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Secondary teachers' instructional practices on argumentation in the context of science and religious education

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ABSTRACT

Argumentation is widely recognised as a core practice of science, but the relation between argumentation in the teaching of science in contrast to the teaching of other school subjects has not been sufficiently addressed. In this study, we investigate science and religious education (RE) teachers' instructional practices related to argumentation in lower secondary lessons in England. Through qualitative analysis of a pair of science and RE teachers' instructional practices, we characterise how the teachers participating in a professional development project understand and teach argumentation. Data sources included questionnaires, lesson materials, classroom video recordings, and written teacher reflections. Findings suggest that both teachers recognised the value of argumentation in their subject, but some variations existed in the nuances of their views and particularly how different instructional strategies were utilised to achieve the lesson goals related to argumentation. The study highlights the teachers' different understandings and enactments of argumentation as a disciplinary practice and an instructional objective in science and RE lessons. We call for further consideration of argumentation in different school subjects and how argumentation can enrich science teaching in interdisciplinary contexts.

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Argumentation; science and religion; teacher practice

1. Introduction

Argumentation has been researched in the context of various school subjects including science (Duschl & Osborne, 2002; Jimenez-Aleixandre & Erduran, 2007), mathematics (Forman et al., 1998; Stylianides et al., 2016), history (Nokes & De La Paz, 2018; van Drie & van Boxtel, 2019) and English (van der Heide et al., 2016). One example of cross-disciplinary opportunity for research on argumentation is at the intersection of science and religion. The intersection of the two subjects has been explored in diverse ways including from different disciplinary orientations such as philosophy (Haack, 2003), sociology (Evans & Evans, 2008), psychology (Argyle & Beit-Hallahmi,

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1998), and history (Harrison, 2016). In terms of education, the teaching of evolution by natural selection has centred strongly in considerations of teaching about science and religion (Cobern, 1994). Yet, the context of argumentation in relation to science and religious education (RE) remains a relatively uncharted territory, particularly in terms of how science and RE teachers deal with how knowledge claims are established in their subject relative to the other subject. There is minimal understanding of how argumentation can be conceptualised similarly or differently in science and RE lessons, and how such comparisons can impact teachers' instructional practice (Erduran et al., 2019).

The central role of teachers in cultivating pupils' argumentation skills is well established in the literature (McNeill et al., 2016; Osborne et al., 2004). A particularly challenging element of teachers' learning involves conventionally unfamiliar aspects of their subjects, such as the epistemic practices within the disciplines. Epistemic practices are the cognitive and discursive activities that are targeted in education to develop an epistemic understanding (Duschl & Gitomer, 1991; Sandoval et al., 2000). Argumentation is an example of such epistemic practices. Argumentation plays a central role in the building of explanations, models, and theories (Siegel, 1989), as scientists use arguments to relate evidence that they select to the claims they reach through the use of warrants and backings (Toulmin, 1958). Furthermore, argumentation is a significant tool instrumental in the growth of knowledge (Kitcher, 1988) as well as a vital component of disciplinary discourse (Pera, 1994).

In order to facilitate the teaching of argumentation, teachers need a significant change of beliefs and views from the traditional teacher-centred instruction (Osborne et al., 2004). A shift from a teacher to a pupil-centred approach requires much time and effort. While teachers need relevant knowledge and skills to teach argumentation, it has also been argued that such knowledge and skills often vary for the specific school subject. Since argumentation is a core part of disciplinary practice in many subjects, the aims and methods of argumentation are influenced by the nature and culture of the specific subject in question (Engelmann et al., 2018). Concurrent to such observations about the teaching of argumentation, many contemporary issues in society such as climate change, genetic engineering, and scarcity of water resources require a holistic approach to argumentation drawing on multiple disciplines other than science (Christenson et al., 2017; Zeidler & Sadler, 2007). Given these complexities, a crucial step in teaching argumentation in schools is to understand how argumentation can be contextualised in different disciplines, particularly from teachers' perspectives, and consider what can be learned from such a comparison.

Considering that there are limited number of studies about argumentation at the interface of science and RE (Erduran, 2020), comparing teacher's argumentation teaching practice in the two subject contexts will provide an exploratory account that might benefit the incorporation of argumentation in science teaching. Argumentation has been a key feature of many RE syllabi in England (e.g. Lambeth Council, 2015; Northumberland County Council, 2016) where the emphasis on argumentation in the science curriculum has been more peripheral (Chan et al., 2021). The purpose of a comparative analysis of a science and an RE teacher's teaching practice is not to provide an exhaustive account of what science or RE teaching would entail in argumentation, neither is it to generalise from this pair's teaching practice to a broader group of teachers. After all, there may be many variations between the teachers in terms of not only the subject matter but also range of professional experiences and attitudes. Rather, we are interested

in understanding (a) how a science and an RE teacher interpret argumentation at the onset of an argumentation project when they both volunteered to participate in the project and (b) how the contrast of science and RE teaching may potentially provide some insight into how argumentation can be enhanced in science teaching.

The primary purpose of this paper, then, is to illustrate how teachers' understanding and teaching of argumentation compare in science and RE. Considering the traditionally limited interaction between science and RE teachers in professional development settings (e.g. Hall et al., 2014), the paper explores, through an in-depth case study of one science teacher and one RE teacher, teachers' practices in teaching argumentation to lower secondary school pupils in England. The study is derived from a 3-year funded research project called *Oxford Argumentation in Religion and Science*, which was based at the University of Oxford between 2018 and 2021. The project aim was to understand how argumentation works in science and religion and how best to develop lower secondary teachers' skills for cross-subject considerations, including the similarities and the differences between argumentation in science and religion. The empirical study was guided by the following research questions:

1 How do science and RE teachers view argumentation?
2 How do science and RE teachers' instructional practices on argumentation compare?

By comparing argumentation practices in science and RE classrooms, we seek to ultimately contribute to the discussion about interdisciplinarity in science education (Broggy et al., 2017) and cross-subject teacher collaboration to address complex and controversial issues involving science (Hand & Levinson, 2012). Examining argumentation in other disciplinary contexts will be helpful not only for reflecting on argumentation in science but also for seeking ways to facilitate collaboration and cross-fertilisation with other subjects for more meaningful and nuanced instruction of argumentation.

2. Literature review

2.1. Argumentation in science and RE

Argumentation refers to the justification of claims with reasoning and evidence (Jimenez-Aleixandre & Erduran, 2007) and has been drawing considerable attention from educators in the past 20 years. Argumentation has been highlighted as a core learning goal in recent science education reform documents around the world (Erduran et al., 2014; NGSS Lead States, 2013). In England, the Key Stage 3 science curriculum for pupils aged 11-14 states the ability to 'present reasoned explanations, including explaining data in relation to predictions and hypotheses' (p. 4) as a learning goal. Von Aufschnaiter et al. (2009) suggested that the introduction of argumentation in the science classroom can provide pupils access to disciplinary cognitive and metacognitive processes such as modelling, develop pupils' communication and critical thinking skills, achieve scientific literacy by engaging in talking and writing about science, and develop ideas about the evaluation of scientific knowledge. Argumentation studies in science education have been active not only in the context of learning scientific content knowledge but also in socioscientific issues such as climate change (Nussbaum et al., 2012; Sadler, 2004).

