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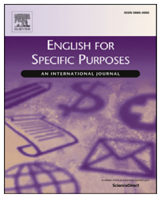

A move/step model for methods sections: Demonstrating Rigour and Credibility

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A B S T R A C T

In the tradition of Swalesian genre theory, this manuscript explores the rhetorical composition of research article Methods sections through a top-down analysis of a corpus of nine hundred texts representative of thirty academic fields. The analysis resulted in a comprehensive cross-disciplinary model, called Demonstrating Rigour and Credibility (DRaC). The model contains three moves and sixteen steps, which are defined in terms of functional and content realizations. DRaC further served as the analytic framework for corpus annotation. Manually annotated corpus data revealed the moves and steps with high distributional prominence as well as those that are not frequent but occur consistently within and across disciplines. Visualizations of individual texts in a sample of disciplines demonstrated inter-disciplinary and intra-disciplinary patterns and variation in move sequencing. Additionally, algorithmic analysis of the annotated corpus showed that soft and hard sciences form clusters based on their use of DRaC steps, providing a deeper understanding of how shared conventions of rhetorical composition distinguish cross-disciplinary similarities in Methods discourse. The findings lend themselves to application in genre writing pedagogy and, more broadly, hold implications for theories of social and cognitive genres.

1. Introduction

As genre analysts investigate discourse embedded in the context of a communicative event, they view genres as social and cognitive phenomena. Social genres are generally characterized in terms of texts that are determined by social communicative goals (Pilegaard & Frandsen, 1996), such as service encounters, personal letters, lab reports, journal articles, etc. To accomplish the socially recognized goals of text genres, writers stage content in a conventionalized move structure, the moves being discoursal units that accomplish coherent communicative goals (Swales, 1990, 2004). Each move is in turn realized by distinct rhetorical steps that convey specific functional meanings. Cognitive genres were proposed as units of discourse rendering types of a highly complex category, which refers to the "overall cognitive orientation and internal organization of a segment of writing that realizes a single, more general rhetorical purpose to represent one type of information within

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discourse" (Bruce, 2008a, p. 39). Bruce (2005, 2008b) explains that different types of rhetorical purposes can instantiate different cognitive genres, and that social genres operate with the means of various cognitive genres. For example, scientific reports have specific rhetorical purposes, which characterize their different sections, and thus combine a range of cognitive genres (e.g., *report* in Results sections and *explanation* in Discussion sections). Therefore, the two phenomena are not mutually exclusive; on the contrary, together social and cognitive genres enhance the effectiveness of discourse. Moreover, Devitt (2015) emphasizes that theorizing and analyzing genre as both contextualized cognitive and social action can approach the often contradictory "space" between genre theories and genre pedagogies (p. 394). Cognitive genres, however, are only beginning to gain prominence in genre analysis, and studies connecting social to cognitive dimensions promise to provide a deeper and more practically applicable understanding of their relationship to social genres.

Social genres, especially those that pertain to academic and professional contexts, have been subject to copious investigation. In the domain of English for Academic Purposes (EAP),[3] largely aiming to inform academic writing pedagogy, work on the research article (RA) genre and its Introduction, Methods, Results, and Discussion/Conclusion (IMRD/C) part-genres has been the most extensive. With a broad focus, this agenda inquires about structural organization, content schemata, rhetorical conventions, and related linguistic choices. Swales' (1981) move/step analytic framework, particularly the CARS (Create a Research Space) model for Introduction sections, has been prolific in the analyses of rhetorical composition. Originally, move analysis was intended as a tool that would assist novices in developing an understanding of scientific writing conventions. Due to its investigative potential for identifying subtle textual characteristics, it has been applied to a wide range of social genres including grant proposals, legal documents, philanthropic discourse, etc.

The RA genre has been at the forefront of move analysis; however, existing studies of IMRD part-genres have not yet put forth move/step models suitable for cross-disciplinary pedagogical applications. To date, the Introduction is the only section for which the CARS model has been thoroughly described, validated through analyses of corpora in various academic fields (Loi, 2010; Ozturk, 2007; Sheldon, 2011), and applied to practice (e.g., Swales, 2011). Devitt (2015) posits that aspiring student scholars generally want and need such straightforward descriptions of discourse forms, which, as classroom practice indicates, play a significant role in their understanding and use of the genre. Another important issue is that, while Methods present novice research writers with difficult decision making about what content to include, how to organize it (Ellinger & Yang, 2011), and the level of detail expected (Smagorinsky, 2008), this section has been investigated the least compared to Results (Brett, 1994; Lim, 2011; Williams, 1999) and Discussion/Conclusions (Holmes, 1997; Parkinson, 2011; Peacock, 2002). Undoubtedly, due to heavy discipline-specific content, it is very challenging for non-specialists to analyze Methods-related discourse in various fields.

Addressing the lack of comprehensive descriptions of Methods discourse is important, as corpus-derived models representative of Methods rhetorical resources used by the disciplines may proffer tangible descriptions that would both help novice writers and would potentially enable "a notion of genre as textually grounded social actions with curricula that extend through different levels of cognitive development" (Devitt, 2015, p. 397). An example worth following is Bruce's (2005) cognitive genre model for general discourse structures, which was applied to the analysis of two small corpora of Methods sections in social and physical sciences (2008a). Drawing on the characteristics of Biber's (1989) four text types, Bruce operationalized Methods' rhetorical structures as four cognitive genres (*report*, *explanation*, *discussion* and *recount*). Importantly, he conceptualized these cognitive genres as discourse units emerging in response to "human intention" and thus relating "to general rhetorical aims to represent certain types of knowledge within discourse" (p. 42). The rhetorical focus in his model, however, covers intentionality only to a certain extent, referring to ways of presenting information: non-sequential in *report*, with orientation on means in *explanation*, in relation to outcomes/conclusions/choices in *discussion*, and sequential or chronological in *recount*. If the ultimate goal is to generate a discourse model for teaching and learning purposes, this higher-order description of cognitive genres should be consolidated and perhaps enriched by a complementary analysis of Methods discourse as social part-genre. Specifically, a deeper understanding of the realizations of moves and steps should provide more specific insights about both the rhetorical purposes and the type of information used to present knowledge in Methods discourse. A dual social and cognitive approach can ultimately serve to operationalize discourse-organizing patterns and the relation between propositions and linguistic choices determined by rhetorical purposes.

