E·S·P·Today
JOURNAL OF ENGLISH FOR SPECIFIC PURPOSES AT TERTIARY LEVEL

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CONSTRUCTING AN ARGUMENT IN ACADEMIC WRITING ACROSS DISCIPLINES

Abstract

Argument construction is an important aspect of academic writing. Although literature presents a number of theoretical and pedagogical models of argument, research is lacking into authentic argument construction in expert writing. Moreover, it is not clear how disciplinary variation affects the construction of argument. Therefore, this paper analyses argument in four disciplines – philosophy, literature, chemistry, and computational science. The results show a degree of variation among disciplines. Three models of argument have been found, called here *premise-based argument* (found in philosophy and literature), *hypothesis-based argument* (found in computational science and to a lesser degree in literature) and *exposition-based argument* (in chemistry). These models differ from the theoretical and/or pedagogical models proposed in the literature, suggesting that EAP students might be asked to produce arguments very different from arguments encountered in the reading in their discipline. Given the disciplinary variation observed, the paper supports applying English for Specific Academic Purposes (ESAP) as well as English for General Academic Purposes (EGAP) approach to teaching argument construction.

Key words

argument, argumentation, academic writing, English for Specific Academic Purposes (ESAP), English for General Academic Purposes (EGAP).

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1. INTRODUCTION

Learning to construct an argument in writing is an important skill that EAP students need to master. For instance, Wolfe (2011) found that the majority (59%) of undergraduate writing assignments across various disciplines in a US university require students to develop an argument. For this reason, EAP programmes frequently focus on writing argumentative essays, a genre that many students find challenging (e.g. Bacha, 2010; Stapleton & Wu, 2015). Argument construction skills, however, apply not only to taught students but also to researchers: for instance, the British Researcher Development Framework (QAA, 2011) considers argument construction as one of the intellectual abilities a researcher needs to develop. It follows that argument can be found in manifold and diverse academic genres, not only in argumentative essays.

Regarding argument conceptualisations, a number of theoretical and/or pedagogical models of argument have been proposed (e.g. Britt et al., 2007; Fahnestock & Secor, 1988; Toulmin, 1958/2003; Wingate, 2012; Wolfe, Britt, & Butler, 2009). It is not clear, however, to what extent these models reflect authentic argumentation used by expert writers. Moreover, these models, in their attempt to be universally applicable, fail to recognise variation across disciplines. While conventional ways of argument construction will be familiar to subject experts, there is little on the topic in EAP literature.

This paper, therefore, aims to find patterns of structure of argument in disciplines which differ epistemologically. It should be noted that our paper does not claim to equip EAP teachers with specialist disciplinary knowledge of argument; rather we hope to make EAP teachers more informed of various forms argument can take. To this end, we analyse argument in a small sample of expert writing in four disciplines, namely research articles in philosophy, literature, chemistry, and computational science. The research questions we address are the following:

1. In what ways does the structure of argument vary across the four selected disciplines?
2. What elements can be considered as constituting argument in the four selected disciplines?

The rest of the paper is organised as follows: Section 2 reviews relevant literature on argument. Data collection and analysis are described in Section 3. Section 4 presents and discusses findings and pedagogical implications. Section 5 draws conclusions.

2. MODELS OF ARGUMENT

Following Andrews (2005), we distinguish between argumentation as a process and argument as an outcome. This paper focuses on argument only. As a starting point,

we take Lee and Deakin's (2016: 21) definition of argument as "developing and defending a position; appealing to a reader's logic and emotion; anticipating and countering a reader's reactions; and aligning with or distancing oneself from cited sources." Their definition thus involves the writer's own position set within the context of and based on previous research. Equally important is that the writer acknowledges and refutes opposing views that the reader might have. By taking Lee and Deakin's (2016) definition as the working definition of argument in this paper, our understanding of argument here is broader than arguing for or against a statement presented in an essay question, as done in much pedagogical literature (e.g. de Chazal & Rogers, 2013: 143).

Several theoretical models of argument have been proposed (see e.g. Andrews, 2005 for an overview of four models). The best known one is Toulmin's (1958/2003) model from classical rhetoric, which consists of three essential and three optional elements. The essential elements are claim, ground and warrant. The claim is the central proposition of the writer backed by the ground, or evidence. The warrant is the relationship between the claim and the ground. The optional elements, namely backing, qualifier and rebuttal, serve to make the argument more precise. The backing provides further support for the warrant. The qualifier tones the claim down by acknowledging the circumstances under which the claim might not be true. Finally, the rebuttal is a view that is contrary to the claim, and it serves to avoid bias. Karbach (1987: 85) illustrates Toulmin's model of argument with the following example. The claim is that *a 15% service charge should be added to patrons' checks in lieu of tipping*, toned down by qualifiers *so* and *maybe*. The claim is based on the grounds that *waitresses who make a dependable wage will be less likely to leave present employment*. The warrant that links the claim and the grounds is *because a high turnover of employees reflects unfavorably on profits* further supported by the backing *since paperwork and training in hiring new employees are time-consuming and costly*. Finally, the rebuttal is *unless waitresses' reactions to the new policy result in poor service*. It must be noted, however, that the term 'warrant' could be interpreted differently. For example, from a philosophical perspective, warrant may take on different meanings, depending on the model of justificatory reasoning required according to the epistemological role of normative practices within a particular discipline (Weinstein, 1992 as cited in Siegel, 1997).

Although Karbach (1987) reports a successful application of Toulmin's model in her composition classes, others remain sceptical in terms of pedagogical usefulness of the model. For instance, Andrews (2005) considers Toulmin's model useful for a theoretical analysis of an existing argument but not for pedagogical application that results in the construction of a new argument, because it does not allow variation and because it is difficult to distinguish between the warrant and the backing. Another criticism comes from Stapleton and Wu (2015), who point out that the quality of the argument depends on the quality of the grounds, which is not subject to scrutiny in Toulmin's model. Therefore, they conclude that the model focuses merely on "the surface structure, or the shell of the argument" (Stapleton &

Wu, 2015: 12). Finally, Wingate (2012) points out the model is difficult to apply at the macro level rather than the micro level of individual claims.