RE in England is also a subject where argumentation has important roles to play. The subject has the aim of examining different religions and worldviews and formulating pupils' own views based on such understanding (Guilfoyle et al., 2020). Understanding the structure of religious ideas and claims and constructing arguments are thus central to RE, as represented in the curriculum goals (Chan et al., 2021). Recently, some studies have explored the intersection of science and RE in the context of argumentation. Erduran et al. (2020) investigated science and RE teachers' views about argumentation in the two subjects and found that both teacher groups recognise the value of argumentation, although there were several notable differences in terms of why they believed so and what aspects were emphasised. Their study also reported that RE teachers use certain instructional strategies such as group discussion and debates more frequently than science teachers. Guilfoyle et al. (2020) discovered more nuances in the differences of arguments in science and RE as perceived by teachers. The teachers addressed that the kinds of evidence acceptable in science and RE are different, and the place of moral and ethical values can be a differentiating feature between arguments in science and RE. Although these early findings provide initial information for a cross-disciplinary understanding of argumentation, understanding how these aspects manifest during the instruction would require classroom-based observational investigations of teacher practices.

2.2. Studying teacher practices in argumentation

The role of the teacher is instrumental in supporting pupils' argumentation skills across school subjects (Christenson, Gericke & Rundgren, 2017; Simon et al., 2006). In recent years, there has been growing interest in researching teacher practice, going beyond the traditional focus on their knowledge and belief (Ball & Forzani, 2009). Since argumentation is a socio-cultural process of negotiating and adapting practices in the context of the lesson goals and established classroom practices (Kelly, 2008), how the teacher creates and manages the opportunities to learn argumentation is central to what pupils learn. Lazarou et al.'s (2016) study based on Engeström's activity theory showed that argumentation is a systemic activity rather than a set of discrete events, where the teacher's motive, willingness, and other personal characteristics meet with various instruments, rules, and social practices. Highlighting the role of teachers as facilitators of argumentation, Aydeniz and Ozdilek (2016) reported that teachers face various challenges when implementing argumentation in the classroom, such as pupils' lack of familiarity with argumentation, gaps in pupils' conceptual understanding, and classroom management during argumentation activities.

In this sense, teachers' instructional practices are a result of complex interactions between their previous knowledge and experience as well as the socio-cultural contexts in which teaching occurs. As Cohen et al. (2003) described, teaching is the work of drawing on one's professional knowledge and skills to help pupils attain intended learning goals. Jimenez-Aleixandre and Erduran (2007) claimed that the role of teachers in understanding the role of argumentation as a learning goal and providing pupils with instructional opportunities for argumentation is crucial in science learning. Several studies in science education have looked into the argumentative practices of teachers in the classroom. For example, Özdem Yilmaz et al. (2017) analysed Turkish science

lessons to identify instructional strategies used for argumentation and found that some of their practices were aimed at developing pupils' meta-level knowledge about argumentation pertaining to its role in knowledge construction.

One particularly interesting aspect of teacher argumentation practice is how teachers frame argumentation in the specific curricular and instructional context in which the lesson occurs. González-Howard and McNeill (2019) analysed two U.S. middle school science teachers' lessons and found that, although both teachers actively engaged their pupils in argumentation through the use of teacher talks and physical actions, the framing of argumentation in the two lessons differed. They identified two modes of framing argumentation goals in the classroom: One teacher emphasised developing individual understandings through argumentation, whereas the other teacher's lesson was aimed at developing a 'communal understanding' shared by the class (González-Howard & McNeill, 2019, p. 821). This result suggests that argumentation goals can be framed in different ways by the teacher, which in turn might impact how students take up the goals of learning about/through argumentation (Berland, 2011). In this sense, our study can be viewed as an attempt to consider the framing of argumentation in two different subject contexts, namely science and RE.

Teacher practice in argumentation and reasoning has been studied in the context of school subjects other than science, including mathematics and humanities subjects. Van Drie and van Boxtel (2019) examined what instructional strategies are used by history teachers in the Netherlands to elicit pupils' historical reasoning. They found that teachers make deliberate choices in terms of their own roles in the whole-class discussion based on knowledge of different instructional choices and knowledge of their pupils. It was suggested that teachers' use of instructional strategies could be influenced by the characteristics of the specific domain being taught. Recently, Fischer et al.'s (2018) edited volume examined how scientific argumentation can be taught across various school subjects with a focus on domain-specific and domain-general aspects of argumentation. Despite these research efforts, there is currently little understanding of how argumentation can unfold in RE teaching practice and how such practice compares with that in the science classroom, and as such, what can be learned from comparing argumentation across different subject contexts to improve the teaching of argumentation in the science classroom.

3. Methods

3.1. Science education and RE in England

In England, the national curriculum for state-funded schools is grouped into four Key Stages: Key Stage 1 (ages 5–7) and Key Stage 2 (ages 7–11) cover primary education, and Key Stage 3 (ages 11–14) and Key Stage 4 (ages 14–16) cover secondary education. Science is a compulsory subject for all state-funded schools, and many pupils choose science subjects (physics, chemistry, and/or biology) for high-stakes examinations such as GCSEs (General Certificates of Secondary Education; taken at the end of Key Stage 4) and A-levels (a school-leaving qualification generally required for university entrance). Most secondary science and RE teachers train through either school-based or university-based courses after their first degree in a relevant

discipline. Once the training has been completed, teachers gain qualified teacher status and complete a 12-month induction programme before becoming legally eligible for permanent employment.

Similarly, RE must be studied by all pupils in all state-funded schools in England to pupils across the Key Stages, but the difference is that parents are legally allowed to withdraw their children from taking RE (HM Government, n.d.-b). It is also a subject for GCSEs and A-levels and covers various religions and worldviews across the globe. In 2020, around 225,108 pupils in England signed up for RE GCSE (HM Government, n.d.-a). Instead of a national curriculum, RE in schools follow locally agreed syllabi. According to the recent analysis of locally agreed syllabi in England by Chan and Erduran (in press), the elements of argumentation are frequently highlighted as curriculum goals, and argumentation was frequently rationalised in relation to personal expression within democratic participation, and epistemic and empathetic flexibility. RE syllabi often include learning goals related to the interface of science and religion, such as exploring 'To what extent are the concepts of truth, explanation, meaning, and purpose in religion and science complementary or conflicting?' (p. 36). Although independent schools do not have to follow the LAS, they are still required cover similar contents as part of the school curriculum through which 'pupils should understand that … different people may hold different views about what is 'right' and 'wrong'' (Department for Education, 2019, p. 21).