This study analyzes a large multi-disciplinary corpus of RA Methods sections. Our objectives were to identify characteristic moves and steps, describe their functional and content realizations, and investigate their occurrence within and across 30 disciplines. Employing a top-down approach to corpus analysis, we developed, tested and validated a rhetorical move/step model, termed Demonstrating Rigour and Credibility (DRaC). The model was applied to corpus annotation to further examine move/step distribution and sequencing. Additionally, the corpus analysis results were triangulated with input from academics in the targeted disciplines. By comprehensively defining the conventional moves and steps of Methods discourse and delving into the patterns shaped by the disciplines, this study not only underscores the value of corpus-based move analysis, but also draws important implications for cognitive genre theory and for academic writing pedagogy.

[3] Genres are studied from different perspectives of genre theory. Johns (2008) provides a comprehensive overview of genre schools including English for Specific and Academic Purposes, Systemic Functional Linguistics, and New Rhetoric.

2. Descriptions of methods discourse

Within the broader knowledge territory, the Methods section anchors the study in the space of a well-established methodological tradition. This section functions as an epicenter, "the core from which radiate the content and organization of each of the other sections" (Smagorinsky, 2008, p. 394). It is an explicit bridge between the review of relevant literature and the newly-obtained results. Largely factual, Methods includes details about the progression of procedural steps and provides sufficient specification for replication studies. Authors may also cite relevant landmark studies (Bazerman, 1988) and justify the choices they made in the research process (Gladon, Graves, & Kelly, 2011). Rooting reported research in established approaches and techniques helps authors underscore the validity of their study (Roe & Den Ouden, 2003) and ward off criticisms (Swales, 1990).

Discourse analyses of the Methods section, albeit scant, offer informative representations of its composition (Lim, 2006). Having examined macro-structural differences of IMRD-structured RAs in Applied Linguistics, Yang and Allison (2004) reported unconventional subheadings indicative of this section's content schemata (Experimental Design, Present Study, Research Method, Settings and Subjects). Graves, Moghaddasi, and Hashim (2013) showed that, unlike the hard and soft sciences, Mathematics lacks Methods sections even though methodologies do exist and are alluded to in the proof techniques. Martínez (2003) revealed regularities in the thematic structure of Methods in Biology, inferring possible relations to rhetorical goals. Nonetheless, previous works have largely bypassed the development of comprehensive move/step models to be applied in disciplinarily heterogeneous academic writing courses. The few studies that distinguished micro-level functions are summarized in Table 1. The move categories are clearly comparable, but only Lim (2006) and Kanoksilapatham (2007, 2015) delineated the steps within the moves.

Because approaches to conducting move analysis have been lacking standardization, "we know little at present about the general patterns of discourse organization across a large representative sample of texts from a genre" (Upton & Cohen, 2009, p. 587). Moreover, researchers pursue different levels of abstraction when determining and segmenting communicative purposes, which presents a problematic inconsistency leading to variable descriptions with varying degrees of specificity (Parodi, 2010). This is true for studies of Methods discourse, too. Also, examining relatively small Methods corpora or few individual disciplines, existing works "are descriptive in terms of content categories, rather than structural in terms of internal textual organization" (Bruce, 2008b, p. 159).

Lim (2006) posits that a Methods rhetorical model is difficult to devise because a narrowly defined step or move may not be entirely appropriate for all academic disciplines. Undoubtedly, due to specialized content and epistemological diversity, it is quite challenging for non-specialists to analyze Methods discourse. Perhaps that is why a considerable gap surfaces upon a close review of instructional resources. 'How to' guides (e.g., Katz, 2009) proliferate the materials on Methods writing. They offer seemingly straightforward tips, though are "hardly the stuff that can guide student writing" (Swales, 1981, p. 6). Generally presented as formulaic recipes with essential ingredients, such tips fail to describe Methods discourse as a communicative event and essentially demote the complexity of argumentation. Moreover, they do not draw on conventional occurrences and recurrences of discourse units that constitute the core of methodological recountal in authentic publications.

Because novice writers lack basic familiarity with the recurrent use of conventionalized forms of scientific discourse, EAP scholars argue for opening the genre scene, especially to second language writers, with texts and their structures (Johns, 2011). Initiation to genre writing through the prism of textual practices in the disciplines and explicit pedagogy, which largely relies on move analysis research, helps set clear learning objectives and offers a springboard for novices' understanding and use of genre discourse (Hyland, 2007). Given the scarcity of existing EAP instructional materials for Methods writing, large-scale multi-disciplinary examinations may illuminate paths to producing empirically-grounded guidelines applicable across various disciplines, similar to Swales' CARS model, which would enable explicit pedagogy for this challenging part-genre. With the ultimate objective of making Methods discourse more accessible and achievable to novice writers, we intend to provide salient rhetorical tools with which students could more effectively enact genre conventions. This study thus focused on devising a pedagogically relevant move/step model that would represent the spectrum of rhetorical strategies in relation to the communicative goals realized in Methods sections. Additionally, the study explored Methods' internal structure, which allowed for intra- and cross-disciplinary comparisons and valuation by experts in the disciplines.