Another model, based on types of reasoning, is that of Fahnestock and Secor (1988). They propose several types of stasis, namely fact (e.g. *To what extent is X used?*), definition (e.g. *What is X?*), cause and effect (e.g. *What is the effect of X?*), evaluation (e.g. *Is X good or bad?*), and policy or procedure (e.g. *What should be done about X?*). These stases appear to be different forms that a central claim of an argument may take. Other elements, most notably evidence (Toulmin's 1958/2003 grounds), however, are missing in Fahnestock and Secor's (1988) model. As such, their model is incomplete and not suitable for pedagogical application on its own.

In yet another model, Britt et al. (2007) consider argument to have three elements – theme, predicate, and side. The theme is the topic of an argument. The side is the writer's position on the topic, that is, whether the writer is arguing for or against. Finally, the predicate is a proposition on the topic expressing the writer's side. An example is *Banning cell phones while driving* (theme) *is unnecessary* (predicate; side: against). Britt et al.'s (2007) model, however, suffers from the same limitations as Fahnestock and Secor's (1988) model above, namely that it only concerns a claim, but not other parts of argument. What follows, then, is that the term argument has been used variously in the literature – to refer to a claim only, i.e. to the expression of the writer's position (micro level), or to refer to the construction of argument that includes not only a claim but also support for it (macro level in Wingate, 2012). In this paper, we use the term argument with the latter meaning.

In a similar vein, Wingate (2012) presents a model of argument at the macro level and distinguishes three elements of argument: selection of relevant evidence, the writer's position, and the presentation of the position in a series of logically ordered propositions. She points out that students' ability to construct strong arguments depends on their subject knowledge, the ability to write logically and coherently, and the ability to develop their own voice and stance. Wingate's model has certain advantages compared to the other models discussed. First, in contrast to Fahnestock and Secor (1988) and Britt et al. (2007), it incorporates elements beyond a claim by including evidence, similarly to Toulmin (1958/2003). Unlike Toulmin, however, Wingate (2012) highlights the quality of evidence based on its relevance and relation to the writer's subject knowledge. Second, unlike the other models, Wingate's acknowledges that an overall argument is built up from several related individual claims. Nonetheless, Wingate does not illustrate her model with textual examples – which probably results from approaching the construction of argument at the macro level only. In this paper, therefore, we attempt to explore argument at the macro level while providing illustrative examples from our data at the micro level.

All of the above models, however, suffer from the same shortcoming, namely that they do not refute alternative positions. While Toulmin's (1958/2003) model does incorporate a rebuttal, it is understood as conditions under which the claim

does not apply, or "circumstances in which the general authority of the warrant would have to be set aside", in Toulmin's (2003: 94) words. As such, Toulmin's rebuttal limits the writer's argument rather than refutes an opposing argument the reader might have (cf. Lee & Deakin's 2016 definition of argument above). Yet, as Wolfe et al. (2009) show, such a failure to acknowledge and refute an opposing view, which the authors term *myside bias*, is a common problem of unskilled writers. It follows that to help students write stronger arguments, a pedagogical model should incorporate an acknowledgement of a counterargument and its rebuttal, as argued by Liu and Stapleton (2014). Therefore, Wolfe et al.'s (2009) model, developed for pedagogical application, has three elements: a claim composed of a topic and a predicate, supporting reasons for the claim, and presentation and rebuttal of common counterarguments. Similarly, Chandrasegaran's (2008) pedagogical model includes assertion of one's position, support for the position, and addressing counterargument. The anticipation of the reader's opposing view follows Bakhtin's (1981) approach, which considers argument to be interactive, particularly when referring to contestation of knowledge. Similarly, Ivanič and Camps (2001: 5) emphasise the writing process as "profoundly social and interpersonal".

While we acknowledge the relevance of other factors, such as coherence and writer's stance and voice from Wingate (2012), we do not focus on these in this paper for the following reasons. On the one hand, coherence is a characteristic of good writing in general. On the other hand, stance and voice serve to fine-tune the position and claims but are not in themselves propositions, and as such they do not build the argument directly.

While much research has been done into stance and voice (e.g. Hyland & Sancho Guinda, 2012), especially in terms of metadiscourse (e.g. Hyland, 2005), including metadiscourse in argumentative essays (Lee & Deakin, 2016), research is largely absent into how expert writers present arguments at the macro level. One exception is Barton (1995), who analyses essays in the Chronicle of Higher Education written by academics. She finds that claims are typically presented as the first sentence of a paragraph and counterarguments are typically presented as the second sentence of another paragraph and introduced with a transition marker with a contrastive meaning, e.g. *but*, *however*, and *on the contrary*. This is consistent with Mur Dueñas (2009), who concludes that argument in English is typically developed as an antithesis. The presentation of argument in expert writing, we argue, has important pedagogical implications: when EAP students are asked to construct arguments in their own writing, what examples of argument can they see in their reading?

A related issue is disciplinary differences in the presentation of argument. Peacock (2010), for instance, found that texts in hard sciences, namely in chemistry and materials science, are more descriptive and narrative and less argumentative than texts in soft sciences. Basturkmen (2012) found two types of argumentation in discussion sections of research articles in dentistry, namely providing alternative explanations for the observed findings (also noted in language teaching by

Basturkmen, 2009), and comparison to previous literature in order to highlight the importance of the given study. Wolfe (2011) found that university students are required to produce argumentative writing in engineering and fine arts more often than in natural sciences, arts and humanities. These findings suggest that the construction of argument might vary across disciplines and raise questions of the relative importance of teaching argument to EAP students from a variety of disciplines.