3.2. Study context

The empirical study was based on the data collected in the first year of a three-year funded project aimed at promoting science and RE teachers' teaching of argumentation at secondary schools in England, particularly at Key Stage 3 (11–14 years-old pupils). The overarching aim of the project was to develop, implement and evaluate a programme targeted at science and RE teachers, utilising continuous professional development workshops and cross-subject collaborations at schools (Erduran et al., 2019). Among a total of 14 teacher pairs on the project, Sophia and Rachel were identified by researchers as information-rich cases (Patton, 2015), based on their understandings of argumentation and collaborative planning experiences. Specifically in this paper, we report a comparative case study of Sophia and Rachel to gain insights into how argumentation can be framed and implemented differently in the science and RE classroom context. Given that teachers' classroom practices such as argumentation are shaped by various personal and social, cultural, and policy contexts (Lazarou et al., 2016), the in-depth case study methodology was deemed appropriate to investigate the teachers' practices (Yin, 2017). The aim of the comparison was not to draw generalisable conclusions about argumentation in science and RE but rather to explore the 'what' of teachers' classroom practices that can help to 'develop pertinent hypotheses and propositions for further inquiry' (Yin, 2017, p. 9) in the field. Considering the limited set of studies about argumentation at the interface of science and RE, the contrast of an RE teacher's teaching practice in relation to an argumentation lesson in a science topic is intended to provide an exploratory account that might benefit science education.

3.3. Participants and data collection

The school where both teachers were employed was located in a rural area in England. It is non-selective and co-educational but fee-paying and independently run. The school does not have a listed religious character, but when describing RE provision on their school website, a 'Christian foundation' is cited. The school caters for pupils from 3–16 years with enrolment numbers of 140 in the 11–16 years range. A recent inspection report indicates that a large majority are from White British families and that 24% of the pupils in the school are identified as having special educational needs. Rachel, the RE teacher, had 30 years of experience in teaching, while the science teacher has 21 years' experience. The teachers in this school were also supported by a dedicated staff member for supporting teachers' engagement in research. In their collaboration, Sophia and Rachel met on a weekly basis to discuss the implementation of argumentation in their respective classes. They decided to focus their efforts towards aligning the language of argumentation in the two subjects rather than engage in co-planning of lessons or teaching overlapping topics. In their lessons, both Sophia and Rachel used an argumentation framework called P–E–E (point–evidence–explanation). The P–E–E framework is a structure commonly used by teachers to support pupils' construction of written responses, particularly in humanities subjects such as English (Gibbons, 2019).

At the point of data collection, the professional development project was in its early phases (i.e. two of six workshops had taken place). The content of these workshops (2 hours each) was focused on teachers initially scoping their curricula for areas of connection or overlap, opportunities for argumentation, and teacher collaboration. Furthermore, the project team provided explicit input on the meaning of argumentation, including introducing Toulmin's framework and associated language of claim, evidence, warrant, etc. Teachers explored and critiqued a range of activities provided by the project team. These activities were selected from science and RE teaching materials that the project team thought addressed elements of argumentation. They also thought about the ways these activities might foster argumentation, if they resemble anything from their current practice, and if they could suggest any improvements to these activities. In these activities, teachers proposed some potential ways in which argumentation could be facilitated in science and RE, both within their subject and in collaboration with the other subject. Figures 1 and 2 illustrate some of these activities during the workshops. The professional development sessions of the project was constructed on a number of key principles which were decided upon by the project team from the outset. These principles, in brief, prioritised collaboration, clear and positive communications, a genuine recognition of expertise brought by participants, and the need for the project burden to be reasonable for participating teachers' workload. Furthermore, it was a key principle that modelling would be used as an explicit teacher education strategy, but with a willingness on the part of the project team to be critiqued when modelling practice.

Following the workshops, teachers were asked to engage in initial trials of collaboration on teaching argumentation which could then be reflected upon in the third workshop. Though the individual meetings that Sophia and Rachel engaged in within their school were not specifically scaffolded by the project, the professional development

Figure 1. A group of science and RE teachers are provided with classroom activities for teaching argumentation and then discuss how the activities can foster argumentation skills and how they could be adapted for classroom use.

programme sought to provide support for teachers developing their ways of working. These included (1) focused examination of curriculum documents, (2) guided collaboration planning templates, (3) exemplars of argumentation practice with individual

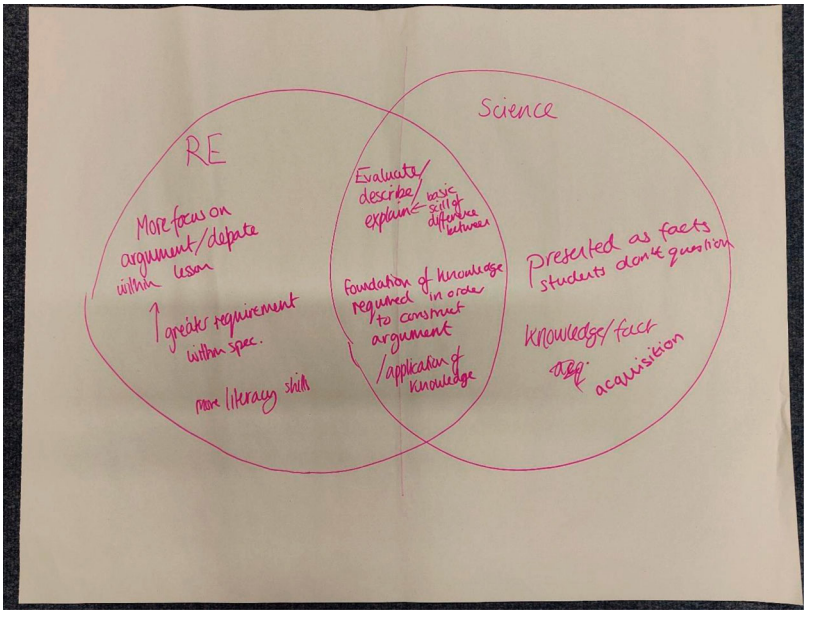

Figure 2. A Venn diagram created by a teacher group about the common and contrasting aspects of science and RE in relation to argumentation.

subjects and in cross-curricular teaching contexts. The outline and content of the later workshops (which took place after collecting the data for this paper) can be accessed on the project website (https://www.oarseducation.com/).

Data sources were teacher surveys (which were collected prior to any collaboration), lesson materials, classroom video recordings, and teachers' written reflections after the collaboration. The survey included questions designed to capture teachers' perceptions and beliefs about argumentation prior to engaging in any professional development sessions (Erduran et al., 2020). For this particular paper, responses to questions about teachers' views of argumentation within their subject and the other subject were used for analysis. Lesson materials including presentation slides, information sheets, and pupil activities were also collected. Classroom recordings focused on the teachers' practice; teachers were given a lapel microphone to capture their instructional features. The lessons, each around 50 min long, were given to Year 9 pupils at the school and recorded on the same day. After the lesson, teachers' reflections on the lesson were collected in the form of written interviews.

3.4. Data analysis

For Research Question 1, we used teacher surveys, classroom recordings and teacher reflections to understand teachers' views of argumentation, specifically their views of (a) what argumentation is and (b) why it is important to teach about. The first author read through the three data sources to identify statements related to these two aspects of teachers' views and generated a matrix including relevant teacher quotes and interpretations of the quotes. Teacher surveys and reflections provided information about their self-reported views, whereas our analysis of classroom recordings was focused on how the teachers communicated these views to their students. The other two authors then reviewed the matrix against the raw data for reliability and consistency. Comparing the two teachers' cases led to developing several themes about their views of argumentation. For example, we noted that both teachers found the importance of argumentation in its close relation to high-stakes examinations, but they took different approaches to addressing this to their students (see Section 4.1).

