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**To cite this article:** Hayden Godfrey & Sibel Erduran (2023) Argumentation and intellectual humility: a theoretical synthesis and an empirical study about students' warrants, *Research in Science & Technological Education*, 41:4, 1350-1371, DOI: [10.1080/02635143.2021.2006622](https://doi.org/10.1080/02635143.2021.2006622)

**To link to this article:** <https://doi.org/10.1080/02635143.2021.2006622>



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Published online: 21 Dec 2021.



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# Argumentation and intellectual humility: a theoretical synthesis and an empirical study about students' warrants

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## ABSTRACT

**Background:** Argumentation, the justification of claims with reasons and/or evidence, has emerged as a significant goal in science education in recent years. Yet, there is limited understanding of secondary students' arguments and particularly their use of warrants in interdisciplinary contexts such as science and religious education. Furthermore, research on argumentation in science education has not paid sufficient attention to how students' arguments may potentially reflect intellectual humility. The concept of intellectual humility reinforces the view that one is not excessively arrogant regarding their beliefs, or excessively dismissive of their or others' beliefs.

**Purpose:** It is important to understand students' engagement in argumentation particularly in the context of topics such as evolution and creationism that often present tension and conflict. For classroom argumentation activities to be fruitful, students' understanding of warrants as well as their intellectual humility are prerequisite.

**Sample:** The data are drawn from Year 9 students' engagement in a card sort activity in the context of a funded project in England. The activity engaged the students in a task on the origins of life, where evidence and reasons were related to evolution versus creationism.

**Design and Methods:** The card sort activity was designed to limit students' contributions about different evidence and emphasise specifically, the link (warrant) by providing fixed evidence and claims. During the activity, students were presented with 'evidence cards'. Students were asked to consider each card and place it under the claim that they felt the card supported even if the student did not support that claim personally. They were further asked to explain why they thought the evidence might be used to support that claim. Students' verbal accounts of their warrants for placing cards were explored.

**Conclusion:** Students' warrants included repetition of evidence statements without articulating the reasons. As intellectual humility concerns accurately tracking the positive epistemic status of a belief or argument, a lack of coherence within students' arguments contradicts the embodiment of intellectual humility.

## KEYWORDS

Argumentation; Warrants;  
Intellectual humility;  
Secondary science; Toulmin

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## Introduction

Argumentation, or the justification of knowledge claims with evidence and reasons (Toulmin 1958) is a component of existing science curriculum standards (e.g. Department for Education 2014; NGSS Lead States 2013) as well as religious education (RE) syllabi (e.g. Lambeth Council 2015; Northumberland Council 2016), creating a precedent for its theoretical and empirical study in education. Argumentation research within science education has taken an interdisciplinary approach as the synthesis with varying conceptual areas has produced '*constructive research agendas*' and pertinent '*practical applications*' in the teaching and learning of argumentation (Erduran and Jimenez-Aleixandre 2007; Erduran et al. 2019; Lazarou and Erduran 2021; Ozdem et al. 2017). Argumentation in the context of traditionally disparate school subjects such as science and RE raises questions about how argumentation is framed. There are at least three theoretical bodies of research framing argumentation studies: (a) developmental psychology, including the distributed cognition perspective (e.g. Kuhn & Udell 2003; Mason 1998); (b) language sciences as for instance the theory of communicative action (e.g. Lemke 1990); and (c) interdisciplinary investigations drawing on history, philosophy and sociology of science and religious studies (Bender-Szymanski 2013).

Educational research on argumentation could potentially benefit from a robust theoretical orientation and it can itself potentially inform foundational disciplines through empirical research in schools. For example, discussions about the extent to which argumentation research in education contributes to cognitive and metacognitive processes (Kuhn and Crowell 2011) could inform the situated cognition perspective (Brown and Campione 1990). The multitude of disciplinary orientations underpinning argumentation studies as well as the potential reciprocal relations with educational research point to the scope of argumentation in application to different disciplines and school subjects. For instance, the framing of argumentation as a communicative competence is relevant for learning both in science and philosophy of science (Giere, 1988) RE given the broad remit of this competence in schooling. Likewise the foundational literature from cognitive psychology illustrates how argumentation plays a role in the development of metacognitive skills which are important for learners' self-regulation (e.g. Hacker, Dunlosky, and Graesser 2009) about arguments.

In this paper, we review how argumentation is related to research in science and RE teaching and learning more specifically by focusing on how secondary students provide warrants for their arguments. Considering the vast amount of literature on argumentation in science education (Erduran, Ozdem, and Park 2015), our focus here is on a particular aspect, namely warrants that are used to justify claims in arguments. Thus, our discussion starts with a nuanced perspective on argumentation in relation to warrants of beliefs. This section contributes to the articulation of warrants which is fairly understudied from a theoretical point of view in science education. Here we draw on Stephen Toulmin's framework of argumentation (Toulmin 1958) to illustrate how warrants operate within arguments. Next, we turn to a discussion on 'intellectual humility', a concept that has not been previously addressed in argumentation studies in science education. The concept of intellectual humility reinforces the view that one is not excessively arrogant regarding their beliefs, or excessively dismissive of their beliefs (Church and Samuelson 2017). The literature on intellectual humility is reviewed with the aim of producing a synthesis with

literature on argumentation, particularly in relation to warrants. Such a synthesis extends the discussion on warrants in that it highlights how (a) warrant must reflect the varying epistemic strength with which the evidence supports the truthfulness of the claim through the inclusion of modal qualifiers and the conditions with which the evidence supports the claim; and (b) a warrant has a distinct role in argumentation and is not merely a repetition of the evidence or reasons in support of a claim, or the claim itself. It is instead independent reasoning of why the evidence presented is appropriate to supporting the claim and provides an accurate reflection of the epistemic strength with which it supports the claim. We present empirical examples from a study conducted with Year 9 (13–14 years old) students in the context of the funded *Oxford Argumentation in Religion and Science* (OARS) project ([www.OARSeducation.com](http://www.OARSeducation.com)) carried out in England focusing on research and development on argumentation in science and religious education.

