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The representation of authorial and external voice in popular science book writing: a systemic functional linguistics approach

Ahmad Qassim Al Darwesh
College of Language Sciences, King Saud University, Riyadh, Saudi Arabia

Abstract

Purpose – Investigating the dialogistic resources within a multiplicity of popularized disciplines shall provide further insight into the interpersonal status of popular science book writing, which can be converted into transferrable writing skills to (post)graduate students in the Saudi educational context. This study aims to investigate the representation of authorial and external voice in popular science book writing (PSBW), exemplified by the lexico-grammatical resources that make up a proposition (i.e. the statement or the argument by which the author conveys their voice) within the writer's discourse.

Design/methodology/approach – The study uses a mixed-method approach to analyze how authorial and external voice is represented through the lexico-grammatical resources from a 93,078-word corpus extracted from various popular science book writings. The authorial and external voice is analyzed by the UAM CorpusTool3.

Findings – The results suggest significant differences between hard and soft disciplines, suggesting that popular science book writings employ discipline-specific lexico-grammatical phrases appropriate to projecting both the authorial voice and that of the external one. The scalability of projecting authorial and external voices seems to depend on whether the topic belongs to a hard or soft discipline. Hard science disciplines tend to insert their voices assertively, while more authors of soft science disciplines tend to treat the proposition in a spectrum of possibilities and give more affordances to the external voice with which they interact.

Research limitations/implications – Part of this analysis was to interpret the analyzed popular science corpus in the context of writing pedagogy and realize this interpretation within the most recently reported state on scientific writing in Saudi higher education. The literature presently shows a scarcity of English writing programs across Saudi universities. Not all programs have made it mundane to teach scientific writing to (post) graduate students from various scientific disciplines. Designing long-term scientific writing programs is of utmost importance to tackle the writing difficulties, as reported by researchers such as Al-Harbi (2021), who also train students to develop audience-oriented writing skills.

Practical implications – Integrating popular science text in scientific writing programs should be in the early stages and should not remain constant throughout the duration of the course because it is meant as a timely intervention to help (post)graduate students cross over from one genre to the scientific writing genre. It should ideally provide them with the ability to shift the orientation of their writing, accordingly, making them, for example, mindful of the targeted reader. Depending on the type of reader, whether an expert or otherwise, the student-constructed discourse should naturally align with the conventions and the discourse of the discipline.

Originality/value – In multiple reports within the literature, Saudi university students face writing difficulties not only at the undergraduate level but also at the (post)graduate level. Reportedly, they are marred by the lack of communicative, rhetorical function and discourse knowledge, along with linguistic issues in employing appropriate hedging or conjugating a justification for a claim while constructing an academic discourse. Therefore, this study brings an analysis of popular science books and interprets them in light of their viability as teaching materials, in the hope that they diversify the EAP content, ameliorate the writing deficiencies and elicit audience-oriented writing and thinking skills.

Keywords Higher education, Popular science genre, Systemic functional linguistics, Writing skills

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Introduction

Scientists convey scientific findings to the public to enhance science literacy. Popular science writing (PSW) uses accessible language to present these findings. Popular science books (PSBs) employ a conversational and dialogical tone for leisure reading and knowledge expansion. Readers may include science enthusiasts or experts exploring new fields. PSBs are the longest-established means of popularizing science, providing information in an entertaining tone rather than the technical language suited only for experts (Turney, 2008).

Because of their accessibility, the PSW genre has been used as treatment for writing instruction. PSW-based tasks have helped Swedish L1 students at the thesis stage with organizing the content (i.e. mediating the level of its abstraction), structuring aspects of the text, and the writing style (Pelger, 2018). Wu *et al*. (2018) also emphasize the value of learning to write in a popularized style, arguing that it develops clarity and coherence of the text, inasmuch as the writer's disposition and stance.

The communication of science to non-specialist readers through PSW is scarcely explored in Systemic Functional Linguistics (SFL), with limited studies focusing on popular science articles (PSAs) and book reviews, but excluding books (Babaii *et al*., 2017; Saidi and Saiedi, 2020). Notably, only PSAs have been examined regarding authorial and external voice by Hyland (2010) and Hyland and Fu (2014). These studies found that the journalistic style of PSAs attributes scientific knowledge to external voices rather than authorial voices, as they are often written by science journalists. In contrast, PSBs, authored mainly by scientists, present scientific knowledge directly.

From the perspective of the PSW genre and dialogistic features, the consulted literature reveals that PSAs in the field of medicine are the only PSW medium investigated. Hence, analyzing the dialogistic resources of multidisciplinary PSBs could add further insight on their interpersonal features, which can be converted into transferrable writing skills to solve writing deficiencies faced by (post)graduate students Saudi Higher Education (HE).

This study aims to investigate the representation of authorial and external voice in popular science book writing (PSBW) (see Appendix 3 for definitions). The lexico-grammatical resources make a proposition (i.e. the statement or the argument by which the author conveys their voice) within the writer's discourse. The authorial and external voices relate to how the writer's refers and situate their own voice in the text (i.e. authorial) and that of those other voices, either concrete or abstract subjects (i.e. external). The phrases *Aristotle believed* . . . and *Several studies report* . . . are respectively concrete and abstract subjects. The importance of authorial voice as a dialogistic resource to be taught in academic writing with explicit instruction has been well-documented in intervention studies at the master's degree level (Farsani *et al*., 2023; Zhao, 2013).

Literature review

Systemic functional linguistics

SFL, a functional theory of grammar developed by Halliday and Matthiessen (2014), describes language's meaning-making function in context. Language meaning is construed through three simultaneous metafunctions when language is used, either spoken or written: Ideational, Interpersonal, and Textual. These metafunctions form a semantic system integrating lexico-grammatical resources in contextual language exchanges. The clause serves as the foundation for these metafunctions.

The Ideational metafunction interprets human experiences by categorizing the world, including naming objects (e.g. building types, animal types) and actions (e.g. repairing, drinking) within clauses. Humans, as social beings, experience and make sense of the world both experientially and logically.

The Interpersonal metafunction adjusts the situational context based on the personal and social relationships between interlocutors, shaping communicative behavior and attitudes. This enables interlocutors to assess the clause's lexico-grammatical resources. While the

Ideational metafunction reflects human experience introspectively, the Interpersonal metafunction represents its interactive aspect.