For Research Question 2, classroom recordings were analysed to identify how Sophia and Rachel facilitated argumentation in their lessons. One major challenge in analysing classroom discourse is deciding the unit of analysis, or unitisation (Campbell et al., 2013), since how we segment the lesson transcripts significantly affects the interpretation of data (Erduran, 2007). In segmenting the transcripts, it is important to ensure the unit of analysis is 'tight enough to capture what we want to capture' (Erduran, 2007, p. 59) in the phenomenon under investigation. For the current study, we divided the lesson transcripts into unit segments, each entailing a teacher move to initiate, sustain or conclude argumentation in the classroom. These moves included both verbal (asking a question, explaining a concept, responding to student talk) and non-verbal (e.g. pointing at whiteboard, moving around the classroom) actions, which were then coded and interpreted in relation to argumentation. An example of segmentation from the start of Sophia's lesson is provided in Table 1.

Codes were generated both deductively and inductively, partly from the literature on teacher's instructional use of argumentation in the classroom (e.g. challenge the accuracy, setting expectations, encourages further justification) (Simon et al., 2006;

Table 1. Segmentation example.

Time	Teacher action	Code
00.50	Teacher gives oral instruction for task [PPT #1]: Figure out from the picture who is right about what happens to skydivers.	Provide an argumentation task
00:58	Teacher says: 'I want a justification for your answer. A justification for your answer. A reasoned explanation to go with it. And I want reasons.' Students engage in the task.	Ask to provide justification
01.42	Teacher repeats instruction as students do the task: 'You need to think about what we did. So read what they said, and decide who you think is right, and you want to justify your choice. Who was right? Make a choice and give me a reason.'	Explain argumentation terms Ask to take a positions

Özdem Yilmaz et al., 2017) and partly from the emergent descriptions of the data (e.g. reflect on the argumentation process, distinguish evidence from reasoning). For the latter, we considered the teacher moves and utterances in relation to the components of argumentation in Toulmin's framework and labelled each into a short descriptive code that best captures the nature of the teacher practices. First, the three authors focused on one lesson video (science) to identify argumentation-related instructional strategies found in the lesson, and jointly analysed the video. Each author looked for the expressions containing 'justify', 'argue', 'reason', and so on to discern teacher talks that are relevant to argumentation. We then met to discuss the nature, intent and meaning of each teacher talk in the transcripts and reach an agreement on the interpretation. This was repeated for the second video (RE), followed by a meeting where the entire team met to revisit the video to calibrate the analysis and seek evidence confirming or disconfirming the interpretation. This collective analysis was conducted iteratively, by each round of analysis leading to a revised categorisation to be used for the next round. The iterations continued until the three authors reached 100% agreement on the categorisation and coding.

In the next phase of analysis, we grouped the codes based on the purpose of the teacher move to generate categories and themes. This process involved comparing the codes and emergent categories and identifying how the categories might relate to each other (Strauss & Corbin, 1998). Three categories of practices emerged in this stage: (a) defining and characterising argument, (b) meta-level statements involving instructional considerations, and (c) argumentation strategies, which are described in Table 2. Each teacher's case was first analysed holistically in terms of the three categories. We identified the features of each teacher's practice in these categories, which were then compared between the two teachers to characterise each teacher's instructional practices on argumentation. This process was first conducted by individual authors and then discussed in meetings among the three authors. During the analysis, several discernible patterns were identified in terms of how the teachers related argumentation to high-stakes examinations, how the goal of learning argumentation was framed, and how these were differently manifested in their classroom conversations as well as task enactments. These themes and supporting evidence from data were discussed among the researchers through collectively revisiting the lesson videos and looking for confirming and disconfirming evidence (Erickson, 1986).

Table 2. Science and RE teachers' instructional practices on argumentation.

Category	Instructional practice	Sophia	Rachel
Defining and characterising arguments	Explain what it means to reason/argue/explain	Y	
	Explain argumentation terms	Y	Y
	Provide a framework for argumentation	Y	Y
	Give an example of a complete argument		Y
	Distinguish evidence (what) and reasoning (why)	Y	Y
Meta-level statements about argumentation	Ask to think about why arguments are important	Y	Y
	Meta-reflection on the argumentation process		Y
	Meta-refection on the components of an argument		Y
	Reflect on the argumentation process	Y	Y
	Explain the role of writing in learning		Y
	Differentiating merely rephrasing and reflecting		Y
	Pointing to the evaluation of an argument		Y
	Set the expectation for pupils' arguments	Y	Y
	Emphasise the argumentation focus of the task		Y
Argumentation strategies	Provide an argumentation task	Y	Y
	Rephrase pupils' reasoning to clarify	Y	Y
	Ask to provide justification	Y	Y
	Ask for reasons for a phenomenon	Y	Y
	Ask to expand a claim	Y	
	Challenge the accuracy	Y	
	Counterargue against an incorrect claim	Y	
	Ask to take a position	Y	Y
	Ask to compare explanations	Y	
	Notice pupils' good practices and recommend to others		Y
	Make a link to other subjects		Y
	Ask to come up with a claim		Y
	Invite a pupil to present their argument		Y

4. Findings

In this section, we first describe how Sophia and Rachel viewed argumentation in relation to their subject, based on their survey and interview responses as well as classroom data. Then we discuss what types of teachers' instructional practices on argumentation were observed in their lessons. We present the inductive categories of teacher practices that were constructed from the two lessons and then investigate in more depth the two case studies. We conclude by highlighting the similarities and differences of the teachers' practices in relation to teaching their subjects.

4.1. Teachers' views of argumentation

The teachers' views of argumentation are summarised in Table 3. Sophia, a science teacher, believed that an argument involves 'forming a reasoned, logical set of responses to a question and justifying a position with reasoning.' She said that argumentation is important for pupils to 'go beyond basic learning of facts' and 'develop higher-order thinking.' In contrast, Rachel, an experienced RE teacher, said that argumentation is primarily concerned with 'putting across ideas and bringing in different points of views and perspectives on a topic.' Believing that a good argument consists of a clear expression of a claim and presentation of relevant evidence, Rachel said that the current way RE was taught encouraged pupils to consider different viewpoints, often drawing on scientific evidence, and such skills would be highly relevant to pupils' lives.

Table 3. Teachers' views of argumentation.