### Argumentation in Science and Religious Education

Argumentation, simply defined, is the coordination of evidence and reasons to support claims or the process of engaging with or generating arguments (Toulmin 1958). Arguments have an epistemic value, providing justification for knowledge, whether as individual expressions in social dialogues, or internal dialogues (Kuhn 1993). Argumentation has been an area of research in science education (Lin, Lin, and Tsai 2014) and RE (Bender-Szymanski 2013) as well as the intersection of science and RE (Brickhouse et al. 2000). In both science education and RE, there are questions that demand the coordination of evidence, reasons and claims. For example, in the context of science teaching and learning, the topic of evolution relies on the use of evidence to justify why evolution by natural selection is a justified theory (Basel, Harms, and Precht 2013). In the case of RE, the nature of evidence may or may not necessarily be about empirical evidence. As an interdisciplinary subject, RE draws on philosophical, historical, sociological as well as educational accounts, and as such historical data (as an example) may be considered evidence in justifying particular religious claims. For example, in RE lessons argumentation can involve the debate about the existence of God and how different religious texts might justify it. Indeed, RE in some countries such as England has a long tradition of engaging students in examination and evaluation of religious claims (Freathy and John 2019). Research at the interface of science and RE have highlighted students' difficulties including their teleological and anthropomorphic explanations (Kampourakis and Zogza 2009) and understanding of concepts such as adaptation in the case of evolution (To, Tenenbaum, and Hogg 2017). Some studies have proposed argumentation as a potential strategy in facilitating students' understanding of evolution (Tavares, Jimenez-Aleixandre, and Mortimer 2010).

A prominent model of argument in education is Toulmin's Argument Pattern which refers an argument in terms of claims, data, warrants, backing qualifiers and rebuttals (Toulmin 1958). Toulmin's framework has been widely used in argumentation studies (Verheij 2005). Toulmin referred to such domain-specific features as the 'field-dependent' features of an argument, while also recognising the existence of 'field-invariant' elements which have been articulated in various school subject contexts including science (Erduran 2019; Jimenez-Aleixandre, Rodriguez, and Duschl 2000), history (Pontecorvo and Girardet

1993), and English (Rex, Thomas, and Engel 2010). A particular discipline or school subject has unique features of argumentation that reflect its epistemology (Goldman et al. 2018). The interdisciplinary character of argumentation has been highlighted in the literature (Erduran et al. 2019). In the context of RE, Chan, Fancourt, and Guilfoyle (2020) conducted an analysis of RE syllabi which demonstrated that argumentation was linked to personal expression within democratic participation, and epistemic and empathetic flexibility. The authors demonstrated that in examining a representative range of locally agreed RE syllabi in England using Toulmin's model, argumentation was widely expected as a learning outcome, indicated by approximately one reference in every four pages in the 35 syllabi analysed. In the context of the science curriculum in England, there is a history of inclusion of argumentation related themes, including the major themes such as 'Ideas and Evidence' and 'How Science Works' components of the science curriculum in recent years (La Velle and Erduran 2007) and 'Working Scientifically' component in the current curriculum (Department for Education 2014).

### **Argumentation and Warrants of Claims**

For the purposes of education for informed citizenship, there has been a signposted ideological commitment that teaching science needs to accomplish much more than detailing what we know (Erduran and Jimenez-Aleixandre 2007). Crucially, pupils and citizens need to understand how we know and why we believe what we know through science i.e. science as a way of knowing (Leach et al. 1996). Thus, an important educational function is the exposure of the '*epistemic core of science*' (Erduran and Kaya 2019) where there is a need to understand why certain reasons, or data, sufficiently support beliefs. Additionally, recognition is required of '*not only the strengths of scientific beliefs, but also the limitations*' (Osborne and Young, 1998). Necessary in the recognition of '*limitations*' of beliefs is comprehension of how different forms of evidence can support the truthfulness of different claims with varying epistemic strength.

In order to elucidate the nature of arguments, Toulmin (1958) structured the first three steps of argumentation through a claim, the evidence supporting that claim, and a warrant (the justification of why the evidence supports the claim). An argument first involves an assertion '*which puts forward a claim – a claim on our attention and to our belief*' (p. 11). A claim is inherently linked to the notion of belief because if one puts forward a claim, then it is a claim that others should believe it (Harris 2011). If a claim wishes to be taken seriously (or believed to be true) it must be justifiable; that is, there should be evidence and/or reasons in support of that claim. If someone were to claim that '*Everyone called Harry has black hair*', the self-evident follow up is '*how can you support this claim*' with evidence and reasons? (p. 90).

However, not all evidence is relevant and/or sufficient to support a claim. In terms of relevance, evidence in support of the claim '*Everyone called Harry has black hair*' could manifest through observations and witness accounts of everyone called Harry, alongside photographic evidence of their hair colour. However, the claim cannot be supported with a large-scale statistical study of the swimming speed of dolphins. In terms of sufficiency, if one were to support the above claim with the anecdotal evidence '*my friend has told me*', then this would be insufficient to support the claim. Therefore, the types of data and reasons provided in support of a claim, through the lens of relevance and sufficiency, will

*'be of very different kinds, according to the nature of the problem we are pronouncing judgment about'* (Toulmin 1958, 91). Therefore, *'science as a way of knowing'* must facilitate understanding that evidence in support of a claim must be relevant and sufficient in support of the claim being made. We will use the term *'appropriately'* as the collated term for sufficiency and relevance of evidence in supporting a claim.

Thus, a step is required from the presentation of evidence in support of a claim which must justify its presence *'to show that, taking this evidence as a starting point, the step to the original claim or conclusion is an appropriate and legitimate one'* (p. 90). This necessary step manifests through the distinct role of a *'warrant'* in argumentation; namely, the justification that the evidence presented in support of a claim appropriately warrants the truthfulness of that claim. The quality of that connection (i.e. the warrant) is the primary framework in *'grading, assessing and criticising'* the merit of an argument; namely, how appropriately does the evidence support the claim, and thus prove the claim to be true?