3. Methodology

3.1. The corpus

The Methods corpus used in this study contains a total of 1,423,131 words (see Table 2).[4] It is a sub-set of a specialized corpus of 900 RAs from 30 disciplines, each represented by 30 texts, which was created for a bigger project with a pedagogical focus (Cotos, Huffman, & Link, 2015). The corpus was compiled in collaboration with faculty consultants, who were full professors and associate professors with strong publication records and active research agendas. Therefore, all the consultants had a profound understanding of research and writing in their disciplines. Consultants were recruited based on their response

[4] The acronyms for each discipline are used in the file names that comprise the corpus and will appear in the Results section.

Table 1
Existing move/step schemas for Methods sections.

Study & Discipline	Moves	Steps
Lim (2006) 20 RAs, Management	Data collection procedures	Describing the sample Recounting steps in data collection Justifying data collection procedures
	Delineating procedures for measuring variables	Presenting overview of the design Explaining methods measuring variables Justifying the methods of measuring variables
	Elucidating data analysis procedure	Relating data analysis procedures Justifying data analysis procedures Previewing results
Kanoksilapatham (2007) 60 RAs, Biochemistry	Describing materials	Listing materials Detailing the source of materials Providing the background of materials
	Describing experimental procedures	Documenting established procedures Detailing procedures Providing the background of procedures
	Detailing equipment Describing statistical procedures	
Kanoksilapatham (2015) 180 RAs, 3 Engineering sub-fields	Describing procedures	Announcing objectives Specifying protocolized procedures Detailing procedures Providing procedural background Justifying procedures Describing research sites Declaring ethical statements
	Featuring other methodological issues	Describing materials and participants Setting apparatus Identifying data sources
	Reporting and consolidating findings	Stating findings Interpreting findings Comparing findings Explaining findings
Chang and Kuo (2011) 60 RAs, Computer Science	Explanation, implication, comparisons, or limitation Methods or theories Reference to tables or figures Definitions, variables, equations, or measurement Literature review or reference to other studies Assumptions, conditions, criteria, or hypotheses Purposes and major tasks Background information for methods or theories	
Zhang, Kopak, Freund, and Rasmussen (2011) 12 RAs, Psychology	Relate to prior/next experiments Justify methods Preview methods Describe participants Describe materials Describe tasks Outline experimental procedures Present variables Outline data analysis procedures Present reliability/validity	

to a campus-wide call for participation in the larger study.[5] Each faculty consultant was informed about the overall purpose of the project and then asked to recommend a set of research articles in their discipline. While having only one consultant per discipline is a limitation, being able to draw on actual disciplinary expertise for corpus compilation is a major advantage compared to many studies where researchers could only rely on random sampling of publications and personal judgment of quality. Also, we acknowledge that a 30-text selection cannot accurately represent the diversity of disciplines (see Bazerman et al., 2005; Trowler, 2012), and we cannot affirm that these texts reflect no idiosyncratic preferences; however, we attempted to account for an adequate corpus representation and avoid bias through the following selection criteria:

[5] The uneven number of Arts/Humanities and Social Science disciplines (N = 8) versus Natural and Applied Sciences (N = 22) is representative of the results of our recruitment efforts. In part, the unevenness was also conditioned by the objectives of the bigger project, which was funded to develop a move/step framework for writing in STEM (science, technology, engineering, mathematics). Because several non-STEM faculty were highly motivated to participate in this work, we included their disciplines in our corpus as well. On the other hand, some disciplines (e.g., mathematics, statistics, architecture, history) had to be excluded because their scholarly writing conventions differed drastically from those of experimental research reports and required a separate strand of analysis with more extensive collaboration with disciplinary experts.

Table 2
The Methods corpus.

Arts/Humanities & Social Sciences (8 disciplines; 23%; 486,358 words)	# words per discipline (30 texts per discipline)
1. Applied Linguistics (APLI)	45,472
2. Art and Design (ARTD)	49,130
3. Curriculum and Instruction (CURI)	74,712
4. Economics (ECON)	98,405
5. Business (BUSS)	64,247
6. Psychology (PSYC)	50,938
7. Sociology (SOCI)	48,585
8. Special Education (SPED)	54,869
Natural and Applied Sciences (22 disciplines; 77%; 936,773 words)	**# words per discipline (30 texts per discipline)**
1. Agricultural and Bio-Systems Engineering (AGBE)	49,710
2. Agronomy (AGNY)	47,635
3. Animal Science (ANSC)	40,384
4. Bioinformatics (BINF)	56,637
5. Biomedical Sciences (BMSC)	31,246
6. Biophysics (BIOP)	29,546
7. Chemical Engineering (CHEE)	44,661
8. Environmental Engineering (ENVE)	55,102
9. Food Science (FOOD)	41,386
10. Forestry (FORE)	49,218
11. Geological and Atmospheric Sciences (GEAT)	38,292
12. Horticulture (HORT)	39,734
13. Immunobiology (IMMU)	33,137
14. Mechanical Engineering (MECE)	53,523
15. Meteorology (METE)	37,713
16. Microbiology (MICR)	43,448
17. Molecular, Cellular and Developmental Biology (MCDB)	23,379
18. Physics and Astronomy (PHAS)	44,443
19. Plant Physiology (PLPH)	39,106
20. Synthetic Chemistry (SYCH)	41,757
21. Urban and Regional Planning (URRP)	52,301
22. Veterinary Medicine (VETM)	44,415

1. IMRD-structured reports of experimental research
2. Sampled from three to five highly reputable journals based on impact factors and reputation in the discipline
3. Written by different authors (both native and non-native speakers of English)
4. Representative of a wide range of topics and research methods
5. Recently published (within three years before the time of corpus compilation)
6. Selected based on a holistic evaluation of the quality of scholarship, quality of writing, and quality of visual presentation.