	Sophia	Rachel
Subject	Science	RE
Lesson synopsis	Terminal velocity (physics)	Writing essays in RE (various topics; see Appendix 2)
What is an argument	'Forming a reasoned logical set of responses to a question posed' 'Justifying a position with reasoning' 'Linking areas of learning and expertise to support a line of thinking about a problem.'	'The art of developing an argument' 'A way of putting across ideas and bringing in different points of view/perspectives on a topic.' 'Good argument includes clearly expressed points supported by relevant evidence.' 'Developing argumentation skills means to be better at clearly laying out the claim/point, evidence and warrant/explanation. I would like them to structure their responses clearly.'
Why is argumentation important	'Pupils need to be able to formulate reasoned responses to develop higher order thinking about the subject and go beyond basic learning of facts. Without the ability to develop their higher order thinking their progress to understand will be limited.'	'Whilst it is also an essential life skill, it is necessary for the GCSE.' 'I believe that current RS teaching truly encourages pupils to consider different viewpoints, one of those being scientific evidence. In my experience secondary school RS teachers encourage pupils to question and challenge religious beliefs which is why I call the class Religious Studies not Religious Education. The value of the subject as a Humanities subject at school is in how it teaches argumentation and a wide breadth of general knowledge which is so relevant to life.'

A cross-case comparison shows that both Sophia and Rachel highlighted the existence of a specific problem or topic, a claim, and clear reasoning as defining features of argumentation. However, there were also some differences in their views. One such difference was that Sophia assumed the claim as a definite answer to the science question, as opposed to Rachel, who recognised the multiplicity of claims about the same topic. Moreover, while both teachers described argumentation as the logical reasoning process to reach the claim, Rachel also emphasised empirical evidence in developing the reasoning.

In describing why argumentation is important, both teachers referred to its relation to GCSEs, a high-stake examination that pupils sit at the end of Year 11 in England. The relevance of argumentation to examinations, however, was articulated differently by the two. In her lesson, Sophia described the importance of argumentation to her pupils with the following remark:

> … You can get more marks on your exam questions, you have a better understanding. You can form your understanding and explain your ideas. And you know if you understand and explain your ideas, then you remember it, don't you? Because it makes logical sense. So for us to make a logical sense, and have a good understanding, we need to be up here in our learning.

Here, she frames argumentation as an essential process to reach a satisfactory level of understanding. According to her, the process of argumentation allows one to make better sense, achieving better understanding, which would eventually lead to getting high marks in the examination. This makes an interesting contrast with how Rachel

connected the high-stakes examinations with argumentation. Rachel believed that argumentation is 'necessary for the GCSE' and spent a significant amount of time in her lesson to discuss the examination link of her lesson, as in the following examples:

> … And if we fast forward into the future, if you are going to do a GCSE RS, writing an essay does actually become quite important. So it's really good for us to understand how to do it well. So I want to help you to build on what you've done on your exam, and to prepare you for Year 8, Year 9 and beyond.

> … And the last E, you have got to explain. If you just, you know I teach English as well as RS, so I've just been marking RS essays exams and English exams, and a lot of people, they have point and they have evidence, but they don't write about it. They don't actually explain it. So you have to e-x-p-l-a-i-n that what it is that you are talking about. (Rachel's lesson)

Comparing the two, Rachel's way of linking argumentation to high-stakes examinations can be viewed as more direct, in the sense that she stressed how considering the argumentative structure would help pupils get more marks. In comparison, in Sophia's case, argumentation was framed to be beneficial primarily for better learning rather than the examination itself.

4.2. Teachers' instructional practices on argumentation

The analysis of teacher moves during the lessons led to identifying three categories of argumentation-related teacher practices, along with an additional category of teacher practices that we labelled as 'doing school'. In the following, we discuss each of these categories and how Sophia and Rachel used them in their respective lessons to facilitate argumentation.

4.2.1. Instructional strategies and 'doing school'

Based on the analysis of lesson recordings, the teachers' argumentation-related classroom practices were inductively categorised into three broad activities: (a) defining and characterising arguments, (b) meta-level statements about argumentation, and (c) argumentation strategies (Table 2). Each of the three categories represents the theoretical foundations (e.g. Toulmin's argumentation pattern and P–E–E), the connections between theoretical constructs and instruction, and the teachers' specific talk moves and actions within the lesson. Specifically, the **defining and characterising arguments** category included explaining argumentation and its elements, often through examples and a specific framework. **Meta-level statements about argumentation** were to take a step further from simply telling pupils about argumentation to asking them to reflect on it and relate it to actual content in the subject curriculum, similar to what Tang (2017) called 'metadiscourse'. For example, while discussing a specific problem in science, the teacher can ask pupils to explicate what is the claim and evidence. Another example would be when the teacher shares and reminds of a lesson goal related to argumentation to pupils. This category also included teachers' statements about why arguments are important, why writing is important in argumentation, and what the teacher expects pupils in terms of their argumentation skills. **Argumentation strategies** were the teacher moves in the classroom that elicited argumentative conversations between the

teacher and a pupil (or the whole class) as well as between pupils. These included the teacher elaborating, rephrasing, challenging pupils' claims or reasoning, encouraging pupils to take a side, make comparisons between arguments, and share their arguments.

In addition to these three categories, we identified some teacher acts that were more general and routine classroom practices but still played some role in the argumentative practice in the lesson. Following Jiménez-Aleixandre et al. (2000), we labelled these teacher actions as 'doing school' (versus 'doing science'). These 'doing school' moves were often combined with the instructional practices in Table 2, playing important roles in the lesson. These actions included stating procedural routines of the lesson, referring to external summative assessments, asking pupils to proofread their own writing, encouraging talking and sharing ideas between pupils, and encouraging making notes.

Analysis of lesson recordings revealed several distinct argumentative features of Sophia's and Rachel's lessons that emerged in the specific lesson contexts. The teachers commonly used the P–E–E framework in their lessons to facilitate pupils' argumentation, but they used it in distinctive ways in their respective subject and lesson contexts and for different purposes. It offered pupils a scaffold to communicate their thinking by encouraging them to make each point individual point explicit in their response, supported with evidence, and sufficiently developed such that the reason the evidence supports the point is clear. Rachel, also a teacher of English, recognised that this P–E–E structure could be closely linked to the claim-evidence-warrant structure, which had been introduced in the professional development on argumentation. Though the components may have nuanced differences, for example, between explanation and warrant, the pupils at the school were already familiar with the P–E–E structure and as such, the teachers thought it advantageous to expand the use of P–E–E rather than introducing a new acronym or set of terminology. Below we describe Sophia and Rachel's classroom practices in detail.

4.2.2. Sophia's lesson: achieving a higher level of understanding of science topics

The topic of Sophia's lesson was terminal velocity. At the start of the lesson, she presented a task about what would happen to a skydiver who falls off a plane and subsequently opens the parachute. In the PowerPoint slides, three possible answers were given: the skydiver will accelerate, stay at the same speed, or decelerate (see Appendix 1). After presenting the task, Sophia asked her pupils to decide their answer and provide justification for their answer:

1		(Class begins.)
2		(Sophia shows a PPT slide for the task.)
3	Sophia	I want a justification for your answer. A justification for your answer. A reasoned explanation to go with it. And I want reasons.
4		(Pupils engage in the task.)
5	Sophia	You need to think about what we did. So read what they said, and decide who you think is right, and you want to justify your choice. Who was right? Make a choice and give me a reason.
6	Sophia	If you are finished, can you write down who you think, and be ready to justify your choice. If you want to practice with the person next to you on your justification and reasons, then talk it through with the person while we're waiting for everyone else.