A crucial consideration that logically follows is that certain evidence or reasons will support a claim with *varying epistemic strength*, with epistemic strength being produced based on the different forms of appropriate evidence in the domains of science and religious education (Church and Samuelson, 2016). For example, the claim *'Everyone called Harry has black hair'* could be supported by evidence that *'I know three people called Harry, and they all have black hair'*. However, this evidence supports the claim with limited epistemic strength, and thus the reasoning provided for a warrant regarding this evidence should reflect the partial support of the claim it provides. Toulmin (1958) reasons that warrants lead to conclusions about claims that *'can be inferred necessarily or certainly and those whose conclusions can be inferred only possibly or with probability'* (p. 126). Thus, if one were to identify everyone in the world called Harry and take a picture confirming that they all have black hair, the semantics of the warrant can and should reflect that the evidence supports the claim in its totality (and thus can be inferred necessarily). However, if only one hundred people in the world called Harry were photographed, and almost all of them had black hair, one could then warrant this claim with a reflection that the evidence only partially supports the claim (only possibly or with probability). The stronger the evidence in support of that claim, the stronger the warrant should semantically reflect the support of that claim.

The semantic reflection of the epistemic strength with which evidence supports a claim is defined by Toulmin (1958) through the use of modal qualifiers, and/or stating the conditions with which the claim is true or false. Toulmin articulates the distinction between necessary arguments and probable arguments: i.e. between arguments in which the warrant entitles us to argue unequivocally to the conclusion (which can therefore be labelled with the modal qualifier *'necessarily'*) and arguments in which the warrant entitles us to draw our conclusions only tentatively (qualifying it with a *'probably'*) subject to possible exceptions (*'presumably'*) or conditionally (*'provided that ...'*) (p. 126). In other words, warrants should semantically reflect whether a claim is *'necessarily'* true, or whether evidence supports a claim probabilistically (such as *'probably, almost certainly the case'*).

For example, in the context of religious studies, if one were to claim that *'God is loving'*, and eighty percent of God's actions in historical texts considered divine were accounts of loving acts of God, then one could semantically present the warrant through the following; it is probably or presumably the case that God is loving because most of his actions in the divine text are loving. Therefore, it is presumably the case that the actions which may

not be obviously loving were justified on faith, yet because the evidence does not provide total or necessary support of the claim, one should semantically reflect the probabilistic epistemic strength (probably, presumably) with which the evidence supports the claim. In this manner, warrants and modal qualifiers are inextricably linked with the common theme of mapping the varying epistemic strength with which claims should be assigned in relation to the supporting evidence in the argument.

Furthermore, arguments should state the conditions with which a claim is true, or a claim is false. For example, relating back to the science domain, if there were two towns (A and B), and everyone from town A called Harry had black hair, then the claim *'Everyone called Harry has black hair'* is true insofar as the condition of them being from Town A is met. Conditions also reflect whether evidence supports claims with varying epistemic strength, narrowing the precision of claims according to the conditions with which claims are true or false in line with the evidence presented. Consideration of the conditions with which a claim is true in relation to the evidence further reinforces the mapping of the varying epistemic strength that warrants necessitate; once again, the varying epistemic strength of a claim is mapped out in specifying the conditions where the claim is more or less applicable.

A crucial consideration for the following conceptual synthesis with intellectual humility concerns the *distinct* roles of a warrant and a qualifier within argumentation. For example, the claim *'Harry's hair is black'* cannot be warranted by restating the claim *'Because Harry's hair is black'*. Toulmin mentions that certain kinds of evidence simultaneously fulfil the roles of evidence and warrant; thus, presentation of evidence fulfils both the roles of warrant and evidence (for example, if the evidence unambiguously supports the claim, such as *'All people called Harry have been photographed with black hair'*). However, if evidence does not support claims in their totality, then evidence must be warranted reflecting whether the evidence supports the claim *'unambiguously'* or *'only tentatively, conditionally or with qualifications'*. Therefore, warrants and qualifiers are distinct from evidence insofar as the evidence does not unambiguously support a claim to be necessarily true under all variety of conditions. Overall, warrants should not merely indicate that any evidence in support of a claim supports them in their totality (or with the same epistemic strength). There should be recognition that certain kinds of evidence support certain kinds of claims with appropriately varied epistemic strength through the warrants that are provided in support (Church and Samuelson 2017).

## Intellectual Humility and Argumentation

The concept of intellectual humility has been defined as *'the virtuous mean between something like arrogance, on the one hand, and self-deprecation ... on the other'* (Church and Samuelson 2017, 6). In other words, one is not excessively arrogant regarding their beliefs, or excessively dismissive of their beliefs. Alternatively, they attribute truth and justification of their beliefs as they ought. However, a pertinent question is by what standard one attributes truth and justification as they ought, especially considering the different rules of generating epistemic strength across domains. The seminal account of intellectual humility by Roberts and Wood (2003, 2007) highlights the virtue as fundamentally being defined as a *'striking or unusual unconcern for social importance, and thus*

*a kind of emotional insensitivity to issues of status'* (Roberts and Wood 2007, 272). In this framing, one is not necessarily unaware of his/her status, but there is no concern regarding status (Church and Samuelson 2017).

Yet defining intellectual humility fundamentally on social status can lead to untruthful outcomes where knowledgeable persons on particular subjects can produce or allow untruthful representations of their expertise (Church and Samuelson 2017). In line with the Roberts and Wood (2003) framing of intellectual humility, an individual may downplay their expertise by being intellectually humble, even if their knowledge should appropriately be attributed that expertise, because of an unusual concern for social importance. As there is no care for social status, untruthful consequences can be produced in not accurately representing the epistemic strength of beliefs or arguments communally.