The Textual metafunction involves rearranging clause construction to suit the communication context, aiding in the presentation of the first two metafunctions. As clauses form a discourse, it must flow appropriately to the context, ensuring continuity and coherence for comprehension.

The three metafunctions relate to Field, Tenor, and Mode, forming Register theory. Field, part of the Ideational metafunction, pertains to the subject matter of the clause. Tenor examines the social dynamics between interlocutors. Mode addresses aspects of the clause and discourse, including the medium of communication (written or spoken), channel (e.g. oral), and rhetorical mode (e.g. informative, didactic, explanatory). Register theory offers a linguistic context for the clause. According to Martin (2015), genre is introduced as an overlay to the variables. Genre refers to social processes targeting a specific communicative goal, regulating linguistic choices within its cultural context and fostering genre-specific knowledge and a community of practice.

Engagement System of the Appraisal Theory

The Appraisal Theory, adopted in SFL to explore the interpersonal meaning of communication (Martin and White, 2005), consists of three primary systems: Attitude, Engagement, and Graduation. This study focuses on the Engagement system (ES), aligning with the Interpersonal metafunction. ES is based on two assumptions for interpersonal language use: the writer projects authorial or external voice either by expanding or contracting. The extent of this expansion or contraction is realized through dialogistic resources indicating the intended communicative function, under the Heteroglossic subsystem.

Expand branches into Entertain and Attribute, with Entertain including hedges (e.g. may, can, must) and Attribute subdividing into Acknowledge and Distance. Conversely, Contract reflects the interlocutor's stance within Proclaim and Disclaim subsystems. Proclaim includes Occur, Pronounce, and Endorse, while Disclaim encompasses Deny and Counter. The dialogistic effect on the proposition is evident in the author's commitment to its validity and value, achieved through Expand dialogistic features. In Contract, the dialogistic effect reflects the plausibility of the proposition, with the author adopting a specific stance toward it, as shown in each example:

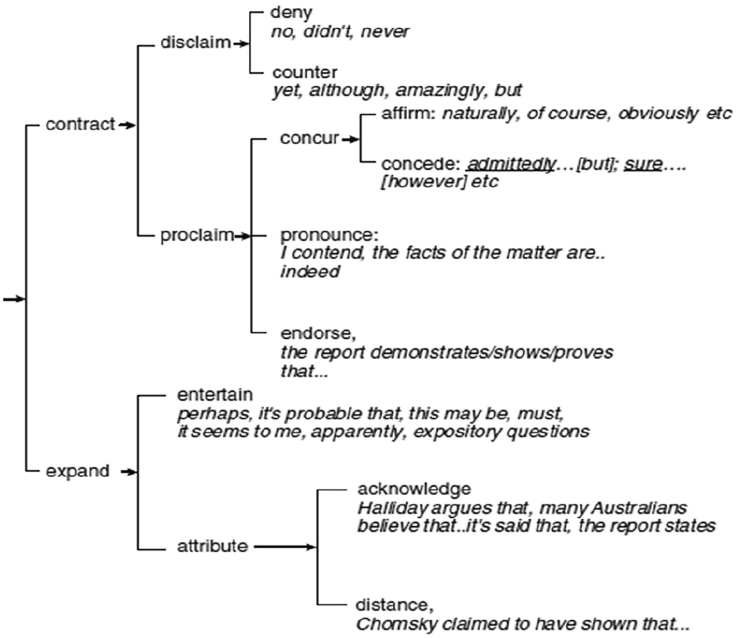
> . . . the 'naturalistic fallacy': ***the belief that*** *what happens in nature is good.*
>
> ***It is a brute fact*** that greater rewards will go to people with inborn talent . . .

Figure 1 conceptualizes the dialogistic relationship between the authorial voice and the external ones.

According to Martin and White (2005), the second assumption posits that the meaning of bare assertions extends beyond their composition. These statements, termed Monoglossic, appear in various PSBs and seem to lack both authorial and external voices. Devoid of dialogistic resources, they may be perceived as objectively committed to factual statements.

> Human beings are good at understanding the world.
>
> Morality binds and blinds.

These statements have no dialogistic markers indicating an overt authorial stance at the front of the proposition such as "*I believe*/*I argue*, *the belief that*/*the argument that morality binds and blinds*." Despite that, analyzing these two monoglossic statements within their intended context reveals the author's projection, as the heteroglossic backdrop of alternative viewpoints and voices alters the interpretation (Martin and White, 2005).



Source(s): Figure by Martin and White (2005)

Figure 1. Engagement system

Dialogistic features in popular science writing

Dialogism in PSW primarily appears in PSAs from online science magazines, which feature extensive interaction resources. Hyland (2010) analyzed PSAs from Scientific America and Science Daily, focusing on proximity—a concept that aligns the writer's voice and content with the reader, influenced by demonstrative interaction resources (e.g. *this*, *these*). His study identified a pattern of author credibility attribution in the order of academic position, field of expertise, and institution (e.g. "*Matthew Tresch, assistant professor of biomedical engineering at the McCormick School of Engineering and Applied Science of physical medicine and rehabilitation at the Feinberg School of Medicine*"). This structured attribution reduces hedging while emphasizing scientific findings, such as "*This discovery will prove fundamental in understanding the effects . . .*"

Research articles systematically incorporate authorial stance to support findings and build arguments (Nasirizadeh and Paramasivam, 2024). In contrast, PSA writers may exaggerate scientific findings due to journalistic practices aimed at engaging readers. Hyland and Fu (2014) analyzed 200 PSAs and 200 opinion articles, noting both genres use interactional resources like inclusive pronouns (e.g. *we*) and interpersonal ones (e.g. *you*).

Studies suggest a correlation between the PSW genre and interaction features like hedging, interpersonal pronouns, and author attribution. The release context of PSAs influences the linguistic resources shaping authorial stance and discourse. For instance, Shen and Tao (2021) noted that writers in opinion columns and medical articles during the coronavirus pandemic adopted a cautious stance due to the chaotic situation. Several SFL studies show a convergence of dialogistic features with the PSW genre, using scientific writing (SW) language (e.g. verbs: *show*, *suggest*, *argue*, *claim*; nouns: *theory*, *concept*, *assumption*, *possibility*) to mirror scientific papers in lay writing (Figini *et al*., 2019; Hunston, 2013; Koroleva, 2017). However, SW employs hedges differently. Poole *et al*. (2019) examined epistemic modals (e.g. *can*,

could, *may*) in the journal Nature, finding that as a scientific field matures, lexical boosters (e.g. *demonstrate*, *establish*, *prove*) increasingly replace hedging. While authorial stance in SW depends on the field's epistemological maturity, stance in PSW focuses on reader-writer engagement.