In this opening remark, Sophia makes a meta-level statement about what she expects of her pupils while doing the task. Instead of just asking for correct answers, she stresses 'justification' 'reasons,' and 'reasoned explanation' in her task instruction (Line 3). Since there were three possible conclusions, she asks each pupil to choose one of the positions (i.e. claims) about what would happen with the skydiver's velocity (Line 5). Meanwhile, she also encourages pupils to talk and discuss their arguments here (Line 6) and also throughout the lesson.

After giving pupils three minutes to work on the task, Sophia invited them to share their answers. Most pupils thought that the skydiver would decelerate; Some thought he would remain at the same speed. Sophia asked the pupils to justify their answers and then reminded them of the P–E–E framework to point out that their reasoning was insufficient (Line 4):

1		The teacher shows a slide on the keywords related to reasoning (P-E-E)
2	Sophia	I'm gonna just put up some keywords to remind you of the types of keywords we used when we reasoned before. Okay? What factors will affect the speed as they are falling?
3	Pupils	Surface area, gravity.
4	Sophia	You've got all the key things, but I don't think you've reasoned as such. We're gonna stop and review some of this material. … We know a relevant fact, we know lots of facts, we can link those facts together to form an explanation. So I think, our ability to link the facts together to form a reasoned explanation is a little bit unsure right now. Would you agree? We kind of know about what we're talking about, we got lots of key words, we know it's about forces, we know it's terminal velocity, we got lots of key facts, but we haven't formed reasoned arguments, we haven't linked back properly. So we need to try to link back together properly. So we're gonna go back and review some of that work, okay? And the idea behind this is, if we move from our factual learning upwards, why is that a benefit to us? Why is it better to move up in our learning as we go? On the solo scale?
5	Pupils	More marks.
6	Sophia	You can get more marks on your exam questions. You have better understanding. You can form your understanding and explain your ideas. And … if you understand and explain your ideas, then you remember it, don't you? Because it makes logical sense. So, for us to make a logical sense and have a good understanding, we need to be up here in our learning. At the moment, we are not quite there … There's no point in me just go through the exam papers and telling you all the answers.

In this episode, Sophia makes a meta-level statement about her expectations ('We know a relevant fact, we know lots of facts, we can link those facts together to form an explanation,' 'So for us to make a logical sense, and have a good understanding, we need to be up here in our learning') and the shortage of current pupil answers in the light of that ('You've got all the key things but I don't think you've reasoned as such.', 'but we haven't formed reasoned arguments, we haven't linked back properly.', ' … we need to be up here in our learning. At the moment, we are not quite there'). Sophia's remarks suggest that her focus in teaching argumentation was on putting the pieces together to achieve a higher level of understanding of the subject matter, which in this case was the change in the skydiver's speed.

This exchange also shows how she sets the relation between examinations and argumentation. At the end of Line 4, Sophia distinguishes what she calls 'factual learning' from a higher level of learning based on argumentative structure and asks pupils what the benefits of the latter would be. When a pupil mentioned getting more marks as a benefit, she acknowledges it but quickly moves on to more intrinsic values of argumentation discussed above. Combined with her view about argumentation and its teaching, this episode illustrates that Sophia wanted her pupils to realise the value of deeper learning through argumentation rather than taking it simply as a way to get more marks.

4.2.3. Rachel's lesson: learning transferrable skills that can be used for future exams

In Rachel's lesson, the P–E–E argumentation framework was utilised for reflecting on pupils' essays about some topics in RE, such as arguments for and against abortion, or whether suffering is a cause of human action or the result of it. Her lesson began with reviewing the mock exam paper that the pupils completed in the previous class. When the lesson started, Rachel began framing the goal of her lesson, which was to reflect on the answers to the exam paper and learn something that pupils 'could apply in the future':

1		(Class begins.)
2	Rachel	I'm going to give you back your exams, but you're gonna get to look at them for a moment, but what we're really going to focus on today is not so much about what you should've written, what you should've done, but we're going to think about what can we learn from having taken the exam, that we could apply in the future. Okay? So what I always think is that you put so much effort in the exam, and sometimes we see them as an endpoint, like, that's it. That's done. Done exams, yay, summer holidays. But it's good to look at an exam as a starting point as well. What can you learn from having taken that alright? I'll hand this back, and again, you've been getting all your exams back, you know what it's like, kind of up and down of emotions, we've all had those days,

The fact that the lesson focus was not about 'what you should've written' and 'what you should've done' demonstrates Rachel's attempt to avoid simply presenting pupils model answers to the questions as something to imitate. She instead suggests taking the past exam papers as a 'starting point' to learn. Specifically, her aim was to revisit and discuss pupils' essays with a focus on argumentation structure. To do this, like Sophia, Rachel also brought the P–E–E framework to pupils' attention before delving into specific examples (see Appendix 2). She suggested that each pupil could evaluate their own answers through the lens of P–E–E, which they had not been asked when completing the exam papers:

1	Rachel	So you've got them in front of you, you can look at your exam paper while I talk. I want to think about what makes up a good essay. And I think that these ideas are something you are used to be talking about in English. Would that be fair? Have we done that in English? Point, evidence and explain? So what do we tend to abbreviate that to? What do we call that?
2	Pupils	P-E-E.
3	Rachel	P-E-E. Yes. So you've all used that structure already for writing an essay. Whether that's in English or RS, maybe you've done a bit in History as well? You ever done in History?

4	Pupils	No.
5	Rachel	But you've done it in English. So, same in RS. I don't mind if you look at your essay and 'Did I actually do that?'. Doesn't matter if you didn't, coz you'll learn how do it better. So, P-E-E. What do I mean by point? I want to read this with you, and have a little bit of refresher. Now you've done it English, but have you really ever thought about it in other subjects?

In this conversation, Rachel links the P–E–E argumentation framework to English and History and ensures that it was a familiar tool for pupils rather than a new one. Then she uses one of the exam questions ('How do religions teach about helping others?) to illustrate what each element of P-E-E corresponds to in the example:

1	Rachel	So, on the exam, the last question, how do religions teach about helping others? If you were writing that, you'd want to write what it was that you were going to say, wouldn't you? … That's a point. Another way of looking at it is, what you are saying is true, what you are claiming is true in your essay. What is it you are trying to say? And what you want to talk about, those are your points. Yeah? That is what you want to say. Every time you start writing an essay, so you can look again your exam paper … you think, hmm, what am I going to say? What points do I need to make?
2	Rachel	And in RS, just like other subjects, you need evidence. So I just want to recap, evidence is what you say to support your ideas. I've got an idea about something, how do I? I need a bit of evidence to back that up. Back up my points, to have some facts. Yeah? Not just the general idea. Do I have some facts to back up that general idea that I'm trying to say or talk about? So, every point that you make has to have something to back it up. Has to have some kind of evidence, facts and something properly solid behind as your evidence.