The consultants were also required to include in their collection of 30 articles five papers that they evaluated as exemplary in terms of all three considerations listed in point 6 above. The exemplary articles were needed for initial text analysis.

3.2. Analysis

Considering the importance of replicability and generalizability, we adopted the top-down approach to corpus analysis described by Biber, Connor, and Upton (2007), which Upton and Cohen (2009) call the BCU approach. BCU move analysis was complemented by an inductive analysis that forefronts cognitive judgment and produces a balance between the textual data and the researcher's knowledge of underlying rhetorical functions (see Kwan, 2006). Figure 1 illustrates our analytic procedure as unfolding in three phases. The first phase assumed a functional-semantic focus in an exploratory analysis of the Methods sections in 150 exemplary articles supplied by the disciplinary consultants. We distinguished segments of texts based on content areas and their global and local rhetorical purposes. Taking the content into account is particularly useful in analyzing Methods discourse because often the intended functional meanings are implicit in the description of a given aspect of a study. We then categorized segments into units of analysis, which we initially labeled as 'communicative intent' and 'functional type'. The relations between and among these two broad categories were examined to further delineate tentative moves and steps. Similar to Parodi (2010), our procedure contained equalization checks, or measures to ensure that the results of analyses are verified and adjusted in each phase. Our first equalization focused on addressing conceptual duplication and reducing the number of categories, and also served as the starting point in documenting descriptors for move and step definitions.

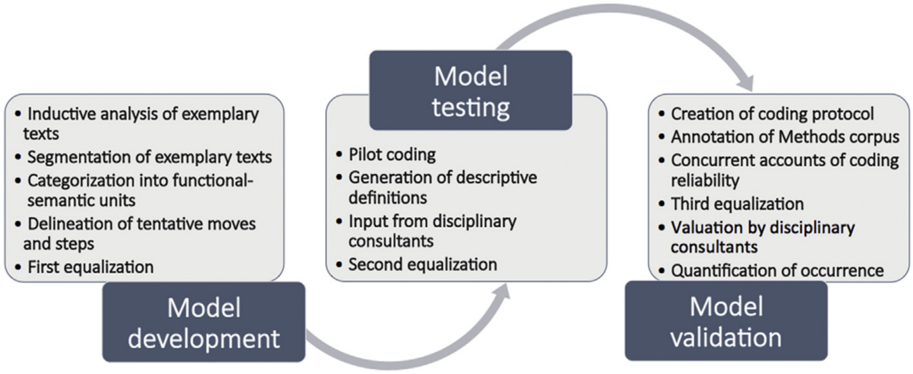

Figure 1. Data analysis phases.

The second phase aimed to test and further refine the move/step model. Individually, we pilot-coded the same set of exemplary texts using the tentative categories. We also conducted parallel discussions of our rhetorical interpretations of coded segments, selected representative examples, and recorded linguistic realizations indicative of given moves and steps. The move/step definitions and examples were presented to our disciplinary consultants, who were asked to return feedback on the clarity of our formulations. Prior to proving feedback, the consultants participated in individual sessions, during which they were explained the move/step concepts with the help of various examples extracted from Methods sections in their discipline as well as from other disciplines. The insights derived from expert input were juxtaposed for the second equalization check to address confusing areas and refine the move and step definitions.

In the third phase, we validated the updated model by manually annotating the entire Methods corpus and quantifying the occurrences of each move and step. The annotation was done following a protocol, which we had developed based on the first and second phases. The unit of annotation was defined as a functional segment of text, which could be either a full sentence or a phrase within a sentence. Because our pilot coding showed that the rhetorical functions were often intertwined, we assigned multiple layers of code to multi-functional segments. In other words, each sentence was given a move/step code indicative of the primary function of the sentence, and if a segment of the same sentence carried an additional functional role, it was coded with a secondary move/step tag. This allowed us to account for discourse multi-functionality and to capture all the instances of rhetorical functions in each sentence. For example, the sentence "*Baseline scores for the different dose conditions were analyzed by separate one-way, separately for each cue condition (i.e., valid go cue and invalid no-go cue).*" was coded as follows:

<methods_m3_analyzing_data | step="describing_data_analysis"> *Baseline scores for the different dose conditions were analyzed by separate one-way, separately for each cue condition (i.e., valid go cue and invalid no-go cue).*

<methods_m2_describing_study | step="describing_tools_instruments_materials">*by separate one-way ANOVAs*

Callisto software was chosen for annotation because it supports multi-layered tagging. Figure 2 depicts an excerpt from an annotated Methods section. The moves are marked with a color code (Move 1 – blue; Move 2 – red; Move 3 – green; grey indicates sub-headings [in web version]) and their names are specified by the tabs in the lower part of the screen. Stretches of text tagged with a particular step are encoded under the move tabs.