As an example, a specialist surgeon may have no care for social status, and thus under-represent their ability to perform a particular form of surgery. If this is the case, the surgeon may not be called in to a hospital for an emergency surgery of this type if it is not believed they are capable. Through the doctor not caring for social status, patients could die needlessly through the doctor's capabilities not being accurately represented in terms of epistemic strength. Therefore, intellectual humility cannot fundamentally be defined by a lack of caring of social status if it is to result in accurate representation of epistemic strength (and thus truthful outcomes). Social status can play a role, but it cannot be a fundamental trait of the conception (Church and Samuelson 2017). Instead, what is required is a disposition to accurately and honestly represent, and self-appraise, the epistemic truthfulness of one's beliefs communally (Damon, Colby, and King 2018). However, as Porter and Schumann (2018) state, this requirement is fundamentally an '*other*' oriented activity. One can only honestly self-appraise and represent the epistemic strength of their beliefs relative to other ideas and other people holding those ideas. Additionally, one can only represent the strength of their beliefs if they are actively engaging with differing viewpoints and ideas. This consideration, we argue, is fundamental to any conception of intellectual humility, namely, the active engagement with differing/alternative ideas to accurately represent the epistemic strength of one's beliefs in relation to the differing claims available.

In this sense, the social aspect of intellectual humility has a fundamental epistemic function which can be conceptualised dialogically (Ford and Wargo 2012). Bakhtin (1986) defined dialogue as an idea constantly and conceptually being in tension with others. The tension, or the '*interanimation*', provides an idea with meaning (p. 271). '*Meaning*' can be defined dialogically through what Ford and Wargo (2012) articulated as the multiplicity of alternatives: that ones' arguments or beliefs are situated within alternatives, and it is from this diversity that ultimately accepted ideas arise. Without an idea existing dialogically in tension with others, there is no way to identify an idea with more epistemic strength than others. Through this reasoning, the community chooses which ideas are accepted through setting its own rules. In terms of the scientific community, the social status of an idea should be equated with how strongly ones' arguments or beliefs are reflected in the evidence available based on the epistemological rules of verification in that community (e.g. the scientific method).

Our account of intellectual humility is consistent with that articulated by Church and Samuelson 2017). Intellectual humility is the virtue of accurately tracking the positive epistemic status of one's own beliefs (p. 24). This definition overcomes the prior criticisms by reframing the role of social status dialogically with an idea existing in tension within a community of alternative and differing ideas. Furthermore, it explicitly underlines the need to evaluate the epistemic strength of beliefs relative to others, phrased as tracking the '*positive epistemic status*' of one's own beliefs. However, crucial for the usefulness of this definition is what tracking positive epistemic status *practically* means. Here, Church and Samuelson do not provide a rigid criterion:

*We don't intend to commit ourselves .... on this score. For now, let's let a thousand flowers blossom. Whether it's safety, sensitivity, evidence, reliability, character virtues, justification, defeasibility .... if it can give a belief positive epistemic status, - or at the very least, positive epistemic status that really matters, then our definition should track it' (p. 2)*

However, through combining this conception of intellectual humility with argumentation, there are various derivations of meaning that can be produced concerning '*accurately tracking the positive epistemic status*' and '*not over or underestimating*' the epistemic strength of an argument. In order to elucidate, '*accurately tracking positive epistemic status*' signifies that evidence will inherently support a claim with varying epistemic strength. If appropriate evidence were merely a dichotomous characterisation of supporting a claim (i.e. either appropriate or inappropriate) then there would be no need to track the positive epistemic status of a belief or argument. It would merely be supported by evidence, and thus true, or not supported by evidence, and thus false. Further, a person who is intellectually humble constantly guards against '*over or underestimating*' the strength of their argument, and thus will recognize that evidence does not always support a claim with totality. Instead, certain evidence supports claims partially, or indicates that the claim could potentially or probabilistically be true, or further that the claim is only true under certain conditions (Toulmin 1958). Thus, an intellectually humble person is constantly evaluating whether the evidence that supports their claims and beliefs is assigned the appropriate epistemic strength (i.e. whether the evidence supports a claim presumably, necessarily, or only under certain conditions) (Damon and Colby 2015). In relation to the epistemic core of science education, an intellectually humble person would '*recognise not only the strengths*' of scientific beliefs, but also the limitations' through identifying the accurate degree to which evidence provides a claim with epistemic strength, and whether there is sufficient evidence to support a claim in its totality, or partially (Osborne and Young 1998; Church and Samuelson 2017).

Accurately tracking positive epistemic status is expressed in the present continuous tense, indicating that the process is fundamentally ongoing. The characterisation of an ongoing process can serve as a fundamental consideration for educational practices in science and religious education. As an example, a specialist brain surgeon may hold the belief that their chosen method of surgery is the most informed in its ability to save people's lives. However, they must constantly stay up to date with the latest medical discoveries to ensure that their belief in this method is in fact accurately reflecting the positive epistemic status that the doctor is attributing (that it can save lives). Yet ideally, the doctor will never stop tracking the positive epistemic status of their belief relative to others because there is always the possibility of the discovery of a more informed

treatment (Harris 2011). Therefore, we argue that *'tracking positive epistemic status'* and namely intellectual humility can inherently be conceptualised as an ongoing commitment to re-evaluate and revise the epistemic strength of scientific and religious beliefs through seeking out more evidence, reasons and alternative claims (Damon, Colby, and King 2018). The same way scientific argumentation should *'recognise not only the strengths' of scientific beliefs, but also the limitations'*, an intellectually humble person would acknowledge that if evidence is limited in supporting a specific claim, then further evidence is required to determine the truthfulness of the claim. Further, if a claim is supported by evidence that merely provides the most informed inference currently possible, but future evidence could challenge the epistemic strength of the claim, then an intellectually humble warrant would acknowledge that further information is required to determine the truthfulness of the claim.

### ***Intellectual Humility and Warrants of Claims***

Intellectual humility and the function of a warrant draw from Kuhn, Cheney, and Weinstock (2000) evaluative stance. One accepts that there are multiple viewpoints, opinions and beliefs, yet there is an objective dimension of knowing by acknowledging uncertainty without forsaking evaluation. While multiple perspectives are accepted to hold epistemic strength, it is always possible that other claims and alternative evidence could hold a higher level of epistemic strength, and therefore one must constantly engage with differing claims, evaluating their epistemic strength through how the claims are warranted in a more aligned manner to the rules of the community or domain. However, if an idea is to be expressed as more epistemically valuable to a community based on their rules or modes of verification, there must also be a requirement to express that idea in a manner that embodies those modes of verification, or in other words, that reflects why the idea more rigorously embodies those modes of verification than alternatives. Therefore, intellectual humility is also dialogic because in a scientific context where there is a multiplicity of alternatives, judgements, claims and potential beliefs, choices must be made to determine which ideas are superior in epistemic strength based on the community's rules.