By stating 'in RS, just like other subjects', she is again highlighting that argumentation based on the P–E–E structure is a general skill that not only applies in her own subject but across different school subjects. Even when discussing the specific exam questions, her focus was more on the P–E–E structure than the content of individual claims, evidence and reasoning. Accordingly, she frequently used meta-level statements to analyse pupils' ideas in terms of P–E–E. For example, in the following exchange, Rachel pointed out that Mark's argument was missing a claim:

1	Rachel	… and anybody, Mark? You can just say it roughly. It doesn't have to be perfect.
2	Mark	So, pregnancy as a result of rape is not going to be wanted by most women, because it's a horrible memory and feeling …
3	Rachel	Can I just pause there? Cause you didn't do the point. You're going straight the evidence. So, your point is this one. [Points at the slide]. Then your evidence is this – pregnancy as a result of rape is not wanted by most women, and then your explanation I thought was really good.
4	Mark	Yeah, so, yeah. Um, pregnancy as a result of rape is not going to be wanted pregnancy, because it's a horrible memory and feeling, because rape is bad, and also they might not be ready, um, because they might be too young, you might not have enough money to buy the food, or may not have not the right house or anything.
5	Rachel	Okay, alright. Did you see Mark was saying thing, and having the 'because', it kind of took him into making a better explanation, didn't it? Once he got his evidence, explanation and his point. Support his point.

Here, by interpreting Mark's statement in terms of P–E–E, she illuminates to pupils the underlying, meta-level structure of his argument and identifies a missing component (Line 3). After Mark's claim became clear, she praises that he used the word 'because' which allowed him a better explanation (Line 5). One interesting aspect of this conversation is that her question and feedback do not concern the substance of the pupil's argument but the structure of it. In other words, her meta-level statements do not concern whether the claims, reasons, and evidence that Mark used were sound in the light of what they had learned in the subject as much as identifying the argumentative components and how they link together. This feature of her instruction was repeatedly observed in the rest of the lesson when the class went through other specific exam questions.

4.2.4. Comparison of instructional practices across science and RE lessons

The comparison of instructional practices in Table 2 shows several patterns in the two lessons. In the 'defining and characterising arguments' category, although both teachers explained argumentation terms such as evidence and reasoning, and made a distinction between the two, there was also an important difference. Sophia elaborated on 'what it means to argue' whereas Rachel used an example of the complete P–E–E argument to give pupils some sense of argumentation as a learning goal. In the 'meta-level statements about argumentation', it is notable that Rachel's lesson featured a broader range of meta-level statements than Sophia's. In other words, Rachel was active in using strategies to explicitly link the ongoing classroom conversation back to the goals and processes of argumentation. In the 'argumentation strategies' category, Sophia's argumentation strategies were focused on using various dialogic tools that ask pupils to justify, clarify, compare and counterargue against arguments, whereas Rachel's lesson featured the pedagogical elements such as making links with other subjects such as English and history, and acknowledging pupils' good practice and recommending it to the rest of the class. These contrasts, summarised in Table 2, shed light on the similarities and differences in the two teacher's practices in teaching argumentation.

An in-depth qualitative analysis of each lesson reveals that both Sophia and Rachel used P–E–E as a tool to give a fresh look into the tasks that pupils had already completed. By using the argumentation framework, they had a common aim to develop pupils' higher-order thinking skills that go beyond factual learning and memorisation, and eventually bring benefits to pupils' individual lives. In doing so, they also were aware of the potential benefits of developing argumentation skills to GCSEs and referred to this in the lesson. In addition, both lessons highlighted the cross-disciplinary nature of argumentation that can be applied across many school subjects rather than framing it within their own subject.

There were also some interesting differences between the two cases. First, Sophia and Rachel both tried to convince pupils of why argumentation matters to them through the use of meta-level statements, but in meaningfully different ways. Sophia focused on how it helps to develop deeper learning of the scientific knowledge, whereas Rachel repeatedly appealed to the benefits to high-stakes external examinations. Second, the nature of claims and evidence differed between the two subjects. In Sophia's lesson, the claims were descriptive statements, and the evidence was empirical (e.g. numerical data and graphs), whereas in Rachel's lesson, the claims were mostly normative, and the evidence

was often teachings from authoritative sources such as religious scriptures. Third, the result of argumentation was of different kinds. In Sophia's lesson, the P–E–E structure guided the pupils to formulate a better explanation, but the correct answer for the question still existed, and pupils were expected to reach the same conclusion at the end of the lesson. On the contrary, argumentation in Rachel's lesson was more focused on structuring an argument that can support each pupil's own view about an issue. Argumentation strategies and meta-level statements were utilised accordingly to serve these distinct purposes.

5. Discussion

Studies in science education have suggested that developing teachers' instructional strategies for argumentation is essential to this goal (McNeill & Knight, 2013; Osborne et al., 2019; Simon et al., 2006). Despite the growing interest in argumentation in different disciplinary contexts (Erduran et al., 2019; Fischer et al., 2018), however, cross-subject comparisons of teaching argumentation have been scarce in the literature. Given this gap, the case studies in this paper with the example of science and RE in the context of England can be a useful starting point for future research on this topic. The two teachers in this study believed in the value of argumentation as a life skill that pupils will need to have beyond the acquisition of subject knowledge. Utilising a common framework for argumentation, both teachers used various instructional strategies to define and characterise argumentation, reflect on the process of argumentation in the light of the framework, and statements to promote argumentative conversations in the classroom. This suggests that argumentation can be appreciated in various school subject contexts beyond science, and teachers have the potential to facilitate argumentation in a way that suits their subject characteristics. In this sense, the main contribution of this study is that it gives a fresh look to an established research area (i.e. argumentation) from a cross-curricular point of view, pointing to the possibilities of informing science education from another school subject (i.e. RE), and vice versa. The cross-curricular focus of this study also aligns with the increasing interest in interdisciplinarity in science education research (Broggy et al., 2017; Fischer et al., 2018). Engaging in argumentation in interdisciplinary contexts can provide students with opportunities to integrate different subjects to solve real-life problems (Broggy et al., 2017). Given the focus of RE on religions, worldviews and ethics, cross-curricular teaching of argumentation can contribute to students' engagement in emerging socioscientific issues and informed decision making (Khishfe, 2012), which are key components of deliberative democracy (Erduran & Kaya, 2016).

Some aspects of the teachers' practices observed in this study, such as how they related argumentation to GCSEs, also provide useful insights for the effective incorporation of argumentation into lower secondary classrooms. Given the close connection between the current education system and high-stakes examinations, the focus on GCSEs found in the teachers' ideas and practices should be taken into account in future efforts to support teachers and develop professional development projects. The teachers' emphasis on the GCSE link is even more striking given that the observed lessons were for Key Stage 3 (Year 9) pupils, and GCSEs are not sat until the end of Key Stage 4 (Year 11). It suggests that some elements of 'teach to test' (Madaus,

Russell & Higgins, 2009) were present even before the examination became immediate, but not necessarily in a destructive way where the curriculum is narrowed, pupils are drilled, and only rote learning is encouraged (Baird et al., 2013). Instead, the teachers made links to GCSEs to justify the importance of argumentation as a higher-order thinking skill and thus strengthen pupils' motivation in learning argumentation. The interaction of exam systems and teachers' argumentation practices will be an important avenue for future research to introduce argumentation in different subject contexts, particularly in education systems with a strong focus on external testing, such as England.