This interaction behavior is evident in translated PSAs from English to Chinese. Studies indicate that translators inject their authorial voice by modifying lexico-grammatical features to convey scientific knowledge (Liao, 2014; Sun, 2023). Translated PSAs in other languages also show variations due to translators' emphasis or de-emphasis of the original content (Hamberg, 2022; Kranich and Gast, 2015). Hedging adjusts the certainty of statements to suit the communicative purpose, accommodating non-English-speaking readers (House, 2015; Kranich, 2011). This is termed a "cultural filter," which mediates the accuracy of statements for readers from different cultural backgrounds.

Employing the popular science genre in the Saudi Higher Education

Research has shown significant writing benefits from using PSW, as noted by Pelger and Nilsson (2016), Pelger (2018), and Wu *et al*. (2018). Pelger and Nilsson (2016) implemented PSW tasks with 138 biology students, involving an initial draft and a final draft, and surveyed 64 students. The students reported an improved understanding of their scientific content and more purposeful writing. Pelger (2018) confirmed these findings at the thesis stage, highlighting the cognitive and linguistic benefits of PSW for scientific writing. Similarly, Wu *et al*. (2018) used five PSB excerpts in an undergraduate course to enhance the academic literacy of 300 first-year students, who wrote 600 essays in total. The researchers noted improvements in coherence, clarity, and reasoning skills in the students' writing.

These studies collectively indicate significant improvements in writing skills, including discipline-specific conventions, clarity, coherence, content control, and scientific argumentation. These studies highlight the practical use of PSW as teaching materials to address students' writing difficulties in various educational settings.

In using authorial voice, two significant studies have examined it in writing courses. Zhao (2013) assessed 400 TOEFL iBT essays and found authorial voice to have enhanced idea clarity and the writer-reader relationship through explicit voice mention. Similarly, Farsani *et al*. (2023) explored the impact of teaching authorial voice on 27 Iranian TEFL master's students, who reported improved writing quality and greater awareness of voice in their arguments. Both studies highlight the essential role of authorial voice as a critical dialogistic resource that conveys the author's stances and beliefs in discourse.

However, in the Saudi educational context, two main issues affect SW literature: First, graduate and postgraduate writing production is less studied than undergraduate writing. Undergraduate writing difficulties include paragraph unity, coherence, and technical and linguistic knowledge (Alghammas and Alhuwaydi, 2020; Aloairdhi, 2019; Alotaibi, 2020; Al-Zubeiry, 2019; Ozfidan and Mitchell, 2020). Second, this leads to writing discrepancies at the graduate level, such as inadequate communication of content, authorial voice, text structure, and improper lexical choice (Al Zumor, 2021; Al-Harbi and Troudi, 2020; Qasem and Zayid, 2019).

Efforts to address challenges in academic writing include Al Zumor (2021) suggestion to highlight discipline-specific linguistic features and Qasem and Zayid's (2019) recommendation to increase writing activities. However, the latter's approach depends on instructors' skills, potentially leading to inconsistent results. Al-Harbi (2021) proposes a top-down strategy, advocating for the Ministry of Higher Education to develop one-year SW programs and improve university lecturers' instructional quality.

Varttala (1998) suggests that integrating PSW texts can diversify SW course materials, but only with the appropriate pedagogical approach. The Writing-to-Learn (WTL) initiative promotes coherence and structure over regurgitating scientific facts. WTL pedagogy can enhance students' understanding and ability to evaluate scientific content. Depending on the

educational level and subject matter, WTL can include writing proposals, in-class activities, journaling, term papers, or unassessed assignments (Reynolds *et al*., 2012). Research consistently shows WTL improves discipline-specific writing skills and transitions students from mere fact narration to knowledge construction, enhancing critical thinking (Balgopal *et al*., 2018; Balgopal and Wallace, 2013; Sampson *et al*., 2013).

Although these are encouraging results, cementing the practicality of the WTL approach, its effectiveness rests on setting the appropriate conditions for it to yield positive outcomes. For instance, WTL is effective when students are given enough time to gradually develop their writing skills and their scientific knowledge. In addition, teacher-directed feedback on students' writing during the WTL treatment is pivotal, as it further gives them guidance and mentorship (Fry and Villagomez, 2012).

Writing to Communicate (WTC) differs from Writing to Learn (WTL) by focusing on the reader. WTC emphasizes organizing the writer's ideas for the target audience. Common formal WTC instructions include expository, narrative, and persuasive essays for a general audience. WTC and Public Science Writing (PSW) share features like addressing non-experts and presenting scientific information through storytelling and logical and ethical arguments (Balgopal and Wallace, 2013). Consequently, students' writing can become more dialogical.

Al Zumor (2021) and Qasem and Zayid's (2019) recommendations on teaching text features are pertinent to the PSW genre as educational materials in Saudi Higher Education. If PSW and SW share dialogistic resources in expressing authorial and external voices, PSW's simplified scientific knowledge can help address SW skill challenges among Saudi post (graduate) students. However, due to the lack of integration of this genre in EAP and the shortage of SW programs, Saudi university students face knowledge barriers, particularly in identifying research elements like research gaps, study significance, or distinguishing introductions from literature reviews (Al Mahmud and ur Rahmanu, 2023; Al-Harbi, 2021).

Students struggle with producing academic discourse due to a lack of communicative and rhetorical knowledge, alongside linguistic issues like appropriate hedging and justifying claims. This study analyzes PSBW to assess its viability as teaching material, aiming to diversify EAP content, improve writing deficiencies, and develop audience-oriented writing and thinking skills suitable for (post)graduate levels.

Method

This quantitative study analyzes how authorial and external voices are represented using dialogistic resources in a 93,078-word corpus from various multidisciplinary PSBs. The study is observational, investigating the corpus. Quantitative approaches in Systemic Functional Linguistics (SFL) involve observing language in use or in a social context, which can be explored through corpora, language models (e.g. artificial intelligence), and child language development (He, 2018). These methods emphasize observation and experimentation (He, 2018). Using corpora to investigate language-in-use theories like SFL is comprehensive and useful due to three reasons: the authenticity of linguistic data, the ability to quantify grammar, and the potential for systematic analysis. The study analyzes two variable types: the main category (hard science and soft science) and subcategories (e.g. physics, biology, and philosophy).