In a scientific community for example, the epistemic strength of arguments will be determined by how well each claim is warranted by evidence, but further, how that support can be articulated in dialogue with others. Therefore, warrants should provide a greater understanding of claims than alternatives because they embody the rules of the scientific community, namely that they more rigorously reflect the evidence in comparison to competing claims (Brewer, Chinn, and Samarapungavan 1998). Therefore, the function of a warrant communally has an explicit link to tracking positive epistemic status being inherently dialogic; scientific knowledge is fundamentally a product of dialogue (whether that be internal concerning differing ideas, or external concerning differing persons holding differing ideas) in a community with agreed upon practices, norms and criteria (Ford and Wargo 2012). In this community, the clarity of articulation of the warrant is fundamental to tracking positive epistemic status for oneself and for the community, and thus inherent to practicing intellectual humility.

Furthermore, tracking positive epistemic status reinforces the dialogic, communal aspect of intellectual humility by reflecting the link between communication and understanding. To track the positive epistemic status of an idea indicates that one understands how the idea may or may not reflect the rules of the domain, and that one can articulate that understanding clearly with others in order to understand the gaps in one's own and others' reasoning. As Ford and Wargo (2012) reason, the first aspect of dialogic understanding is primarily conceptual in the manner that being able to explain a natural phenomenon in terms of its reflection of the rules of the community (e.g. a scientific idea) demonstrates one's grasp of that idea, as opposed to what one may know about the idea by rote. Bakhtin (1986) reasoned that the act of explaining an idea involves engaging with a past utterance (e.g. a scientist) by taking it from its own context, time period and purpose, and utilising in one's own situation to advance one's understanding; the present context of reasoning is morphed with the historical idea, creating a receptive dialogue with the scientist and a projective dialogue with the audience of one's explanation, even if the audience is oneself. Therefore, if one is able to articulate a claim or theory in relation to the rules of the community more clearly, then it is probable that one would more effectively understand it, demonstrated by engaging with that idea dialogically.

Tracking positive epistemic status through intellectual humility reinforces that a warrant of a claim is distinct from the claim itself, and the evidence in support of the claim. If a warrant could always be a repetition of the claim itself, or the evidence, then there would be no indication within argumentation that evidence supports claims with varying epistemic strength (Church and Samuelson 2017). Thus, one would not need to track the positive epistemic status of a belief, claim or argument. Embodiment of intellectual humility results in recognition that beliefs must be evaluated in relation to how much the evidence supports their epistemic strength, to ensure they are not over or underestimating that strength. Thus, the distinct roles of a warrant and a modal qualifier are fundamental to the definition of intellectual humility that we espouse because reasoning is required to reflect and determine how much epistemic strength certain evidence provides in support of a claim (Damon and Colby 2015).

## Methodology

The papers' methodological orientation consists of (a) a theoretical synthesis of research on argumentation and religious education and (b) empirical school-based research. The school-based research is used to illustrate empirically some examples of the theoretical synthesis. The empirical study is guided by the following research questions.

## Research questions

- (1) How do secondary students engage with argumentation in relation to warrants of arguments?
- (2) How do secondary students' argumentation reflect intellectual humility?

## Data Sources

The study was conducted in the context of the 3-year OARS Project (Chan, Fancourt, and Guilfoyle 2020; Erduran, Guilfoyle, and Park 2020; Guilfoyle, Erduran, and Park 2021; Guilfoyle, Hillier, and Fancourt 2021, 2020) focusing on science and religious education in England. The data selected for inclusion in this paper were drawn from a sample of 42 students when they had not yet received formal argumentation training and as such, we were interested in how the standard science curriculum may potentially be facilitating argumentation and intellectual humility without an explicit targeting of these skills/virtues. The data consists of student verbal statements as well as their responses in the card sort activity (Table 1) described in more detail elsewhere (Guilfoyle and Erduran 2021). The card sort activity was designed to promote students' argumentation in the context of evolution and creationism. We were interested in how students articulated the justifications of their beliefs through the lens of the conceptual synthesis of argumentation and intellectual humility. The study chose to focus exclusively on Year 9 students. Year 9 is placed in the middle of the designated years of secondary school in England. It was thus chosen as a pertinent point of evaluation concerning how students are both beginning to form justifications of beliefs, and the potential for improvement in the subsequent years of formal education.

The students were engaged individually in the card sort activity. Card sort activities have often been used as pedagogical strategies for teaching argumentation (González-Howard and McNeill 2019) but are used here as a research method to elicit students' warrants for linking claim to evidence. Warrants are often left unstated and thus can be challenging to identify in arguments (e.g. Kelly et al. 1998). The activity was designed to limit students' contributions to specifically the link (warrant) by providing fixed evidence and claims. During the activity, students were presented with 'evidence cards' (numbered 1–9 in Table 1) and 3 competing claims (Columns A–C). Students were asked to consider each card and place it under the claim that they felt the card supported (even if the

**Table 1.** Card Sort Activity.

<b>A. There was no evolution. God Created Humans.</b>	<b>B. There was evolution. God had some part in the process.</b>	<b>C. There was evolution. God had no part in the process.</b>	<b>D. Does not support any of these three perspectives.</b>
Humans are highly complex. Complex things must have a designer.(1)	The Hebrew for 'day', yom, can also mean long periods of time. So each of the 6 days of creation could have lasted millions of years. (3)	That humans descended from a common ancestor is supported by evidence in biology, genetics and geology. (6)	Natural selection means that those creatures with characteristics that give them an advantage are more likely to survive and so more likely to pass on their genes. (8)
Humans are different from animals in that they have souls. Souls do not evolve but must have been given.(2)	Evolution is a tool that God used to develop human life.(4)  A scientific description of a process does not diminish God's active control of that process.(5)	The scientific timeline of creation is longer than the 6 days referred to in the bible.(7)	The Bible says that humans must subdue nature and rule over every living creature.(9)

There are at least three different perspectives on how life came into being. Which piece of texts supports each perspective?

student did not support that claim personally). They were further asked to explain why they thought the evidence might be used to support that claim. Students were instructed to place the card in column D if they felt that the card could not be used to support any of the three claims. For some cards there may be more than one acceptable claim, depending on the warrant provided.

