.

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Data availability The data that support the findings of this study are available on reasonable request from the corresponding author.

Declarations

Conflict of interest The authors have no conflicts of interest to disclose or other declarations to make.

Ethical approval An ethics application was approved by Canterbury Christ Church university in 2019 (19/EDU/015) following the BERA ethics guidelines (2018).

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