Data selection

Data were collected from publicly available PSBs in English, categorized as hard and soft sciences. Some excerpts were purchased in paperback and electronic formats, while others were sourced from Google Books. Given that PSBs can span hundreds of pages, excerpts were kept within a reasonable length, adhering to UK Copyright law, which permits less than five percent text extraction from books (Intellectual Property Office, 2014). Disciplines in both categories were selected based on the highest research output at top Saudi Arabian universities,

as reported by the Scimago Institution Rankings in 2022. Each science category contains three disciplines, each represented by six book excerpts. Approximately 2,500-word excerpts were transcribed into plain text files for UAM CorpusTool3 analysis. The corpus totals 93,078 words (46,448 for hard science and 46,630 for soft science). Hard science disciplines include Physics, Biology, and Chemistry (Appendix 1), while soft science disciplines are Philosophy, Psychology, and Linguistics (Appendix 2). The corpus summary is provided in Table 1.

Books in each discipline were categorized based on their titles, Goodreads classifications, and the authors' scientific backgrounds. Text selection followed two main criteria: texts were randomly chosen from the beginning of chapters or subchapters, and figures, images, and charts were omitted; only direct quotations were included.

Data analysis procedures

This study utilized the UAM CorpusTool3 by O'Donnell (2008) to examine the Engagement System (ES) within Appraisal Theory. The ES tool navigates dialogistic lexes and phrases in the writer's proposition at the clausal level, defined as a statement expressed through indicative dialogistic or lexico-grammatical resources.

The analysis was structured as follows: First, dialogistic formulations were reported by category (hard science, soft science), followed by descriptive and statistical testing. Second, the variable was reported by subcategory (e.g. biology, psychology, physics) with the same statistical procedure. The chi-squared test in R Studio examined significant categorical differences in the corpus.

To ensure normal distribution in the PSBW corpus during the pre-analysis stage, the one-sample Kolmogorov-Smirnov Test (KS Test) was conducted at two inquiry levels: by main science categories (hard science, soft science) and by individual disciplines within these categories (biology, chemistry, physics, etc.). The statistical results for both levels were not significant ($p > 0.000$***), indicating that the dataset at both inquiry levels does not follow a normal distribution.

Engagement system analysis. The ES system assesses the dialogistic language used by speakers or writers to engage with their interlocutors. Writers convey voice and stance through dialogistic resources, projecting themselves to the reader. This projection, termed a proposition, can be analyzed using the ES system. The examples below illustrate the two primary ES features, Expand and Contract:

. . . the 'naturalistic fallacy': ***the belief that*** what happens in nature is good.

It's a brute fact that greater rewards will go to people with inborn talents . . .

The tool gives a list of ES features in the order of the heteroglossic formulations. The first text example could be annotated as Expand. The tool gives extra notational features under Expand, so it can ultimately be annotated as [Expand:Attribute:Acknowledge]. The second example could thus be [Contract:Proclaim:Pronounce].

Table 1. Summary of the hard science and the soft science data

Category	Hard science	Soft science
No. of disciplines	3	3
No. of text in a single discipline	6	6
Average word count for each text	2,500	
Total word count by category	46,448	46,630
Total word count	93,078	

Source(s): Table by author

The UAM CorpusTool3 offers linguists semi-automatic annotation and statistical processing for lengthy texts, balancing subjective and fully automatic analysis to ensure reliable results. Context-sensitive annotation is easily reviewed and tabulated according to ES subsystems. The tool includes an additional Engagement subclassification, Justify under Proclaim, absent in Martin and White's original scheme (2005), but it will be included in the annotation, as shown in Figure 2.

Results

Category results

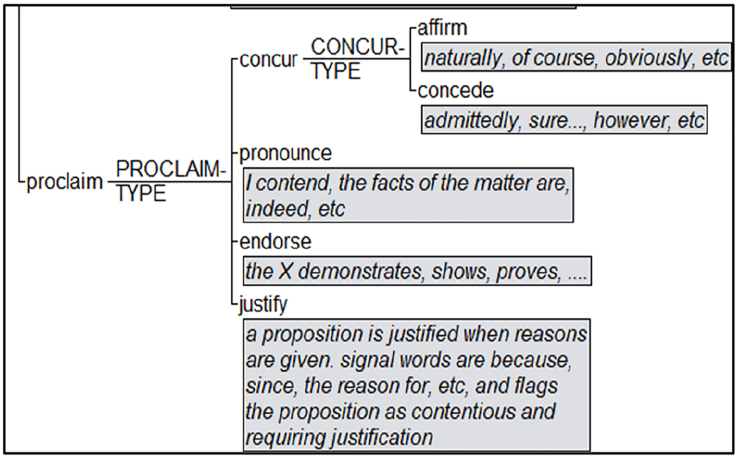
Table 2 aggregates data by science category: hard science (HS) and soft science (SS). Disclaim, including Deny and Counter, totals (n = 772, 28.81%) for HS and (n = 724, 25.47%) for SS. Proclaim features—Concur, Endorse, Pronounce, and Justify—total (n = 827, 30.86%) for HS and (n = 764, 27.93%) for SS. Expand features total (n = 864, 32.24%) for HS and (n = 1,037, 37.92%) for SS.

The chi-squared test results indicate a significant difference between the two groups ($X2$ = 58.52, df = 9, p = 0.000***). This suggests that PSBW in hard and soft fields represent authorial and external voices differently. Authors in hard sciences more frequently insert their voices (Proclaim), while those in soft sciences consider a range of possibilities and give more affordances to external voices (Expand).

Subcategory results

Table 3 presents a descriptive analysis of popular science disciplines, with subtotals and percentages calculated for the main Engagement features: Monoglossics, Contract, and Expand. The percentages for Contract and Expand correlate with their main categories. For instance, Contract is divided into Disclaim and Proclaim, with further breakdowns into Deny and Counter for Disclaim, and Concur and Pronounce for Proclaim.

Monoglossic formulations in the HS datasets are more prevalent in Biology (n = 88, 11.14%) compared to Chemistry (n = 70, 9.59%) and Physics (n = 59, 5.09%). Similarly, in the SS datasets, Psychology shows higher Monoglossic formulations (n = 95, 10.65%) than Philosophy (n = 66, 6.85%) and Linguistics (n = 49, 5.56%).