The activity was conducted outside of lesson time as part of the data collection efforts of the project. The students engaged in the activity on an individual basis. Students were given about 20 minutes to complete the activity. Students' placements of cards were recorded by taking photographs of their completed set which would have had the cards placed under particular claims. Following this activity, students were asked by a researcher to justify which claim they themselves support, and why. The researcher asked questions such as 'why do you think that?' and statements such as 'tell me why you placed the card here' but did not interrogate the students further in the sense of a formal and structured interview. Rather, the interview was more like a conversation between the researchers and an individual student at a time about the decision-making about the card placements and lasted about 15 minutes. The students' verbal interaction with the researcher was audio-recorded and transcribed.

Asking students to justify their own claims was underpinned by the varying epistemic strength inherent to our definition of intellectual humility (Church and Samuelson 2017). Students, despite matching evidence, were asked to consider differing forms of evidence against each other, and as such, we were interested in whether the scaffolded beginning of evidence fixed to claims would translate to a consideration of the varying epistemic strength of differing evidence supporting conflicting claims. Further, the matching activity having a structured 'correct' order indicated to students that evidence must be sufficient and relevant (collated as appropriate) to support a claim, and thus we were interested in whether this consideration translated to an intellectually humble reflection of how sufficient each evidence card was in assigning epistemic strength in relation to competing claims.

### **Data Analysis**

The framework of a thematic analysis from Braun and Clarke (2006) was employed in the data analysis. The framework involves a symbiotic relationship with the data; the researcher attempts to take an active but not overly dominant role in interpretation through multiple, looplike rounds of iteratively and rigorously questioning the inferences drawn. Further, the researcher embraces their theoretical basis as a fundamental lens of qualitative data analysis, which in this case, stemmed from the unique conceptual synthesis of intellectual humility with argumentation. Braun and Clarke provide a six-step process which attempts to systematically limit the inferences of the researcher as close to the data as possible, and away from any theoretical interest, in an attempt to limit biased inferences. Drawing from step one and two, our initial goal was to familiarise ourselves with data through correcting the autogenerated transcripts by listening to recordings of interviews. At this stage, we did not make thematic connections across interviews as we did not want themes generated excessively early in the process potentially dictating what we looked for in others (Braun and Clarke 2006). Therefore, we attempted to code each interview individually in the order that they were recorded.

Embodying step three, interviews were then reanalysed with parallels being drawn between codes of different interviews, which were then defined as themes; namely, the broader parallels of codes that we had attributed when drawing inferences across interviews in line with Creswell's description of themes as '*broad units of information that consist of several codes aggregated to form a common idea*' (Creswell and Plano-Clark 2011, 186; Elliot 2018). Step four and five involved an iterative process of questioning the thematic inferences generated in the previous stage, as well as the codes forming the themes. This translated to a constant cycle of relistening to recordings with the perspective of assuming we would be biased towards our theoretical interest, and a strict questioning of whether the original data supported our thematic inferences. This manifested practically through a constant guarding against merely putting quotes together to form a theme that reflected the usefulness of our interested concepts, but that was not thematically represented by the sample (Braun and Clarke 2006). Aligning with Braun and Clarke (2013), a theme was not created unless the codes forming it expressed (and thus represented) the views of two-thirds of the total to demonstrate the pattern of reasoning. Similarly, for our study two thirds of our sample of 42 led us to focus on the patterns that were prevalent in 28 students. We report only one or two representative quotes that demonstrate the theme of the wider group in the results.

### **Ethical Considerations**

Our research received ethical approval from the appropriate ethics committee of our institution. Researchers conducting the card sort activity with the students and did not seek to challenge the views of participants but merely allowed them to express what they believed and why they believed their claims. As participants were discussing deeply held beliefs, there was the potential for strong emotions to be expressed. Interviewers did not seek to challenge beliefs; instead, identifying reflections from their perspective.

### **Results and Findings**

The thematic analysis of the interviews generated three major themes in the data. The themes about warrants were as follows: (a) warrants as repetitions of claims and evidence, (b) partial warrants disconnected from justification of claims, and (c) no warrants to support beliefs. Following a review of these approaches, the nature of the warrants will be discussed in relation to how they relate to intellectual humility.

#### **Themes about warrants**

##### ***Warrants as repetitions of claims and evidence***

A general theme was that students' warrants were repetitions of the claims, and beliefs, that students espoused regardless of the claim being supported. One student replied to the question '*Which of these claims do you support and why?*' with the following statement.

*I'm a Christian and I do believe that God made the world in seven days. I've believed in Christianity all my life and I believe it.*

Here, the claim is not supported by a warrant. The belief is justified in a circular fashion, namely by restating the belief itself. The student is merely expressing that they have believed their claims all their life, but no evidence, or warrant, is provided in justifying that belief. Another example was:

*I would agree that there was evolution and God had some part in this process because ... I think like God, that he used evolution in a way to help and create humans.*

Once again, the belief is restated to justify the credence of it in a circular fashion. No warrant is provided because the only justification is a restatement of the claim or belief itself. Furthermore, claims were generally not hedged with qualifiers or conditions. Almost all beliefs and claims being stated by the sample did not contain phrases likened to 'presumably, necessarily' indicating that a claim would be supported with varying epistemic strength, or that further information was potentially required to determine whether the claim could be supported necessarily or in totality.