3. METHODS

To enable us to gain insights into argument across disciplines, our sample includes journals from 'hard' disciplines, specifically chemistry and computational science, and from those which are considered 'soft' disciplines, specifically philosophy and literature. The choice of disciplines was based on our personal and research interests. It is necessary to note that part of our sample may be considered as representing the disciplines in a broad sense (for example, computational science rather than sub-disciplines such as artificial intelligence) since we wish to make suggestions for the EAP classroom. Even in the English for Specific Purposes (ESP) classroom, it is rare to find such specific branches of disciplines; hence our choice of labelling these two disciplinary samples in a broader sense. We used a journal database, namely Journal Citation Reports, to select high impact journals within each field. The journals we selected were purposefully not interdisciplinary since we wanted to use clear disciplinary fields as a starting point for this research, in order to be able to easily categorise argument tendencies within each discipline. The journals we selected are as follows:

Chemistry: *Chem*
Computational Science: *IEEE Transactions on Neural Networks and Learning Systems*
Literature: *Language and Literature*
Philosophy: *Educational Philosophy and Theory*

We chose a sample of five articles per journal (see Appendix), which dated from 2019 and 2020. The nature of the analysis was exploratory, interpretative and qualitative, with a strong pedagogical purpose. We read the articles in their entirety and conducted a discourse analysis manually rather than by using corpus methods. In this way, we consider argument at a macro rhetorical level, as overarching and encompassing, potentially, all sections of the article under scrutiny, so its 'elements' might be present in any article section. Each sub-sample within a particular discipline was analysed by one of the authors (amounting to two disciplines per author), so in this sense, there was no inter-rater agreement. However, to make sure

that we aligned with each other in terms of identification of argument, we discussed each model of argument, as illustrated in one article from each discipline.

It is important to note that our methods differ from a genre analysis. Our examination of texts for elements of argument is firstly in contrast to a Swalesian (1990) genre analysis, which examines moves in a particular section or genre in an exhaustive fashion. Moves and steps indicate rhetorical stages within each section, whereas we have identified overall argument and those sentences which advance argument, also identifiable through the author's voice. We therefore choose the term 'element' in order to distinguish from moves and steps in sections, contra Chandrasegaran (2008). In addition, unlike a Systemic Functional Linguistics (SFL) approach (e.g. Halliday, 1978; Martin & Rose, 2007) in which genre analysis is seen through an ideational, interpersonal and textual lens, we do not consider argument as a genre (Pessoa, Mitchell, & Miller, 2017). We analysed argument exclusively in the research article genre for this study. In further contrast to both Swalesian and SFL genre analysis, our interpretation encompassed the noticing of salient sentences and structures which advance argument, rather than a commitment to labelling each sentence as a move or step, which the formerly mentioned genre analysis frameworks tend to abide by.

Within each article, we first identified elements of argument throughout the text. As elements of argument we consider (parts of) sentences which contribute to argument (as defined by Lee & Deakin, 2016; see Section 2) in a text. Our identification of elements of argument is thus based purely on rhetorical criteria, and no formal criteria (i.e. no pre-determined linguistic structures) were used. This procedure was similar to Barton's (1995) identification of *claims* and *counterclaims*, yet our analysis was broader, as it will be seen below, as we used Lee and Deakin's (2016) definition quoted above. We then analysed the function of individual elements within argument, to identify emergent patterns within each discipline area, allowing for the production of models based on these sentence extracts.

4. RESULTS AND DISCUSSION

Rather than finding one and the same model of argument across all our texts, we have found three different patterns in relation to argument, which we call *premise-based argument*, *hypothesis-based argument*, and *exposition-based argument*. We will now discuss each of these patterns in turn.

4.1. Premise-based argument

The first pattern we have identified is a type of argumentation that presents and supports a premise, which we call premise-based argument. This type of argument is found in most papers in both soft disciplines in the sample (N = 9), i.e. in all the

five articles in philosophy and in four articles in literature. Four elements have been identified in premise-based argument in the sample (see Figure 1).

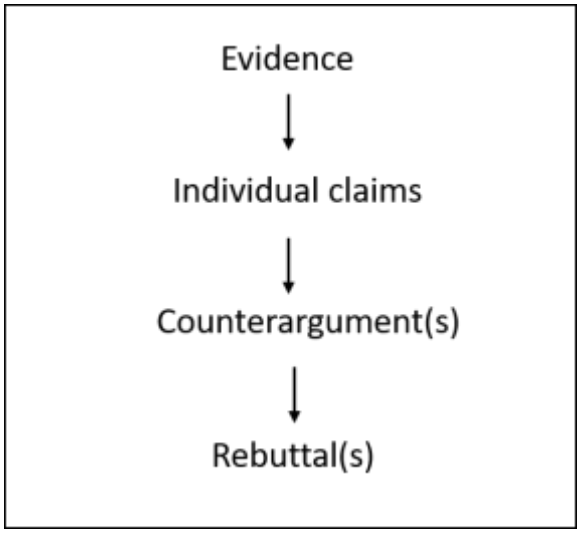

Figure 1. Premise-based argument

The writer's premise rests on individual claims, as illustrated in example (1).

> (1) For this reason we argue that, despite being rarely used in stylistics, an approach to metaphor processing that accounts for intention is well suited to stylistic analyses as both are concerned at some level with choice. (Literature 5)

To present claims, writers might use the language of cause and effect, e.g. *for this reason* (example 1) and *if … then* (example 2), in order to guide the reader along the writer's logical reasoning and thus to convince the reader of the presented argument.

> (2) **If** it is clear to me that different stylistic dimensions of a poem must have a significant role to play in its cinematic realisation, **then** what exactly should this be? … It would **not then** be logical to use linguistic evidence from the poem to provide support for images and sounds which have no traces in that poem. (Literature 4)

The individual claims are supported by evidence, another element of argument. Interestingly, evidence often precedes rather than follows claims (3). In other words, claims are presented inductively.

> (3) Given the three examples examined above, and the main ideas drawn from their analysis, it can be stated that, in order for these flashbacks to be successfully understood by film viewers, they must be constructed on the basis of viewers' natural communicative abilities. (Literature 1)

The last two elements of argument are counterarguments and rebuttals. Counterarguments concern individual claims and they are promptly followed by a rebuttal:

> (4) **Some might argue that** both ecopedagogies and post-truthism problematize 'official' truths, but the goal for authentic truth is absent within post-truthism. Post-truthist pedagogies are rooted in false 'knowledges' constructed for deception to follow selected ideologies. **In contrast,** eco-pedagogical work has the goal of socio-environmental justice and planetary wellbeing; **however**, teaching through falsities, towards this goal, counters the Freirean foundations of eco-pedagogies. (Philosophy 2)

To present and rebut counterarguments, writers typically use not only the language of contrast, e.g. *in contrast*, *on the contrary*, *however* (4, 5), as shown previously by Barton (1995, see Section 2), but also the language of concession, e.g. *some might argue*, *having said that*, and negation, e.g. *are not sufficient*, *this is not the case*, *should not be seen* as in the following example:

> (5) **Having said that**, those natural communicative abilities **are not sufficient** by themselves in terms of film comprehension. … **But this is not the case with** a flashback scene... **However**, blending should **not** be seen as the last ingredient or the final touch in the recipe, like the icing on the cake. **On the contrary**... (Literature 1)

Our findings largely agree with Harrell's (2008) model of argument in philosophy education. Harrell considers argument to be composed of a conclusion supported by sub-arguments (our *claims*) and premises (our *evidence*), possibly supplied with objections and replies (our *counterarguments* and *rebuttals*, respectively). Our model does not include a conclusion as we consider this merely a succinct restatement of the writer's claims in the introduction and/or conclusion sections. The elements of argument in Harrell's model are linked by inferences signalled by cause and effect language (e.g. *since*, *given that*, *thus*, *hence*), and we have found similar use of language to present claims (see above). Harrell's inferences are reminiscent of Toulmin's warrant, which is also expressed with cause and effect language, such as *since* and *because* (Karbach, 1987; Toulmin, 1958/2003). This language of cause and effect expresses causal relations, which are not the same as epistemic support, which is derived on the basis of disciplinary shared knowledge and accepted norms (Siegel, 1997). Following Siegel, acknowledging this difference between causality and epistemology has led us not to include the language of cause and effect in our model of premise-based argument, contra Harell (2008) and Toulmin (1953/2003).

In contrast, our model of argument only partially agrees with the pedagogical model of argument developed for literature students by Lewis and Ferretti (2009), who advocate a model called THE READER. It consists of a THEsis, supported with REAsons and Details from analysed literary texts. These are followed by an Explanation of relations between Details, REAsons and THEsis. REAsons, and Details

in THE READER model are similar to the claims and evidence, respectively, in our model. The Explanation seems to be similar to Toulmin's (1958/2003) warrant and Harrell's (2008) inferences discussed above, yet Lewis and Ferretti (2009) unfortunately do not provide textual examples for their model. The final element of the model in Lewis and Ferretti is a Review of the key points presented in a conclusion section. As the Review and the THEsis are essentially a restatement of the writer's position and claims introduced elsewhere, similarly to Harrell's (2008) conclusion, we do not consider them argument elements of their own. What is lacking in THE READER model is an acknowledgement of an opposing view, realised as counterarguments and rebuttals in our model. THE READER model thus suffers from what Wolfe et al. (2009) call 'myside bias', which questions the pedagogical robustness of the model.

4.2. Hypothesis-based argument

This second category of pattern was found in analysis of elements of argument almost exclusively in the computational science sample (N=5); however, there is also an example included from the literature sample (N=1). Within the main body sections exclusively, we observe four typical elements which are experimental in nature and built in ways which test a hypothesis in computational science, with the literature sample discussed below (see Figure 2).

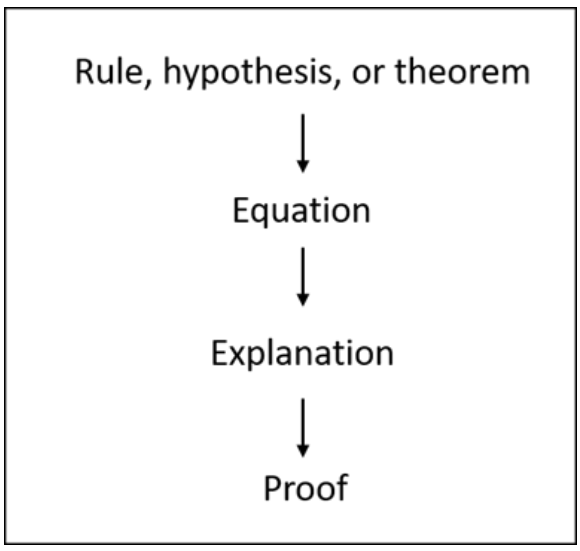

Figure 2. Hypothesis-based argument

The first element typically establishes the introduction of a rule, hypothesis or theorem (example 6).

> (6) In this section, we will utilize the definition of uniform distributed stability proposed in Section III to study the generalization risk bounds of stable distributed learning algorithms. We propose the following Theorem 1 to show the relation between the generalization distributed and empirical distributed/leave-one-computer-out risks.
> Theorem 1: Let n be the size of samples and m…..be the amount of local working computers. (Computational science 5)

Subsequently, the rule, hypothesis or theorem is displayed as an equation as the second element:

> (7) Theorem 1: If the following coercivity conditions: μ>γ 2 2 , ν>γ 2 1 , k > 0 (6) hold true then functional , defined by 5, admits a minimum on the set K = { q ∈ H2 ((0, T), Rn) | q(0) = q0 , q˙(0) = q1 } (Computational science 1)

As a third element, this hypothesis is promptly followed by an explanation of the theorem, subsequently highlighting implications:

> (8) Here, index J is added into ˆ fJ;d(xd|Wc) to emphasize its dependence on the cutoff. Thus, the complexity of the classifier (1), (4), (10) based on the orthogonal series remains linear—O(DRJ)—and is asymptotically equivalent to the original PNN [16]. (Computational science 4)

In general, the fourth element posits an evaluation including a proof remark, which sums up an objective observation (9, 10). Often the proof is labelled explicitly as in example 9:

> (9) Proof: The correctness of the TWNN's algorithm will be validated using inductive arguments. It is apparent that, at any iteration, the TWNN has divided the neurons into two sets: Va and Vn. (Computational science 2)

Example 10 also shows evaluation (hence proof) typical of the fourth element, but not explicitly labelled:

> (10) As we can promptly see, the special choice of the Lagrangian also yields the friction term 2˙ q(t) of the system. (Computational science 1)

As can be seen in both examples, there is a lack of hedging, and this trend is common across the sample. Furthermore, clear self-mention and endophoric markers (Hyland, 2005) are used within articles in order to build knowledge explicitly, particularly in the first element of argument in our model, an example of which is shown here:

> (11) In this section, **we** will utilize the definition of uniform distributed stability **proposed in Section III** to study the generalization risk bounds of stable distributed learning algorithms. (Computational science 5)

In contrast with premise-based argument, we observed a more deductive approach to reasoning, as part of the macro argument structure within this sample. This can be seen through the introduction of a hypothesis which is confirmed through the proof that follows. Furthermore, hypothesis-based argument appears to allow the writer(s) to be illustrative of facts in order to claim scientific objectivity: seeking causal explanations, which are displayed through a series of equations where hedging language is noticeably lacking. This is in stark contrast to the premise-based argument seen in Section 4.1, which can be much more subjective, persuasive and open to interpretation.