Source(s): Figure by O'Donnell (2008)

Figure 2. Justify under proclaim

Table 2. Descriptive analysis of the engagement system

Engagement formulation	Hard science No.	%	Soft science No.	%
Monoglossic	217	8.10	210	7.68
Disclaim				
Deny	390	14.55	358	13.09
Counter	382	14.25	366	13.38
Proclaim				
Concur	344	12.84	356	13.02
Pronounce	95	3.54	126	4.61
Endorse	173	6.46	88	3.22
Justify	215	8.02	194	7.09
Expand				
Entertain	645	24.07	750	27.42
Acknowledge	170	6.34	192	7.02
Distance	49	1.83	95	3.47
Heterglossic	2,463		2,525	
Total	2,680	100	2,735	100

Source(s): Table by author

Contract in HS is similar in Biology (n = 482, 61.01%) and Chemistry (n = 459, 62.88%) but decreases in Physics (n = 658, 56.72%). Physics has more Contract instances but a lower percentage due to the dataset size (n = 1,160). In Physics, Expand represents a significant portion of the distribution (n = 443, 38.19%), unlike Biology and Chemistry which have nearly identical values (n = 220, 27.85%), (n = 201, 27.53%).

In SS, Contract holds similar value in Philosophy (n = 549, 57.01%) and Linguistics (n = 513, 58.16%) but decreases by ten percent in Biology (n = 428, 47.98%). Similarly, Expand shows comparable values in Philosophy (n = 348, 36.14%) and Linguistics (n = 320, 36.28%), but it rises by five percent in Psychology (n = 369, 41.37%).

The values of Disclaim and Proclaim correlate with Contract as their primary feature. In the HS category, Disclaim is similar in quantity for Biology and Chemistry (n = 218, n = 228) but differs in percentage distribution (27.59%, 31.23%). In Physics, it is larger (n = 326, 28.10). In the SS category, Disclaim in Philosophy (n = 271, 28.14%) and Linguistics (n = 246, 27.89%) is similar, while Psychology is significantly lower (n = 207, 23.21%).

Disclaim includes two Engagement formulations: Deny and Counter. Deny primarily uses negators like *not, nothing, never, neither/nor* to express negation. These negators position the author's negating stance regarding the proposition. Deny often co-occurs with hedges such as can, would, and have to, which are part of Entertain. Deny negates the affirmativeness introduced by Entertain, as illustrated by phrases like "*Nor can I think of any parallels elsewhere in life, on any scale* (Hard science – Biology)." Deny frequently co-occurs with Counter, Concur, and Entertain.

Counter is represented through coordinating conjunctions (e.g. but, or, yet) or phrasal resources (e.g. in contrast to, rather than, compared with), combining hypotactic and paratactic clauses. These resources provide a contrasting authorial stance on previously stated propositions. The countered propositions are linked with Concur: Affirm, Entertain, Acknowledge, and Deny. For instance, "*Aristotle believed that all things in the universe had a telos or purpose toward which they aimed, even though he did not believe that the gods had designed all things* (Soft science – Philosophy)."

Physics (n = 332, 28.62%) in HS and Philosophy (n = 277, 28.76%) in SS contain higher Proclaim formulations than their subcategory peers, with Physics exceeding Biology (n = 264,

Table 3. Descriptive analysis of the engagement formulations in hard and soft science

Engagement formulation	Hard science						Soft science					
	Biology		Chemistry		Physics		Psychology		Philosophy		Linguistics	
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
Monoglossic	88	11.14	70	9.59	59	5.09	95	10.65	66	6.85	49	5.56
Contract	*482*	*61.01*	*459*	*62.88*	*658*	*56.72*	*428*	*47.98*	*549*	*57.01*	*513*	*58.16*
Disclaim	*218*	*27.59*	*228*	*31.23*	*326*	*28.10*	*207*	*23.21*	*271*	*28.14*	*246*	*27.89*
Deny	99	12.53	104	14.25	187	16.12	109	12.22	137	14.23	112	12.70
Counter	119	15.06	124	16.99	139	11.98	98	10.99	134	13.91	134	15.19
Proclaim	*264*	*33.42*	*231*	*31.64*	*332*	*28.62*	*221*	*24.78*	*277*	*28.76*	*266*	*30.16*
Concur	131	16.58	88	12.05	125	10.78	108	12.11	121	12.56	127	14.40
Pronounce	28	3.54	26	3.56	41	3.53	21	2.35	77	8.00	28	3.17
Endorse	58	7.34	48	6.58	67	5.78	38	4.26	22	2.28	28	3.17
Justify	47	5.95	69	9.45	99	8.53	54	6.05	57	5.92	83	9.41
Expand	*220*	*27.85*	*201*	*27.53*	*443*	*38.19*	*369*	*41.37*	*348*	*36.14*	*320*	*36.28*
Entertain	156	19.75	137	18.77	352	30.34	252	28.25	258	26.79	240	27.21
Attribute	*64*	*8.10*	*64*	*8.77*	*91*	*7.84*	*117*	*13.12*	*90*	*9.35*	*80*	*9.07*
Acknowledge	52	6.58	56	7.67	62	5.34	94	10.54	57	5.92	41	4.65
Distance	12	1.52	8	1.10	29	2.5	23	2.58	33	3.43	39	4.42
Subtotal and percentage	790	100	730	100	1,160	100	892	100	963	100	882	100

Source(s): Table by author

33.42%) and Chemistry (n = 231, 31.64%), and Philosophy surpassing Psychology (n = 221, 24.78%) and Linguistics (n = 266, 30.16%). Proclaim, the highest Heteroglossic formulation containing Concur, Endorse, Pronounce, and Justify, warrants the alignment of the writer's proposition as highly favorable (Martin and White, 2005). Concur's lexico-grammatical resources include *of course, at least, basically,* and phrasal resources like *after all* and *needless to say.*

The next feature Pronounce appears mostly in self-mentions (e.g. *I have reviewed, I have argued that*) and adverbs (e.g. *absolutely, basically, indeed*). Pronounce expresses direct authorial voice and stance in the proposition, as seen in "*But shouldn't we least make the attempt? I side with Einstein. I believe there is an objective physical reality.* (Hard science – Physics)".

The third feature Endorse projects a favorable stance toward the proposition introduced by the external voice "*Yet Branemark found that for some reason, titanium hypnotizes blood cells* (Hard science – Chemistry)". Endorse commonly co-occurs with Counter – as demonstrated in the cited example, suggesting that the authorial stance contends with a proposition introduced previously then projects a counterargument toward which the authorial voice leans.