### **Warrants as partial statements disconnected from justifications of claims**

A large degree of justifications of beliefs only contained partial warrants. The students knew a particular piece of evidence mandated a belief in a creator (for example), but they were not detailing why the evidence specifically supported a particular claim. For example:

*I would agree that there was evolution, that God had some part in the process because I do believe in God, I am a Christian. I do believe in the creator God. I also believe there was an element of evolution because we are similar to monkeys.*

The phrase 'because we are similar to monkeys' is the potential beginning of a warrant justifying why the evidence of our genetic similarities to monkeys could support the students' claim (or belief). However, no explicit reasoning is produced connecting the evidence presented to the students' belief. The genetic similarities between humans and apes could conversely support the claim that God had no role in our creation. Therefore, his warrant does not justify why believing in apes supports his claim that God had some part in the process, and only manifests partially as a warrant itself. His comments present the evidence as if it unambiguously proves the claim to be true, and thus a warrant is not required. Another more developed example was the following:

*I agree with the third idea because I don't think first of all God exists, and secondly that if he did exist, he wouldn't have any part in evolution.*

Here, there is a more developed attempt at an explanation, however, the actual explanation is not fleshed out as a warrant. Stating 'if he did exist, he wouldn't have any part in evolution' begs the question as to why that is the case. Therefore, this once again is an example of a partial warrant; there is the beginning of reasoning as to why evidence and reasons support claims, but they require extensive development to fulfil their purpose of justification. In contrast, one student provided a warrant that fleshed out the justification of the evidence (instead of merely repeating or paraphrasing it):

*Because part of the science says that from where we got the first sightings of humans to when they say the big bang happened was over millions of years. So, if God says if the Hebrews, some of them think that if one day is a million, millions of years, then that kind of works with how we scientifically found out. So, I think God had some part in the process.*

The student highlighted the scientific element of creation reflected in the six days representing thousands of years; it then finishes with a summary sentence explaining *'then that kind of works with how we scientifically found out. So, it says God had some part in the process'*. The student is independently articulating why the evidence relates to a personal chain of reasoning that supports the claim, as opposed to regurgitating the belief or evidence. He also uses phrases such as *'that kind of works'* which could be interpreted as a modal qualifier; these phrases indicate the evidence/reasons support the claim with a degree of epistemic strength, and indicate a hedged inference can be made, however, these hedging phrases stop short of indicating the claim can be supported in totality. Instead, it seems the student is expressing his belief *could* be supported to a certain degree considering the evidence presented.

### **No warrants to support beliefs**

Students would commonly express a strong belief, but not justify it with evidence. A significant degree of responses indicated a religious or parental upbringing being the sole determinant of a belief, with others simply stating a belief. At this point, many students in this sample generally do not think that stating a belief requires justification. Instead, one's upbringing was determined as the justification for what one believes. In contrast, one student commented the following:

*Evolution created us and God had no part in the process because I don't really believe in religion. There is more scientific evidence that, like, the earth was created over a period of time, rather than someone just made it. There's like the big bang theory, and we like descended from other atoms and living beings.*

Here, the student justifies his beliefs with reference to evidence, and independently articulates why the evidence supports the claim being made; this is as opposed to relying on upbringing or religious belief to warrant a claim. Further, he makes a balanced, weighted judgment that *'there is more scientific evidence'* to support his claim. There is an indication of tracking the varying epistemic strength of differing forms of arguments, where the student makes a value judgment that there is more epistemic strength (or evidence) to support his claim.

### **Warrants and intellectual humility**

Students' justifications for their own beliefs reflected a lack of understanding of the distinct, practical roles of the concepts of *'evidence'*, *'warrants'*, and *'modal qualifiers'* within argumentation (Toulmin 1958). There was repetition of claims as warrants of beliefs, as well as beliefs being presented without any evidence, alongside partial explanations for warrants. The data suggest that most students of the sample cannot dissect the pieces of an argument, and further cannot understand how each piece is vitally crucial to forming a coherent argument within Toulmin's (1958) framework.

The coherence of Toulmin's framework vitally represents considerations of intellectual humility: (a) evidence is required for an argument or belief to be supported; (b) warrants are required to justify the evidence presented, (c) modal qualifiers and conditionals correctly represent the strength with which the evidence presented supports the claim.

As intellectual humility concerns accurately tracking the positive epistemic status of a belief or argument, each part of Toulmin's framework coherently forms the process of presenting and justifying evidence appropriately according to the epistemic strength it provides to a claim. Thus, a lack of coherence of Toulmin's framework within students' arguments contradicts the embodiment of intellectual humility. One could thus infer that the students have an arbitrary understanding of which evidence *'matches'* with a particular belief on the spectrum of believing in creation to evolution, but they cannot articulate themselves why the evidence supports the respective arguments. A parallel could be drawn between Kohlberg's scoring of the moral development of decisions. Students who simply say arguments should be followed *'because those are the rules'* are reflecting a lower-level of development because they are regurgitating arguments from authority that have been repeated to them (Erduran, Simon, and Osborne 2004) In this sense, they are not internalising why an act is just or not.

The students are potentially not internalising why certain evidence supports a claim; instead, they are repeating justifications from others who have done so and arbitrarily connecting the dots. The inability to articulate how the evidence supported a claim with varying epistemic strength reflected a lack of understanding as to how that evidence appropriately (sufficiently and with relevance) supported their claims. The dialogic aspect of intellectual humility concerned increased understanding through more accurate articulation of the appropriateness of evidence in relation to a community's rules; regardless of the domain, this was not reflected in student responses. If students are merely passive receivers of beliefs and arguments, and not forming their support of beliefs through independent processes, then there is no possibility for the consideration of epistemic strength justifying beliefs crucial for intellectual humility; epistemic strength is not a consideration if beliefs are not being formed based on epistemic strength, but instead formed based on upbringing.

Furthermore, the notion of *'varying'* epistemic strength was a fundamental conceptual trait of the synthesis of intellectual humility with argumentation and was shown to be demonstrated through modal qualifiers or conditionals (Toulmin 1958). However, it seemed that the students approached support of their claim in a dichotomous fashion: *either I believe it, and it is true, or I do not believe it, and it is false*. Further, the justifications (or evidence) in support of claim were not solidified enough to warrant a claim necessarily. Therefore, nuanced consideration of how evidence supports beliefs and arguments was seemingly lacking, with the *'varying'* aspect excessively reduced to binary classification of either true or false. The foundation of intellectual humility depends on a constant and rigorous consideration of how much epistemic strength supports a belief in relation to the evidence; a lack of consideration through presenting warrants in a dichotomous fashion contradicts the varying epistemic strength through which evidence supports beliefs.