Annotating texts in rhetorical terms requires cognitive judgement, and subjectivity can compromise individual interpretations. To minimize subjectivity, we individually annotated a set of the same texts to discuss and clarify instances of disagreement. In addition, calculations of reliability were run throughout the annotation process. Intraclass Correlation Coefficient (ICC) estimates are indicative of relatively high agreement among the three annotators for moves (.86) as well as for steps (.80).[6] These concurrent accounts of coding reliability not only increased the consistency of coding but also informed the third equalization check, which produced the functional definitions presented in the next section. The expert consultants assessed the fit of each category in the model for their discipline and shared their opinions on the perceived occurrence of each move and step, i.e. whether they were generally present, rare, or lacking (see more about the valuation of disciplinary consultants in Section 4.2.5.) The annotated text data was analyzed for frequencies of move/step occurrence in the corpus overall and in each discipline. In line with recent move analysis studies that examine the cyclical patterning of moves (e.g., Brett, 1994; Holmes, 1997; Kanoksilapatham, 2015; Williams, 1999), deeper insights about disciplinary patterns and variation were gained from heat maps illustrating the sequence of moves in the texts of the same discipline, generated using the PHP (Hypertext Preprocessor) scripting language and the GD Graphics Library software. Finally, a *k*-means clustering algorithm

[6] The ICC was calculated by means of a two-way mixed effects model because there was a fixed group of annotators and because the objects measured were random (see Gliner & Morgan, 2000).

Figure 2. Example of annotated text.

(Kanungo, 2002) was applied to differentiate clusters of disciplines based on how authors used the steps. This additional level of analysis extends move analysis research to a still uncharted territory in cross-disciplinary comparisons, as step-based disciplinary clusters have not been previously identified.

4. Results and discussion

4.1. Methods move/step model

The top-down analysis of the Methods corpus resulted in a descriptive model that contains three moves and sixteen steps. Conforming to Swales' CARS metaphor for Introductions, we term the Methods model as Demonstrating Rigour and Credibility (DRaC). Although the naming and composition of moves and steps in previous works differ, all the categories listed in Table 1 are contained in our model as a move, step, or functional descriptor. It should be noted here that the numerical reference to these moves and steps does not indicate organizational sequence, although this sequencing may be a logical approach to structuring the content schemata (see Section 4.2.3). Following, we define the moves and their steps, also supplying representative examples from different disciplines (acronyms are spelled out in Table 2).

4.1.1. Move 1

Contextualizing Study Methods – provides necessary background information for the research approach, setting the scene for study description details and foregrounding the explanation of procedural actions. Thus, it functions as a frame that encircles the description of the study and the analysis of the data.

Step 1 – *Referencing previous works* – situates aspects of the chosen methodology in the breadth of relevant previous works by means of citations, footnotes, and relatively detailed descriptions of methodologies in representative studies. The use of referencing indicates competency in the selection of accepted methods in the field and may facilitate the understanding of the experimental procedure.

- "The near surface stress variation has been previously determined by micro-slotting and is similar to that characteristic of shot-peening profiles [20]." (MECE_2)

Step 2 – *Providing general information* – supplies relevant theoretical, empirical, or informational background aiming to substantiate the methodology of the study. It establishes a connection between the research traditions in the field and the specifics of the reported study. This step may also encompass restating research purposes, hypotheses, gaps in empirical knowledge, and other information that is generally introduced earlier in the paper.

- "Tree cover is usually lower than 50%, but it can be higher on abandoned land and game reserves." (PLPH_21)

Step 3 – *Identifying the methodological approach* – specifies the approach or research design with brevity or elaboration, depending on how common, complex, or innovative it may be to the discipline. Implicitly, it announces a credible research practice and may serve as a transition to a more detailed account of how the study unfolded.

- "The design was a randomized complete block with eight treatments (plastic film mulch) and four replications." (HORT_37)

Step 4 – *Describing the setting* – presents essential characteristics of the research environment such as place, temperature, temporal indicators, lighting conditions, etc. It not only helps the reader conceive of the physical environment or atmosphere, but also calls attention to specific characteristics of the setting that may inform replicability and determine or influence the study outcomes.

- "The pens were in a conventional open-sided house with cyclic temperatures (minimum, 24 °C; maximum, 32 °C)." (ANSC_20)

Step 5 – *Introducing the subjects/participants* – describes essential characteristics of human, animate, or inanimate subjects that were acted upon, observed, or subject to some treatment. This description generally includes their pre-experimental characteristics, such as the number, origin, composition or construction as well as the recruitment, selection, or sampling process.

- "This study included 20 healthy infants with at least one first-degree relative suffering from CD. (MCDB_2)"

Step 6 – *Rationalizing pre-experiment decisions* – aims to justify methodological choices and decisions made prior to the experiment. These justifications reason and explain various aspects related to the conceptualization of the study, including but not limited to the choice of methodological approach, subjects, setting, tools, etc.

- "Together these criteria ensure a suitable sample size that balances between the data collection effort and sufficient statistical power for the subsequent regression analysis." (BUSS_Ex_1)

4.1.2. Move 2

Describing the study – details all the specifics of the study, focusing on what was done in the experimental procedure prior to data analysis and clarifying conditions, treatments, controls, data, tools, in-process judgments, etc. Thus, it fulfills a largely descriptive goal, encompassing key information necessary for potential replication and for a full understanding of how the study derived new knowledge.

Step 1 – *Acquiring the data* – informs about the process of collecting, sampling, or selecting primary or secondary data. Because data are typically acquired with various tools through actions or analyses, data acquisition statements may be embedded in the description of the experimental procedure and may include accounts of tools.

- "Perirenal fat and liver samples from pigs (n = 10) representative of each typology were drawn and pooled on an equal gravimetric basis for the assessment of chemicals of interest." (FOOD_8)

Step 2 – *Describing the data* – presents the characteristics of the data, especially in studies using different types of data or datasets acquired by a third-party. By means of general or specific descriptions (e.g., units of measurement, scales, physical or abstract qualities), it can clarify which aspects of the data may influence methodological decisions or research outcomes.