The last feature under Proclaim is Justify, which oftentimes appears as a connector in hypotactic clauses "*These molecules all have the same structural feature, which is therefore likely to be responsible for the cardiac effect* (Hard science – Chemistry)". The common resources for Justify include *because, thus, hence, consequently* in addition to phrasal resources such as *due in part to the fact, as a consequence, no matter how.* Justify indicates that the authorial voice provides reasoning to the validity of the proposition – or lack thereof.

Expand includes Entertain and Attribute, with values calculated relative to the total Expand value. Entertain is significantly higher in Physics (n = 362, 30.34%) compared to Biology (n = 156, 19.75%) and Chemistry (n = 137, 18.77%), occupying the largest portion of Expand in Physics. Similarly, in the social sciences, Entertain is most prominent in Psychology (n = 252, 28.25%), Philosophy (n = 258, 26.79%), and Linguistics (n = 240, 27.21%), each constituting the largest portion of their respective Expand features.

Entertain refers to the range of warrantability for a proposition, characterized by hedges (e.g. may, might, should) and epistemic verbs (e.g. imply, suggest, consider). For instance, "*The original replicators may have been a related kind of molecule to DNA or they may have been totally different*" (Hard science - Biology). It also includes rhetorical/expository questions, such as, "*Can one really reconcile biological differences without a concept of social justice? Absolutely*" (Soft science – Philosophy). Entertain often co-occurs with Contract features like Disclaim:Counter and Proclaim:Concur.

In the Expand domain, Physics has 91 instances (7.84%), while Biology and Chemistry have similar proportions with 64 instances each, at 8.10 and 8.77%, respectively. Psychology's Attribute formulations are twice as many (94 instances, 10.54%) compared to Philosophy (57 instances, 5.92%) and Linguistics (39 instances, 4.42%).

Attribute consists of Distance and Acknowledge, which make two dichotomous spectrums toward the proposition. The common lexcio-grammatical resources in Distance are verbs such as *proclaim, assume, claim, purport* and adjectives like *interpreted as, hailed, absurd, hardly.* The following excerpted text elucidates the Distance formulation "*There would need to be a gene or a gene network for each purportedly innate concept.* (Soft science – Linguistics)". Distance is noticed to co-occur alongside Counter and Concur, and occasionally Justify.

Acknowledge, in contrast to Distance, aligns the authorial voice with the potential validity of the proposition. Common verbs include *found, believe, investigate, say, argue,* and phrases like *according to* and *it is an argument that*. Acknowledge co-occurs with Proclaim features but less often with Disclaim and Entertain, as in the example: "*I'll call this competing model of the Durkheimian model, because it says that the function of those beliefs and practices is ultimately to create a community* (Soft science – Psychology)."

The chi-squared test was run to find any significant statistical differences within the main Heteroglossic features of the Engagement System, as demonstrated in Table 4.

Table 4. Chi-squared test results of features in the engagement system

Feature	X^2	*df*	*p*
Contract	*116.82*	*25*	*0.000****
Disclaim	*13.242*	*5*	*0.021***
Proclaim	*100.99*	*15*	*0.000****
Expand	17.293	5	0.003**
Entertain	130.49	5	0.000***
Attribute	35.096	5	0.000***

Source(s): Table by author

The *p*-value is below the significance level (0.05) in each Heteroglossic formulation, indicating statistically significant differences between hard and soft disciplines on a feature level. This suggests that PSBW in hard and soft sciences use discipline-specific lexico-grammatical phrases to project both authorial and external voices. The scalability of projecting these voices depends on whether the topic is from a hard or soft discipline.

Discussion

This study examines how PSBs represent authorial and external voices within propositions using lexico-grammatical resources (i.e. dialogistic). HS disciplines use more Proclaim formulations, indicating more assertions and direct authorial voice, whereas SS disciplines employ more external voices to present a range of possibilities regarding the proposition's warrantability, as seen in Expand. Thus, PSBW highlights authorial and external voices, with differences depending on whether the discipline is hard or soft science.

In translating PSBs from English to another language, translators use a "cultural filter" to control hedging intensity (House, 2015; Kranich, 2011). Similarly, a "discipline filter" may explain hedging intensity in PSBW, influenced by the writing conventions of hard or soft disciplines and the field's maturity. Based on Poole *et al.* (2019), a filter mediating the modality of statements can be posited: more mature and robust knowledge within a discipline leads to more assertive use of modals like *must*, *could*, and *can*, rather than *perhaps*, *might*, *may*. Although this cannot be confirmed for this PSBW corpus, similar modality use appears influenced by the popularized disciplines. Investigating the existence and influence of a discipline filter on HS and SS disciplines' writing could be a valuable area of inquiry, exploring distinctions or similarities between the two categories.

Modalities in the PSBW corpus are linked to the introduction of external voices. Their co-occurrence with Concur (a Proclaim feature) strengthens the authorial voice and stance. Modalities also co-occur with Disclaim features (deny and counter) and Pronounce in Proclaim, indicating an argumentative and discursive writing style. Lexico-grammatical features in PSBW enhance claims and assertions, aiming to persuade non-expert readers.

Hyland (2010) noted the order of attribution, where the external author's name is followed by their academic position and institution. This pattern was observed in this corpus as well. However, the communicative intent here differs from Hyland's findings. Hyland's corpus, primarily composed of PSAs, is journalistic and often narrates in a newsworthy, praiseworthy manner. Additionally, PSBs differ from PSAs through the journalistic tactic of "attribution shield." While PSA writers, whether journalists or scientists, cite external voices to lend credibility to their information, PSB authors invoke external voices to strengthen their own narratives or arguments, regardless of whether the representation is critical or supportive.

The excerpts in this corpus are from traditional publishing. Analysis indicates that PSBW authors focus on clear, definitive statements to express their voice and stance, rather than newsworthiness. The key difference between PSBs and PSAs is that PSBs rarely use hedging

or boosting when attributing an external voice, doing so only to show an evaluative stance (e.g. favorably, critically).

The analyzed corpus in this study is rich with self-mentions, inclusive, and interpersonal pronouns, aligning with the results of Pronounce under Proclaim. The self-mentions in this PSBW corpus correspond with Hyland and Fu's (2014) findings in their PSA analysis. This suggests that PSW, whether in PSBs or PSAs, generally features a direct and straightforward authorial voice. The use of self-mentions and these pronouns can be seen as characteristic of the genre.