Earlier in this article it was stated that pupils and citizens, through science education, need to understand how we know and why we believe what we know through science i.e. science as a way of knowing (Leach et al. 1996; Duschl 1990). However, concerning this sample, the process of how one comes to know or believe a claim is seemingly in doubt. If beliefs are being stated and justified by a belief system, or a religious upbringing, and not because of evidence and reasons appropriately supporting a claim, then the epistemological process of the standard science education curriculum are potentially not facilitating an understanding of science as a way of knowing. Additionally, as the prime formulation of beliefs seems to stem from upbringing, whether that be religious in terms of believing in a creator or a belief in evolution, it could be inferred that students are not independently articulating why their beliefs are warranted. This implication cannot be understated. If, at Year 9, students cannot understand the epistemological processes of forming a belief (or claim) within argumentation and through intellectual humility, then students will be mere receivers of beliefs and claims, and not independent, critical actors capable of determining the epistemic strength of conflicting claims.

## Conclusions and Discussion

Intellectual humility was defined as accurately tracking the positive epistemic status of ones' belief or argument to ensure one is not over or underestimating the strength of their claims (Church and Samuelson 2017). However, one must be able to determine how an argument is assigned epistemic strength appropriately; if this ability is not present, then weighing the varying epistemic strength of arguments will be likened to running before students can walk. If a student cannot determine the varying epistemic strength of conflicting claims, then the standard science education is potentially not facilitating an embodiment of intellectual humility if students are not coming to form beliefs because of any epistemological process other than passive acceptance of their upbringing. Students cannot practice intellectual humility before comprehending how differing claims can be weak or strong in terms of epistemic strength, or at least vary in epistemic strength to some degree.

Almost none of the students indicated that further information would be required to determine whether the claims were true or false necessarily. Almost all students stated a belief, with only a small fraction expressing hedging phrases through modal qualifiers indicating that claims could not be supported necessarily or in totality with the current available evidence. The lack of prioritisation or recognition that questions such as the existence of God require further information and study to make or support a more definitive claim is also concerning. Intellectual humility concerns a continuous desire to find a more informed claim or answer, and argumentation reinforced this with the need for a warrant to reflect how informed a claim is considering the current evidence available. However, students need to recognise when a claim requires further information, research, and evidence to be believed or supported necessarily if they are to embody intellectual humility within Toulmin's (1958) framework of argumentation.

## Implications

In terms of the limitations and implications for future research, there are various considerations. The study only evaluated responses at the semantic level, and thus took students' articulations of beliefs as reflecting their thought processes justifying their beliefs (Braun and Clarke 2006). However, it could be the case that students do attribute varying epistemic strength to their arguments and beliefs, but simply cannot articulate that through their limitations of language. Future research could investigate implicit processes concerning justifications of beliefs to perhaps reveal deeper processes beyond the semantic aspects.

The study utilised qualitative research. It could be pertinent to translate these results into a more generalisable instrument to determine whether the themes identified applied to classes and schools in wider contexts across schools in the United Kingdom. This process could be in the form of a sequential exploratory analysis where the qualitative results are further confirmed with a quantitative approach using a more generalisable instrument (Creswell and Clark 2018; Eckert 2013). The key themes of the thematic analysis could have been translated into a quantitative instrument (such as a Likert Scale style questionnaire) then distributed to a larger sample. If the identified themes were further reinforced with a larger sample, there is a higher probability that the effect (or theme) is generalisable to a wider population (Field 2017). We believe it is possible that the complexity of responses from respondents would inappropriately translate into a quantitative instrument, however, it is a consideration if researchers wish to investigate the generalisability of results.

Researchers conducting the interviews in this study did not probe the students for responses as they wished to determine students' articulations of beliefs without assistance. It could be useful to determine whether students express an understanding of varying epistemic strength if they are probed to reflect on this, indicating that the difficulty is in expression and not the consideration of the phenomena itself. Furthermore, a randomised control trial could be conducted specifically targeting the traits of argumentation reinforced within this conceptual synthesis (Creswell et al. 2009). For example, student's quality of argumentation could be compared concerning use of modal qualifiers, consideration of varying epistemic strength, and consideration for the need of future research to make claims '*necessarily*' concerning lines of inquiry where unequivocal claims are not appropriate (as well as other considerations related to the synthesis of this paper). An intervention explicitly targeting the development of argumentation within the framework of the synthesis with intellectual humility could be utilised with one group for an explicit framework of comparison with another, evaluating the quality, merit or development of argumentation with a unique lens.

Despite these limitations and considerations for future research, the synthesis of intellectual humility with argumentation produced various pertinent inferences and points of reflection concerning the teaching and learning of argumentation within science education. Future studies can focus on teachers' as well as students' engagement in intellectual humility to contribute to existing literature on teachers' argumentation (e.g. Martín-Gómez and Erduran 2018; Ozdem et al. 2017). Considering the increasing prominence of argumentation in science education internationally, as evidenced by key curriculum standards such as the *Next Generation Science Standards in the USA* (NGSS Lead

States 2013), the study reported in the paper provides some insight into how students engage in argumentation at the interface of the evolution versus creationism debate can go beyond the tensions identified in the literature (BouJaoude et al. 2011). Finally, the paper provides an additional criterion for evaluating the quality of argumentation within the conceptual synthesis of intellectual humility with argumentation.

## Disclosure statement

No potential conflict of interest was reported by the author(s).

## Funding

Oxford Argumentation in Religion and Science Project was funded by the Templeton World Charity Foundation (Grant Number: TWCF0238) and was led by Sibel Erduran as the Principal Investigator. We thank Liam Guilfoyle, Jessica Chan and Wonyong Park for their contributions to data collection. We are grateful to the pupils and teachers who have participated in the project.

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