This model of argument therefore differs markedly from that which is premise-based due to an experimental approach being at its core, as opposed to a persuasive and subjective one. There is a strong pattern of knowledge building through argument, with each subsection appearing to build on the evidence provided, as well as there being a linguistically explicit link to the former hypothesis-based argument on the topic.

To the best of our knowledge, no discoursal account of elements of argument in computational science has been published. Bench-Capon and Dunne (2007), however, report that argument in artificial intelligence is based on mathematical reasoning and proof (see the equation identified as our second element and proof identified in the fourth element), and as such is objective and definite, in contrast to persuasive subjective argument in everyday contexts. This confirms the differences we have found between hypothesis-based argument in computational science and premise-based argument in philosophy and literature studies.

Hypothesis-based argument also occurs in one paper in literature, namely Literature 3 paper.[1] The first element of argument is the presentation of hypotheses (12):

> (12) The current study … tests two hypotheses: (1) that responses to the ST can differ from responses to the TT as a consequence of the alterations that the text inevitably goes through during translation and (2) that responses to different TTs of the same ST can vary as a consequence of the diverging translation strategies adopted by and/or alterations introduced by the translators. (Literature 3)

This is followed by the presentation of data, namely results of a participant survey, as the second element, not illustrated here for its length. The third element is the rejection or confirmation of the hypotheses (13) subsequently followed by

[1] Given that our sample contains only one paper from literature, we cannot generalise on hypothesis-based argument in literature and we do not present a respective figure.

discussion, explanation and examination of implications (14). This fourth element is typically hedged, e.g. *may* in the example below, *these results indicate*, *this suggests.*

> (13) Based on the results described above, we can now confirm or reject the hypotheses formulated in the 'Methods' section, as shown in Table 2. (Literature 3)

> (14) This **may** be due to the 'marked-ness' of lexical choices made by the translators... (Literature 3)

Although both the model of argument in computational science and the one in the Literature 3 paper aim to test a hypothesis or prove a theorem, they markedly differ in presentation. First, while the individual hypotheses in computational science appear to be built on preceding hypotheses, the hypotheses in Literature 3 seem to be less dependent on each other. Second, while the argument in computational science aims to prove theorems (rather than reject them), the authors of Literature 3 test their hypotheses in order to confirm or reject them. Finally, in contrast to literature, computational science tends not to rely on hedging, which suggests computational scientists' greater commitment to their findings. In sum, the results indicate that there are considerable differences in hypothesis-based argument in different disciplines, which are related to differences in epistemologies. Nevertheless, since our sample contains only one paper with hypothesis-based argument from a discipline other than computational science, further research is needed to confirm these differences.

4.3. Exposition-based argument

Exposition-based argument is found in the sample of chemistry articles only (N=5). It rests on the objective presentation of observed facts in the spirit of scientific positivism (see e.g. Caldwell, 1980):

> (15) The data summarized above provide compelling evidence that alkylzirconocenes exploit an unrecognized opportunity in the field of visible-light-induced nickel-cata-lyzed cross-coupling reactions. (Chemistry 1)

Figure 3. Exposition-based argument

Normally, this argument has four elements (see Figure 3). The first one involves purpose, or justification of the research procedure typically expressed in a sentence-initial non-finite clause with an infinitive of purpose, e.g. *To clarify the above speculation* in example (16). This is followed by the second element of the description of the research process. The third, most elaborated element, includes the statement of findings. The final element attempts to explain the findings and typically uses hedging as necessary, e.g. *Such effect is reasonably attributed to* in example (16). As the argument in chemistry proceeds from specific observations in the research findings to generalisations in the explanations of the findings, exposition-based argument is inductive, as premise-based argument.

> (16) To clarify the above speculation, **[***to- infinitive for purpose***]** we calculated the CO adsorption free energy on the two adsorption sites (see Figure S28). **[***description of research process***]** The results show that **[***statement of findings***]** the CO adsorption strength on the interfacial Rh atoms (Rh-O-Mn on RhMn@S-1) is indeed weakened with the adsorption DG of 1.65 eV in comparison with Rh atoms in Rh-rich site (bare Rh surface, 2.19 eV). Therefore, the Rh-rich sites only show methane selectivity whereas the interfacial site can exhibit high ethanol selectivity. Such effect is reasonably attributed to the contribution of Rh-O-Mn interfaces. **[***explanation of research findings***]** (Chemistry 3)

Unlike argument in dentistry (Basturkmen, 2012), chemistry does not tend to provide more than one explanation for each finding. However, the writers occasionally point out unexpected findings, using attitude markers such as *surprisingly*:

> (17) Somewhat surprisingly, after washing, the d-spacings reduce significantly and range between 13.5–21 A° depending on the solvent used (column 3, Table 1). The most probable cause for this reduction is... (Chemistry 2)

The pattern of argument in chemistry is repeated several times across each paper: in other words, the pattern of purpose – description of research process – statement of findings – explanation is cyclical.

The four-element model of argument we have identified in the chemistry research articles differs from the model of argument for chemistry students advocated in Sampson and Walker (2012). Their model, based on Toulmin (1958/2003, see Section 2) rather than on empirical text-based research, is composed of claim, or an answer to a research question; evidence, or analysis and interpretation of data (Toulmin's ground); and rationale, or justification of inclusion and relevance of evidence (Toulmin's warrant). Several differences can be seen between our model and that of Sampson and Walker (2012). First, an explicit claim is absent in our model – instead, facts speak for themselves. This is more reminiscent of the objective reasoning in computational science than of the persuasive argumentation in premise-based argument found more commonly in the philosophy and literature samples. Second, instead of a claim, our model includes justification of research procedures that the writers selected. Third, rather than providing an explanation of the relationship between a claim and evidence, our model contains an explanation of findings, through which writers show their contribution to the discipline. The differences between the two models may be explained by the different roles student and expert writers play in academia: while students are merely expected to show their understanding of the discipline (excluding dissertations and other research-based genres), expert writers are expected to justify research decisions they had authority to make, and to show original contribution to the discipline. It follows that further research is needed to compare the structure of argument in expert and student writing, and to investigate the impact of power relations on respective argument structures.