- "All data were comprised in the MODELKEY database which covered a total of more than 5 million physico-chemical data entries." (ENVE_42)

Step 3 - *Describing experimental/study procedures* – illustrates exactly how experimental steps were completed, outlining what was done in the study in a step-by-step manner and thereby providing detailed description of various investigative actions and their sequence. Being the nexus of Move 2, it usually hems in an overlap with other functional content, particularly related to tools, materials, participants, data acquisition, and variables.

- "Clones were identified and plasmid DNA was prepared (Clontech) for each of the mutants." (BIOP_21)

Step 4 – *Describing tools* – explicates the nature, composition, and/or origin of the tools used in the study for different purposes. The term 'tools' stands for instruments, materials, statistical packages, recording or measurement equipment, etc. In cases when the tools were specifically developed for the study at hand, their description is detailed in discrete passages; otherwise, the mention of tools is embedded in relevant functional content including but not limited to acquiring data, carrying out procedural steps, and analyzing data.

- "It was examined under a fluorescence microscope (OLYMPUS BX41) equipped with a 50W high-pressure Hg lamp and a calcein filter." (GEAT_Ex_5)

Step 5 – *Identifying variables* – distinguishes any variation in the experimental conditions, explicitly indicating treatments or dependent and independent variables. It can also be used in conjunction with other functions, describing how procedures varied between groups, which aspects were observed for data acquisition, or how variables were compared in data analysis.

- "The variables include CAPE, PW, 850-hPa wind direction, and KI, along with its individual components: 850-hPa Td, 700-hPa dewpoint depression, and the 850-500-hPa lapse rate (γ)." (METE_ 35)

Step 6 – *Rationalizing experiment decisions* – lends credibility to choices that were made as the study was being carried out. It indicates with what purpose specific experimental steps were completed and uses reasoning and explanation to justify certain decisions related to data, tools, or procedures. In addition to legitimizing some aspects of the experiment, this step may implicitly connect in-process decisions to research objectives.

- "The R-band isophote was chosen so that the region inside it contained the same area as the aperture of the r-band half-light radius (PetroR50) of SDSS because the bright galaxies in our R-band image had saturated pixels and we were not able to measure the radius in our data directly." (PHAS_40)

Step 7 – *Reporting incrementals* – imparts off-hand calculations or observations relevant to the experimental procedure but not critical to study results and, therefore, not reported in the Results section. These can be incremental measurements or preliminary qualitative observations that must be reported in order to note gradual change in an observed phenomenon and/or provide a justifiable sequence of experimental steps.

- "Analyses of purified populations showed that the purified BM cells were 80% CD11b+F4/80+, whereas the intestinal cells were 80% CD11b+ and contained both F4/80+ and CD11c+ cells." (IMMU_13)

4.1.3. Move 3

Establishing credibility – aims to persuade readers of the quality of analysis and implicitly claim that the study procedure leads to valid and credible findings. Thus, it centers on the explanation of data analysis procedures, presenting all the information necessary to segue into the results of the study and to render why data processing and/or analysis can be trusted.

Step 1 – *Preparing the data* – provides information on how data were handled for analysis. This is accomplished by explaining data selection processes (e.g., sampling, screening, cleaning, inclusion or exclusion, correction) or data manipulation processes (e.g., transforming, coding, tabulating, or estimating).

- "All 30 interactomes were converted into binary interaction networks by setting a threshold of 5 standard deviations above the mean edge probability, retaining ~1% of all edges." (BINF_18)

Step 2 – *Describing the data analysis* – specifies how data analysis was done by either briefly mentioning or thoroughly describing the analysis procedures. This step typically integrates an account of statistical techniques and coding schemes, which are considered tools; therefore, overlap with Step 4 of Move 2 may be common.

- "The standard deviation (SD) was estimated using the equation SD = B [(A/4B)4 + (A/B)3 + (A/2B)2]." (MICR_3)

Step 3 – *Rationalizing data processing/analysis* – aims to present a rationale for data processing or analysis choices. This step is used to show how the statistical and/or other procedures ensure credibility, to clarify why they are expected to yield valid results, or to acknowledge existing limitations.

- "We adjust standard errors to allow for clustering of error terms by birth country." (ECON_15)

Together, these move and step categories attest that Methods sections are strategically preemptive, as writers aim to persuade the readership that their study was designed according to accepted disciplinary standards. This section functions to argue for the credibility of the researchers who conducted the experiment(s). Explicitly and implicitly, Methods also warrant the credibility of results, an idea also noted by Cargill and O'Connor (2009) and Martínez (2003).

4.2. Methods move/step composition in the disciplines

What sets this study apart from previous research is the application of move analysis to a large multi-disciplinary corpus. This is a highly intensive investment of labor; however, it "pays off by enabling more detailed but generalizable analyses of discourse structure across a representative sample of texts from a genre" (Upton & Cohen, 2009, p. 588). This section describes Methods' rhetorical patterns and discourse complexity, also showing how computational techniques can enhance comparative analyses across disciplines beyond what current methods have offered.