The comparative analysis provides an instance of how argumentation can have different purposes and meanings in different subject settings, and accordingly, can result in different instructional practices of teachers. Given the central role of teachers in promoting cross-disciplinary skills such as argumentation (Jimenez-Aleixandre & Erduran, 2007; McNeill et al., 2016), teacher educators should consider the different nuances across the disciplines to effectively address argumentation. At the same time, such differences point to the potential benefits of cross-subject collaboration for improving instructional skills in professional development settings as well as in classrooms (Erduran et al., 2019). For example, teachers can benefit from learning how argumentation can be interpreted in different school subjects (Erduran et al., 2019), which can be particularly helpful when teaching issues such as intelligent design and other socioscientific issues. Considering the different ways of utilising the P–E–E argumentation framework by Sophia and Rachel, there are opportunities for productive learning from each other. Empirical investigations into the benefits of cross-subject collaborations between science and RE (and other humanities subjects) will be needed to extend the possibilities identified from this study. This can include learning from each other's enactment of argumentation and co-teaching on topics at the interface of science and RE (e.g. animal rights). Given that this study was conducted at the early stage of teacher collaboration, longer-term investigations of teacher collaboration will give further information on the value of such collaborations (see Chan & Erduran, in press, for an example from the same funded research project).

Another important difference was observed in how Sophia and Rachel framed GCSEs in relation to learning argumentation represents two different ways of setting the relationship. The difference could have possibly stemmed from the respective GCSE structures for science and RE, since the RE examination is focused more on writing essays where the marking scheme emphasises the quality of internal logic and reasoning than the conclusion itself, whereas for science, questions mainly require getting the correct answer. It is also related to the fact that the RE curriculum in England is based on a pluralistic approach that recognises different views from different religious traditions, allowing multiple arguments about a single issue, problem, or question (Guilfoyle et al., 2020). Considering the impact of high-stakes examinations on teachers' classroom instruction (Damankesh & Babaii, 2015; Wall, 1997), this is an important topic that will need further investigation. Future research can further unpack the factors that influence subject-specific strategies that teachers utilise in science and RE lessons. In terms of developing teacher professional development, the findings also point to the need for considering teachers' framing of the goal of teaching argumentation to provide an effective and meaningful learning opportunity.

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Appendices

Appendix 1. Excerpts from Sophia's lesson slides

Who is right?– form a reasoned explanation to justify your choice

Fergal
I think that they will move upwards when they open the parachutes

Roshni
I think that they will decelerate when they open the parachute

Sylvia
I think that they will fall at a constant speed when they open the parachutes

Terminal velocity – forming reasoned arguments to explain evidence and observations

I	III	III	III
A relevant fact I know	**Describe**	**Explain - how or why**	**Apply your understanding to different situations.**

KEYWORDS

Force
Balanced
Unbalanced
Resultant
Terminal
Velocity
Vector
Equilibrium

You can use P.E.E. to help formulate your explanations

These help you form reasoned arguments to back up your points

P – point

E – evidence

E – Explain

The Question

The question is good, it's your friend and it's there to help.

Make sure you understand the question.

Identify command words - what it's asking you to do – discuss? Describe? Evaluate? Compare? Outline?

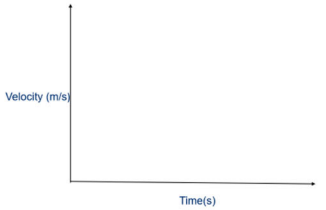
Stick to the topic and answer the question that's been set. If you're asked specifically about one thing don't go off naming everything else related to that just because you've revised it all.

P.E.E.

Always remember to P.E.E.

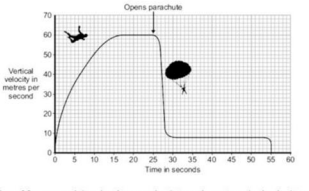
Point. Evidence. Explain. A nice easy structure that's easy to remember and carry out. Make your point, back it up with some evidence and explain the science behind it. Show off your understanding and use the correct terminology!

Sketch the shape of a velocity – time graph that you might see for a parachutist falling from a plane include free falling without a parachute and falling with a parachute.



Describe what your graph shows to the person sitting next to you.
Explain your graph to the person sitting next to you.
Discuss any differences in your graphs and make some improvements to your sketch if necessary.

In this question you will be assessed on using good English, organising information clearly and using specialist terms where appropriate.
The graph shows how the vertical velocity of a parachutist changes from the moment the parachutist jumps from the aircraft until landing on the ground.



Using the idea of forces, explain why the parachutist reaches a terminal velocity and why opening the parachute reduces the terminal velocity.

Who is right?– form a reasoned explanation to justify your choice

Fergal
I think that they will move upwards when they open the parachutes

Roshni
I think that they will decelerate when they open the parachute

Sylvia
I think that they will fall at a constant speed when they open the parachutes

Terminal velocity – forming reasoned arguments to explain evidence and observations

Learning objectives
What I should be able to answer and explain by the end of the lesson:

I	III	III	III
A forces is a push or pull.	**Describe** - balanced forces are equal and opposite	**Explain** - how balanced forces cause no acceleration but unbalanced forces have a resultant force which causes an acceleration	**Apply your understanding** of balanced and unbalanced forces to questions about terminal velocity

KEYWORDS

Force
Balanced
Unbalanced
Resultant
Terminal
Velocity
Vector
Equilibrium

Appendix 2. Excerpts from Rachel's lesson slides and worksheet

What makes up a "good" essay?

Point

- What is it you want to say?
- What are you claiming is true?
- What do you want to talk about?

These are your points

Evidence

- What can you say to support your idea?
- What will back up your point?
- What facts do you have?

Every point needs to be supported by evidence

Explanation

- Evidence needs explaining
- It's like you're talking about your point and evidence in more detail.

Look at your exam paper

- Which ones did you choose?

- Did you use a P-E-E structure?

In your group

- Pick one essay

It can be one you did or one you didn't do. (It doesn't matter)

- Work with your group to fill in the sheet and decide on the PEE this essay needs.

1. 'Suffering is not a punishment for human actions but a result of human actions.' Do you agree with this? Give examples to illustrate your answer.
2. Self-defence is the only reason for fighting. Explain why you agree or disagree with this statement. Under what circumstances is it acceptable to fight a war?
3. Do you think lotteries are bad uses of money? Why do you think so many religions are against this way of using money?
4. What are the most important qualities you think are needed to make good relationships? Discuss this question and explain the difference between aspirations and promises.
5. 'We should have the right to choose when we die?' Discuss this question with reference to euthanasia. Try to reflect both a moral and religious point of view.
6. For what reasons might some religious believers say that, in certain circumstances, abortion is acceptable?
7. Why are people prejudiced? Are they born prejudiced or do they become prejudiced? Give reasons for your views.
8. How do religions teach about helping others? Explain using examples from at least two different religions.

Please check your work through for any improvements you can make.
End of Examination

Planning an essay **Group members:**

Use the table to arrange your ideas for PEE.

Point	Evidence	Explanation