4.4. Summary and pedagogical implications

In sum, our findings show that the structure of argument varies across disciplines, according to epistemological foundations. Following our exploratory approach to identifying ways in which argument is used in each selected discipline sample (philosophy, literature, chemistry and computational science), it is clear that the three argument models observed (premise-based, hypothesis-based and exposition-based) do not map neatly onto aforementioned pedagogical models of argument, such as from Toulmin (1958/2003), Wingate (2012) and Wolfe (2011), despite their prevalence and weight: Toulmin's (1958/2003) being an accepted classic rhetorical argument structure and Wingate's (2012) and Wolfe's (2011)

significant and accepted pedagogical models in EAP. As explored in previous sections, there exist some discipline-specific pedagogical models, with Harrell's (2008) model of argument in philosophy education being the most similar to our findings in this sample. This can be observed particularly in the premise-based argument rather than the hypothesis-based and exposition-based argument, the latter two of which engender argument in an experimental manner, through displaying a justification or hypothesis, and then allowing the results to speak for themselves.

It is striking that conceptual or pedagogical argument models are not necessarily in the interest of students. This is due to the fact that they would not be encountering, or indeed producing these later in their studies, when comparing them with expert writing in their future fields. Pedagogically speaking, it should be observed that we do not expect students to produce expert genres. Similarly, we do not expect EAP teachers to teach disciplinary argumentation, as this would require team-teaching with subject specialists. However, we believe that supporting the building of pedagogical models to scaffold students towards writing in their own discipline, be that more argumentative or more experimental, is more desirable than trying to work with a more general 'one size fits all' model. In addition to these contrasts in models, it should be noted that some argument structures are presented inductively (a strong trend within the premise-based and exposition-based models) and some deductively (as in the hypothesis-based model). This recognition challenges the assumption that a claim should be presented before the evidence is given: clearly, the disciplinary orientations and epistemology influence the way argument is presented in terms of logic in writing. Therefore, we would claim that the common pedagogical model of paragraph that suggests a paragraph should start with a general topic sentence presenting a claim, followed by supporting sentences presenting evidence deductively, is a reductive perspective, depending on the discipline. It is nevertheless noticeable that, despite some similarities, there is not a pedagogical model already established which is akin to our findings for hypothesis-based and exposition-based argument elements.

Indeed, this research goes some way to supporting the ESAP approach in EAP teaching. With ESAP favouring the genres that students will go on to read and produce during their studies, an argument can be made to keep disciplines separate so that students are exposed to the particular areas of discourse relevant to their future field of study. For example, if students are going to produce lab reports, then it would be more desirable to scaffold students towards producing an argument appropriate for this genre. Teaching materials could include our hypothesis-based or exposition-based models described above, for example, depending on the discipline. We therefore posit that, while this would take some time and considerable re-writing of parts of ESAP courses, students should be given pedagogical models of argument which reflect and align more closely with their disciplines, as shown in the expert writing.

Nevertheless, as a result of our research into authentic expert writing, we would like to make some suggestions relating particularly to the teaching of argument on EGAP courses, which extend on Bodin-Galvez and Ding's (2019) observations and also attempt to move beyond the EGAP/ESAP debate. EGAP courses may often require students to produce an argumentative essay using pedagogical models previously discussed. However, following our research and uncovering of hypothesis-based elements of argument in our selected sample, we would suggest that teaching argument with the aim of producing an argumentative essay is somewhat restrictive and not necessarily of value for all of our students: in particular for those whose discipline relies on other models of argument as evidenced in the articles we analysed. Furthermore, computational science students would need to construct argument in a different way to chemistry students, showing that a division cannot be made simply between 'hard' and 'soft' disciplines. Although our models can be applied practically in an ESAP situation effectively, due to a direct disciplinary link, students can still benefit from some exposure to several argument patterns across disciplines. This would take the form of an engagement in interdisciplinarity in the classroom. This could be achieved through group work when exploring argument in the classroom, by engaging in an awareness-raising activity, for example. In doing this, the students can relate to it through the lens of their own discipline, and even work to compare and contrast the argument models presented. Interdisciplinarity could be a core consideration of EGAP courses and arguably a valuable one for students to engage with, in terms of socialisation into the academy, a place which is moving more and more to work across disciplines through cross-departmental and external collaboration.

In sum, it should be noted that EAP materials approaches differ somewhat to the findings in our sample. While this is not necessarily an issue, perhaps EAP practitioners could address the disparity in the classroom if appropriate.

5. CONCLUSION

In conclusion, by comparing and contrasting the instances of argument in selected discipline samples and theoretical and/or pedagogical conceptualisations of argument, we have found that the authentic expert writing samples do not, in fact, reflect these conceptualisations fully. The three models identified (premise-based, hypothesis-based and exposition-based) show clearly that the presentation of argument varies greatly by discipline and, to some extent, even within a single discipline (as found in literature). It remains to be decided, however, how far these features of expert writing should be reflected in pedagogical approaches to argument. It is important to note that we analysed discipline-specific texts from the point of view of subject non-specialists, as EAP teachers are typically expected to exploit texts in the classroom without necessarily having particular subject-specific expertise. Further, in order to inform EAP teachers and their chosen pedagogies, we

did not seek to provide generalisable, conclusive results but rather textual analysis of a select variety of sources to inform the teaching and application of argument.

Limitations of this study include the limited range of disciplines explored and the fact that a small sample of expert writing was examined in an exploratory manner and thus, tendencies were found; but a larger sample is needed to check to what extent they apply. This research needs to be continued in a number of ways: namely by including a wider selection of disciplines, as well as the inclusion of student genres that have been produced for both Master's and Bachelor's degrees across disciplines. By examining these student genres, pedagogical considerations could be expanded further and thus potentially result in a more in-depth discussion and application of argument in academic writing on EAP courses, whether informed by EGAP or ESAP approaches.