PSBW extensively mirrors academic language, using epistemic verbs like *show*, *demonstrate*, and *found*. Examples of these verbs appear under Endorse. Similarly, Pronounce reflects this when the author uses phrases like *I will introduce*, *I must explain*, and Entertain when stating beliefs, such as *Epicureans believed*. The analysis shows PSBW adapts SW sentence structures for general readers, as reported in various SFL studies (Figini *et al*., 2019; Hunston, 2013; Koroleva, 2017; Liao, 2011).

In many cases, the use of academic language is replaced by rhetorical questions that engage the reader. Rhetorical questions have two functions in PSBW, as suggested by the analysis. Firstly, they serve as a rhetorical tool to stimulate the reader's thinking and imagination, achieved by diverging from the discourse using common lexico-grammatical resources like "*but*" and "*or*". Secondly, they act as an accessible entry point for the writer's argument, facilitated by following the question with a Deny (e.g. "no"), Pronounce (e.g. "*I side with Einstein*. *I believe . . .* "), or Concur (e.g. "*absolutely*"). This pattern of introducing the writer's argument via rhetorical questions is seen in the combination of Concur ("*of course*") and Deny ("*not*"). Conditional statements in the corpus similarly exhibit this conversational style, contrasting with SW.

PSBW is characterized by its extensive use of dialogistic resources, emphasizing a highly argumentative writer voice. However, differences in the use of these resources are evident within the PSBW corpus. Soft sciences are more dialectical and less assertive in validating statements, as seen in the Expand feature, while hard sciences exhibit greater assertiveness in authorial and external voices. This indicates a discipline-based filter that influences the degree of assertion in authorial voice and stance. In hard sciences, assertive functional resources (e.g. *must*, *could*) and lexical choices (e.g. *suggest*, *predict*, *argue*) are used to express the authorial stance. This discipline filter is dynamic, evolving with the maturity and development of the field under discussion.

Pedagogical implications

One study objective was to interpret the PSBW corpus in the context of writing pedagogy and its application in Saudi Higher Education (HE). Literature indicates a lack of English SW programs in Saudi universities, with few programs teaching English SW to (post)graduate students from various scientific fields. Long-term SW programs incorporating PSWB materials should address the writing challenges faced by these students (Al-Harbi, 2021) and train them to write within their specific disciplines, enhancing their engagement with their professional community. Integrating PSBW into SW courses should bridge the gap to SW conventions for (post)graduate students.

Intervention studies suggest that incorporating PSW texts helps students recognize the communicative purpose of the PSW genre (Pelger, 2018; Pelger and Nilsson, 2016; Wu *et al*., 2018). Combined with pedagogical approaches like WTL and WTC (Balgopal *et al*., 2018; Fry and Villagomez, 2012; Reynolds *et al*., 2012; Sampson *et al*., 2013), using PSBW excerpts should enhance students' understanding of communicative purpose, discipline-specific writing conventions, text coherence, paragraph cohesion, and control over linguistic and dialogistic resources.

The lexico-grammatical features identified in the PSWB corpus can enhance (post) graduates' SW to be more argumentative and discursive. Four key resources to teach authorial/

external voice and stance are epistemic verbs, modals, stance, and self-mentions, all crucial for constructing text propositions. Epistemic verbs, reflecting authorial voice, are found in Contract and Expand features: Endorse (e.g. *show*, *demonstrate*), Entertain (e.g. *believe*, *suggest*), Acknowledge (e.g. *say*), and Distance (e.g. *claim*, *believe*). The ES features' variety of epistemic verbs conveys a range of contraction for the authorial and external voice. Modality in the authorial/external voice reflects the proposition in Entertain (e.g. can, could, may, should). The writer's assertiveness or laxness toward the proposition is evident from the modality regulating the degree of proposition warrant. For instance, must indicates a highly warranted proposition, while may indicates less. Stance resources include Concur (e.g. *absolutely*, *of course*, *basically*), Disclaim (e.g. *no*, *not*, *but*, *yet*), and Justify (e.g. *because*, *thus*, *therefore*). Lastly, self-mentions, first-person pronouns (e.g. *I*, *we*), are found exclusively in Pronounce.

Farsani *et al*. (2023) and Zhao (2013) found that enhancing authorial voice in L2 argumentative writing helps writers become more aware of their stance and situated beliefs, aligning with this study's observations. However, this study also addresses external voice, noting that identified dialogistic resources can influence the stance and belief of the external voice by shaping how the author represents it.

Lexico-grammatical resources can be acquired through a writing pedagogy that integrates linguistic and communicative aspects of student texts. Local research predominantly targets linguistic competence by explicitly teaching and practicing text features (Al Zumor, 2021; Qasem and Zayid, 2019). However, linguistic competence alone is insufficient for developing the ability to recognize the writer's voice and stance. It must be combined with WTL and WTC approaches, which aim to produce writer and reader-oriented texts. In this integrated approach, students can be trained to identify the writer's voice and stance in PSBW texts to evaluate their dialogistic functions. Subsequently, through various PSW tasks, they can incorporate these dialogistic features into their texts based on the exercise's communicative goal. Thus, pedagogical approaches should aim to: (1) explicitly teach dialogistic resources, (2) identify and evaluate dialogistic features in texts, and (3) produce dialogistic texts with a communicative goal.

The identified dialogistic resources could enhance (post)graduate students' SW skills in Saudi Higher Education. Analysis of the corpus shows that PSBW and SW share dialogistic resources like epistemic verbs, self-mentions, and modalities. By highlighting the similarities and differences between these genres, these resources can be transformed into a transferable pedagogical approach in SW courses. This could address longstanding writing deficiencies such as authorial voice and lack of content knowledge control (Al Zumor, 2021; Al-Harbi, 2021; Al-Harbi and Troudi, 2020; Qasem and Zayid, 2019).

Integrating PSBW in SW programs should occur early in the course and not remain constant, as it serves as a timely intervention to help (post)graduate students transition to scientific writing. It should enable them to shift their writing orientation from popular to scientific form, making them mindful of the target reader. Depending on whether the reader is an expert or not, the student's discourse should align with the conventions of the discipline.

PSBW texts should not permanently replace journal papers for (post)graduate students. Instead, they should facilitate a gradual transition to specialized texts. The duration of using these materials remains experimental due to the lack of studies in the Saudi learning context. Pelger (2018) used popular science materials to improve graduate students' thesis writing over 10 weeks. If PSBW texts are introduced in a scientific writing course, the course should span at least a semester to ensure the development of various thinking and writing skills.