4.2.1. Distribution of moves

A total of 94,925 units (i.e., functional segments of text; see Section 3.2) were annotated as one of the three moves in the Methods corpus. Move 2, *Describing the study*, is the most extensive amounting to 71% (67,337 units), Move 1, *Contextualizing Study Methods*, places second with 22% (21,397 units), and Move 3, *Establishing credibility*, is the least frequent with only 7% (6,191 units). The same patterns are captured in Figure 3, which summarizes the distribution of moves in the corpus per discipline. According to Kanoksilapatham (2005, 2015), who classifies moves as obligatory, conventional, or optional depending on their frequencies of occurrence (100%, more than 60%, and less than 60% of the corpus, respectively), Move 2 in our corpus can be considered obligatory, while Moves 1 and 3 optional. Kanoksilapatham's (2015) *Describing procedures* obligatory move found in three engineering sub-disciplines is comparable to our Move 2; the optional *Featuring other methodological issues* move is comparable to our Move 1. It is also relevant to adduce here that all 30 texts in all 30 disciplines included in our corpus contained Move 1, which suggests that optionality in the case of this move can be indicative of writers' opting for more or less of it rather than for its inclusion versus exclusion. Also, it might mean that the disciplinary community perceives Move 1 as conventional with a lower distribution. Conversely, Move 3 was not included by some writers in some disciplines. Illustrative examples can be gleaned from Figure 5 where the green color representing Move 3 is missing in the heat maps of some texts. Thus, exclusion and inclusion of Move 3 should be interpreted accordingly by writers in a given disciplinary community which tolerates the omission of this move, especially if the functional and content realizations of Moves 1 and 2 adequately attend to the essence and nature of the reported study.

4.2.2. Distribution of steps

All the steps pertaining to the three moves were identified in the Methods corpus. Table 3 shows the frequencies of step occurrences within each move. Some steps occur more frequently and some appear much less. Step 3 of Move 1 occurs in 293 sentences, being the least frequent step of all. Steps 1 and 2 in Move 1 are more recurrent, for more content is needed when authors provide a compelling grounding for their methodology and a coherent orientation to the specifics of their study. Detailed accounts of how the study unfolded and what tools were used in the experimental procedures or data acquisition are likely imperative in Methods, which explains the frequent occurrence of Steps 3 and 4 in Move 2. Step 3 in Move 3 occurs to a lesser extent because it generally includes short, precise information (e.g., confidence levels, reliability indices).

As for step frequencies within each discipline, Figure 4(a) to (c) show that the steps occurring with the highest frequency in the corpus are also most prominent in the disciplines. The asterisks in these figures mark the disciplines where some steps occur with a frequency of less than 2% of the move. With regards to Move 1 (Figure 4a), most disciplines appear to be using four to five steps, eleven disciplines use all six steps, and only Biophysics and Synthetic Chemistry seem to operate with three

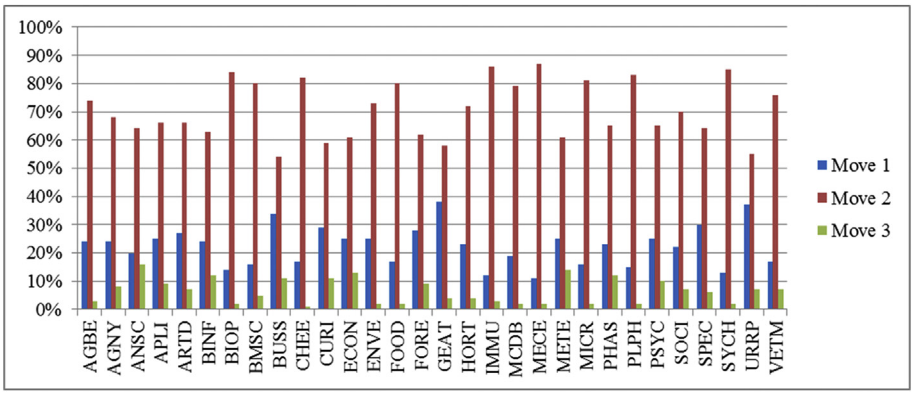

Figure 3. Distribution of moves within and across disciplines.