[Paper submitted 3 Jun 2021]
[Revised version received 14 Oct 2021]
[Revised version accepted for publication 15 Nov 2021]

References

Andrews, R. (2005). Models of argumentation in educational discourse. *Text – Interdisciplinary Journal for the Study of Discourse*, *25*(1), 107-127. https://doi.org/10.1515/text.2005.25.1.107

Bacha, N. N. (2010). Teaching the academic argument in a university EFL environment. *Journal of English for Academic Purposes*, *9*(3), 229-241. https://doi.org/10.1016/j.jeap.2010.05.001

Bakhtin, M. M. (1981). *The dialogic imagination: Four essays* (C. Emerson & M. Holquist, Trans.). University of Texas Press.

Barton, E. L. (1995). Contrastive and non-contrastive connectives: Metadiscourse functions in argumentation. *Written Communication*, *12*(2), 219-239. https://doi.org/10.1177/0741088395012002003

Basturkmen, H. (2009). Commenting on results in published research articles and masters dissertations in Language Teaching. *Journal of English for Academic Purposes*, *8*(4), 241-251. https://doi.org/10.1016/j.jeap.2009.07.001

Basturkmen, H. (2012). A genre-based investigation of discussion sections of research articles in dentistry and disciplinary variation. *Journal of English for Academic Purposes*, *11*(2), 134-144. https://doi.org/10.1016/j.jeap.2011.10.004

Bench-Capon, T. J. M., & Dunne, P. E. (2007). Argumentation in artificial intelligence. *Artificial Intelligence*, *171*(10-15), 619-641. https://doi.org/10.1016/j.artint.2007.05.001

Bodin-Galvez, J., & Ding, A. (2019). Interdisciplinary EAP: Moving beyond aporetic English for general academic purposes. *The Language Scholar*, *4*, 78-88.

Britt, M. A., Kurby, C. A., Dandotkar, S., & Wolfe, C. R. (2007). I agreed with what? Memory for simple argument claims. *Discourse Processes*, *45*(1), 52-84. https://doi.org/10.1080/01638530701739207

Caldwell, B. (1980). Positivist philosophy of science and the methodology of economics. *Journal of Economic Issues*, *14*(1), 53-76. https://doi.org/10.1080/00213624.1980.11503723

Chandrasegaran, A. (2008). NNS students' arguments in English: Observations in formal and informal contexts. *Journal of Second Language Writing*, *17*(4), 237-254. https://doi.org/10.1016/j.jslw.2008.04.003

de Chazal, E., & Rogers, L. (2013). *Oxford EAP: Intermediate*. Oxford University Press.

Fahnestock, J., & Secor, M. (1988). The stases in scientific and literary argument. *Written communication*, *5*(4), 427-443. https://doi.org/10.1177/0741088388005004002

Halliday, M. A. K. (1978). *Language as social semiotic: The social interpretation of language and meaning*. Edward Arnold.

Harrell, M. (2008). No computer program required: Even pencil-and-paper argument mapping improves critical-thinking skills. *Teaching Philosophy*, *31*(4), 351-374. https://doi.org/10.5840/teachphil200831437

Hyland, K. (2005). *Metadiscourse: Exploring interaction in writing*. Continuum.

Hyland, K., & Sancho Guinda, C. (Eds.) (2012). *Stance and voice in written academic genres*. Palgrave Macmillan.

Ivanič, R., & Camps, D. (2001). I am how I sound: Voice as self-representation in L2 writing. *Journal of Second Language Writing*, *10*(1-2), 3-33. https://doi.org/10.1016/S1060-3743(01)00034-0

Karbach, J. (1987). Using Toulmin's model of argumentation. *Journal of Teaching Writing*, *6*(1), 81-92.

Lee, J. J., & Deakin, L. (2016). Interactions in L1 and L2 undergraduate student writing: Interactional metadiscourse in successful and less-successful argumentative essays. *Journal of Second Language Writing*, *33*, 21-34. https://doi.org/10.1016/j.jslw.2016.06.004

Lewis, W. E., & Ferretti, R. P. (2009). Defending interpretations of literary texts: The effects of topoi instruction on the literary arguments of high school students. *Reading & Writing Quarterly: Overcoming Learning Difficulties*, *25*(4), 250-270. https://doi.org/10.1080/10573560903120656

Liu, F., & Stapleton, P. (2014). Counterargumentation and the cultivation of critical thinking in argumentative writing: Investigating washback from a high-stakes test. *System*, *45*, 117-128. http://dx.doi.org/10.1016/j.system.2014.05.005

Martin, J. R., & Rose, D. (2007). *Working with discourse: Meaning beyond the clause* (2nd ed.). Continuum.

Mur Dueñas, P. (2009). Designing EAP materials based on intercultural corpus analyses: The case of logical markers in researh articles. *Revista de Lingüística y Lenguas Aplicadas*, *4*, 125-135. https://doi.org/10.4995/rlyla.2009.739

Peacock, M. (2010). Linking adverbials in research articles across eight disciplines. *Ibérica*, 20, 9-33.

Pessoa, S., Mitchell, T. D., & Miller, R. T. (2017). Emergent arguments: A functional approach to analyzing student challenges with the argument genre. *Journal of Second Language Writing*, *38*, 42-55. https://doi.org/10.1016/j.jslw.2017.10.013

QAA. (2011). The UK doctorate: A guide for current and prospective students [Online]. Retrieved July 16, 2020, from https://dera.ioe.ac.uk/10450/1/Doctorate_Guide.pdf

Sampson, V., & Walker, J. P. (2012). Argument-driven inquiry as a way to help undergraduate students write to learn by learning to write in chemistry. *International Journal of Science Education*, *34*(10), 1443-1485. https://doi.org/10.1080/09500693.2012.667581

Siegel, H. (1997). *Rationality redeemed?: Further dialogues on an educational ideal*. Routledge.

Stapleton, P., & Wu, Y. A. (2015). Assessing the quality of arguments in students' persuasive writing: A case study analyzing the relationship between surface structure and substance. *Journal of English for Academic Purposes*, *17*, 12-23. https://doi.org/10.1016/j.jeap.2014.11.006

Swales, J. (1990). *Genre analysis: English in academic and research settings*. Cambridge University Press.