Conclusion

This SFL study examined the interpersonal metafunction in the lexico-grammatical resources of popular science books. The results illuminate the PSW genre, revealing a scarcity in this area. The findings distinguish what was previously seen as a unilateral register in existing

literature, highlighting differences in communicative function between books and online articles. Earlier SFL studies focused mainly on online articles, lacking distinction between the two mediums within the genre.

The dialogistic resources in books support the discourse's communicative purpose, making PSBW more discursive, argumentative, and persuasive. In contrast, PSAs aim to highlight scientific findings as newsworthy and impactful, hence the use of attribution shields. The PSBW corpus suggests the most significant finding is the proposed discipline filter, a concept requiring further study.

Pedagogically, it is recommended to (1) integrate PSBW in scientific/academic writing courses as an early intervention to bridge to scientific writing and develop argumentative writing and critical thinking skills, and (2) use PSBW as teaching materials to elicit advanced writing skills suitable for the (post)graduate level in the Saudi Higher Education context, including knowledge and content control, argumentation, and awareness of communicative functions and purpose at both paragraph and textual levels.

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Appendix 1

Table A1. Datasets of hard science disciplines

Hard Science books		Author	Year	Publisher
Physics	*The Greatest Story Ever Told – So Far: Why Are We Here?*	Lawrence M. Krauss	2017	Atria Books
	The Big Picture: On the Origins of Life, Meaning and the Universe Itself	Sean Carrol	2016	Dutton
	Time Reborn: From the Crisis in Physics to the Future of the Universe	Lee Smolin	2014	Marine Books
	Cosmos	Carl Sagan	1983	Time Warner Books
	The Hidden Reality: Parallel Universes and Deep Laws of the Cosmos	Brian Greene	2011	Knopf
	The Universe: Leading Scientists Explore the Origin, Mysteries and the Future of the Cosmos	John Brockman	2014	Harper Perennial
Biology	*The Selfish Genes*	Richard Dawkins	1976/ 2016	Oxford University Press
	Behave: The Biology of Humans at Our Best and Worst	Robert M. Sapolsky	2017	Penguin Press
	She Has Her Mother's Laugh: The Powers, Perversions, and Potential of Heredity	Carl Zimmer	2018	Dutton
	Genome: the Autobiography of a Species in 23 Chapters	Matt Ridley	1999	Harper Perennial
	Power, Sex, Suicide: Mitochondria and the Meaning of Life	Nick Lane	2006	Oxford University Press
	The Story of the Human Body: Evolution, Health, and Disease	Daniel E. Liberman	2013	Vintage
Chemistry	*Stuff Matters: Exploring the Marvelous Materials That Shape Our Man-Made World*	Mark Miodownik	2015	Marine Books
	The Disappearing Spoon: And Other True Tales of Madness, Love, and the History of the World from the Periodic Table of the Elements	Sam Kean	2011	Back Bay Books
	Napoleon's Buttons: How 17 Molecules Changed History	Jay Burreson & Penny Le Couteur	2004	Jeremy P Tarcher
	Strange Chemistry: The Stories Your Chemistry Teachers Wouldn't Tell You	Steven Farmer	2017	Wiley
	Roald Hoffmann on the Philosophy, Art, and Science of Chemistry	Roald Hoffmann	2012	Oxford University Press
	The Alchemy of Air: A Jewish Genuis, A Doomed Tycoon, and the Scientific Discovery That Fed the World but Fueled the Rise of Hitler	Thomas Hager	2008	Crown

Source(s): Appendix by author

Appendix 2

Table A2. Datasets of soft science disciplines

Soft Science books		Author	Year	Publisher
Philosophy	*The Blank Slate: The Modern Denialism of Human Nature*	Steven Pinker	2002	Penguin Books
	Speech Matters: On Lying, Morality, and the Law	Seana V. Shiffrin	2014	Princeton University Press
	The Moral Landscape: How Science Can Determine Human Values	Sam Harris	2010	Free Press
	Beyond the Hoax: Science, Philosophy, and Culture	Alan Sokal	2008	Oxford University Press
	The Happiness Hypothesis: Finding Modern Truth in Ancient Wisdom	Jonathan Haidt	2006	Basic Books
	Maps of Meaning: The Architecture of Belief	Jordan Peterson	1999	Routledge
Psychology	*The Righteous Mind: Why Good People Are Divided by Politics and Religion*	Jonathan Haidt	2012	Pantheon
	Thinking, Fast and Slow	Daniel Kahneman	2011	Farrar, Straus and Giroux
	The Moral Animal: Why We Are the Way We Are – The New Science of Evolutionary Psychology	Robert Wright	1994	Vintage
	The Better Angels of Our Nature: Why Violence Has Declined	Steven Pinker	2012	Penguin Books
	The Consuming Instinct: What Juicy Burgers, Ferraris, Pornography, and Gift Giving Reveal about Human Nature	Gad Saad	2011	Prometheus Books
	The Sociopath Next Door	Martha Stout	2006	Harmony
Linguistics	*How Language Began: The Story of Humanity's Greatest Invention*	Daniel L. Everett	2017	Liveright
	The Language Instinct: How the Mind Creates Language	Steven Pinker	2000	Harper Perennial Modern Classics
	The Unfolding of Language: An Evolutionary Tour of Mankind's Greatest Invention	Guy Deutcher	2005	Holt Paperbacks
	Because Internet: Understanding the New Rules of Language	Gretchen McCulloch	2019	Riverhead Books
	Metaphors We Live By	George Lakoff & Mark Johnson	2003	The University of Chicago Press
	The Language Hoax	John McWhorter	2014	Oxford University Press

Source(s): Appendix by author

Appendix 3

Table A3. Glossary

Term	Definition
EAP	English for academic purposes
ES	Engagement System, part of the Appraisal Theory
HS	Hard science, a main category in the corpus
PSA	Popular science articles
PSB	Popular science books
PSW	Popular science writing, a blanket term for the genre
PSBW	Popular science book writing, genre specific to books
SFL	Systemic functional linguistics
SS	Soft science, a main category in the corpus
SW	Scientific writing

Source(s): Appendix by author

Corresponding author
Ahmad Qassim Al Darwesh can be contacted at: 442106345@student.ksu.edu.sa