Toulmin, S. E. (2003). *The uses of argument*. Cambridge University Press. (Original work published 1958)

Wingate, U. (2012). 'Argument!' helping students understand what essay writing is about. *Journal of English for Academic Purposes*, *11*(2), 145-154. https://doi.org/10.1016/j.jeap.2011.11.001

Wolfe, C. R. (2011). Argumentation across the curriculum. *Written Communication*, *28*(2), 193-219. https://doi.org/10.1177/0741088311399236

Wolfe, C. R., Britt, M. A., & Butler, J. A. (2009). Argumentation schema and the myside bias in written argumentation. *Written Communication*, *26*(2), 183-209. https://doi.org/10.1177/0741088309333019

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Appendix

The list of research articles analysed in the study

Chemistry

1. Gao, Y., Yang, C., Bai, S., Liu, X., Wu, Q., Wang, J., Jiang, C., & Qi, X. (2020). Visible-light-induced nickel-catalyzed cross-coupling with alkylzirconocenes from unactivated alkenes. *Chem*, *6*(3), 675-688. https://doi.org/10.1016/j.chempr.2019.12.010
2. Natu, V., Pai, R., Sokol, M., Carey, M., Kalra, V., & Barsoum, M. W. (2020). 2D Ti3C2Tz MXene synthesized by water-free etching of Ti3AlC2 in polar organic solvents. *Chem*, *6*(3), 616-630. https://doi.org/10.1016/j.chempr.2020.01.019
3. Wang, C., Zhang, J., Qin, G., Wang, L., Zuidema, E., Yang, Q., Dang, S., Yang, C., Xiao, J., Meng, X., Mesters, C., & Xiao, F.-S. (2020). Direct conversion of syngas to ethanol within zeolite crystals. *Chem*, *6*(3), 646-657. https://doi.org/10.1016/j.chempr.2019.12.007
4. Yang, Z., Guo, W., Mahurin, S. M., Wang, S., Chen, H., Cheng, L., Jie, K., Meyer, H. M., Jiang, D., Liu, G., Jin, W., Popovs, I., & Dai, S. (2020). Surpassing Robeson upper limit for CO2/N2 separation with fluorinated carbon molecular sieve membranes. *Chem*, *6*(3), 631-645. https://doi.org/10.1016/j.chempr.2019.12.006
5. Zhang, H., Wei, J., Zhang, X. G., Zhang, Y. J., Radjenovica, P. M., Wu, D. Y., Pan, F., Tian, Z.-Q., & Li, J. F. (2020). Plasmon-induced interfacial hot-electron transfer directly probed by Raman spectroscopy. *Chem*, *6*(3), 689-702. https://doi.org/10.1016/j.chempr.2019.12.015

Computational science

1. Betti, A., Gori, M., & Melacci, S. (2020). Cognitive action laws: The case of visual features. *IEEE Transactions on Neural Networks and Learning Systems*, *31*(3), 938-949. https://doi.org/10.1109/TNNLS.2019.2911174
2. Huang, W., & Gao, L. (2020). A time wave neural network framework for solving time-dependent project scheduling problems. *IEEE Transactions on Neural Networks and Learning Systems*, *31*(3), 274-283. https://doi.org/10.1109/TNNLS.2019.2900544
3. Mir, A. S., & Senroy, N. (2020). Self-tuning neural predictive control scheme for ultrabattery to emulate a virtual synchronous machine in autonomous power systems. *IEEE Transactions on Neural Networks and Learning Systems*, *31*(1), 136-147. https://doi.org/10.1109/TNNLS.2019.2899904
4. Savchenko, A. V. (2017). Probabilistic neural network with complex exponential activation functions in image recognition. *IEEE Transactions on Neural Networks and Learning Systems*, *31*(2), 651-660. https://doi.org/10.1109/TNNLS.2019.2908973
5. Wu, X., Zhang, J., & Wang, F. (2020). Stability-based generalization analysis of distributed learning algorithms for big data. *IEEE Transactions on Neural Networks and Learning Systems*, *31*(3), 801-812. https://doi.org/10.1109/TNNLS.2019.2910188

Literature

1. Gordejuela, A. (2019). Understanding retrospection: Blended joint attention and the multimodal construction of film flashbacks. *Language and Literature*, *28*(2), 115-132. https://doi.org/10.1177/0963947018815420
2. Groves, P. (2019). What, if anything, is a caesura? The ontology of the 'pause' in English heroic verse. *Language and Literature*, *28*(3), 263-279. https://doi.org/10.1177/0963947019854001
3. Mastropierro, L., & Conklin, K. (2019). Racism and dehumanisation in Heart of Darkness and its Italian translations: A reader response analysis. *Language and Literature*, *28*(4), 309-325. https://doi.org/10.1177/0963947019884450
4. O'Halloran, K. (2019). Filming a poem with a mobile phone and an intensive multiplicity: A creative pedagogy using stylistic analysis. *Language and Literature*, *28*(2), 133-158. https://doi.org/10.1177/0963947019828232
5. Price, H., & Wilson, J. (2019). Relevance theory and metaphor: An analysis of Tom Waits' 'Emotional Weather Report'. *Language and Literature*, *28*(1), 61-81. https://doi.org/10.1177/0963947019827074

Philosophy

1. Lindberg, S. (2020). Politics of digital learning: Thinking education with Bernard Stiegler. *Educational Philosophy and Theory*, *52*(4), 384-396. https://doi.org/10.1080/00131857.2019.1586531
2. Misiaszek, G. W. (2020). Countering post-truths through ecopedagogica literacies: Teaching to critically read 'development' and 'sustainable development'. *Educational Philosophy and Theory*, *52*(7), 747-758. https://doi.org/10.1080/00131857.2019.1680362
3. Rumianowska, A. (2020). Existential perspectives on education. *Educational Philosophy and Theory*, *52*(3), 261-269. https://doi.org/10.1080/00131857.2019.1633915
4. Tan, C. (2020). Beyond high-stakes exam: A neo-Confucian educational programme and its contemporary implications. *Educational Philosophy and Theory*, *52*(2), 137-148. https://doi.org/10.1080/00131857.2019.1605901
5. Williams, K. (2020). Work, play and language learning: Some implications for curriculum policy of Michael Oakeshott's philosophy of education. *Educational Philosophy and Theory*, *52*(5), 535-548. https://doi.org/10.1080/00131857.2019.1661240