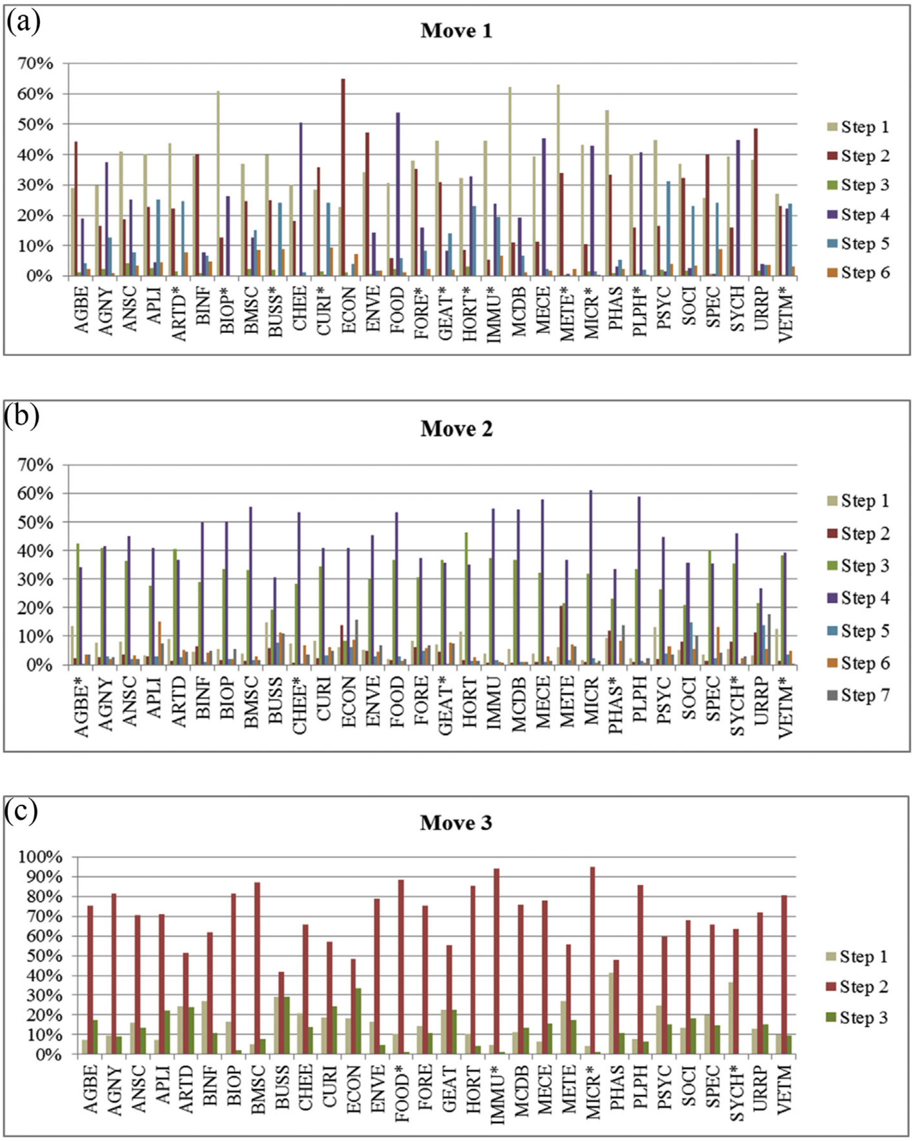

Figure 4. (a). Distribution of Move 1 steps within and across disciplines; (b). Distribution of Move 2 steps within and across disciplines; (c). Distribution of Move 3 steps within and across disciplines.

steps. Spikes of Steps 1 (*Referencing previous works*), 2 (*Providing general information*), and 4 (*Describing the setting*) are consistent across all the disciplines in the corpus.

As mentioned earlier, Move 2 is predominant in Methods sections in individual disciplines, and its steps are broadly employed in all the academic fields represented in the corpus. What stands out the most is the occurrence of all seven steps in each discipline (Figure 4b). Although Step 3 (*Describing experimental procedures*) and 4 (*Describing tools*) have the highest frequency, which is similar to Kanoksilapatham (2007), authors in all disciplines choose to include brief but essential details about data sources, data characteristics, and specifications of variables. Interestingly, Step 6 (*Rationalizing experiment decisions*) has comparably higher frequencies in the social sciences.

It is evident in Figure 4c that Step 2 (*Describing data analysis*) in Move 3 is the main strategy used by all thirty disciplines to establish credibility in the Methods section. Most of the disciplines seem to balance Step 1 (*Preparing the data*) and Step 3 (*Rationalizing data processing/analysis*) (e.g., Art and Design, Business, Geological and Atmospheric Sciences); others tend to rely more either on Step 1 (e.g., Bioinformatics, Environmental Engineering, Food Science, Physics and Astronomy, Synthetic Chemistry) or Step 3 (e.g., Applied Linguistics, Economics).

Furthermore, while some steps are adopted by all the disciplines, there is a degree of variation in the use of certain steps that reflects discipline specificity. For example, Business utilizes a wide range of steps in all the moves, thus bearing a richer

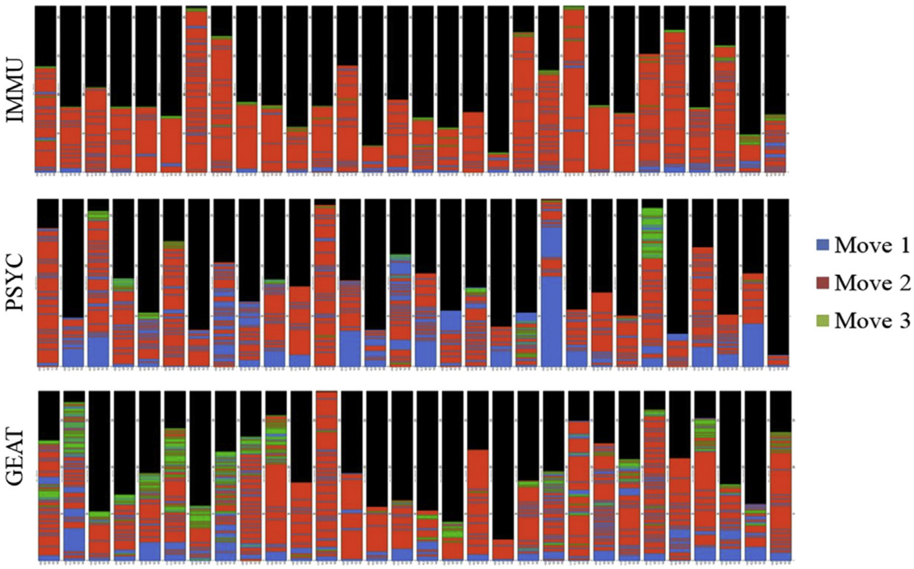

Figure 5. Heat maps exemplifying move sequencing.

rhetorical coloring. Economics, Meteorology, and Urban and Regional Planning operate with a variety of Move 2 and Move 3 steps, but only a few Move 1 steps. Microbiology and Biophysics heavily exploit only one or two steps per move. Such variation can be seen both in the humanities and in the natural sciences, but because they are not evenly represented in our corpus we abstain from claims about patterns that distinguish these broad areas.

4.2.3. *Move-level organization*

The annotated corpus data demonstrates that Methods are not linearly structured. The heat maps generated for all 30 disciplines revealed patterns of move organization. Since word length restrictions do not permit a full discussion of the heat maps of all thirty disciplines, we will focus on three disciplinary sub-corpora: Immunobiology (IMMU), Psychology (PSYC) and Geological and Atmospheric Sciences (GEAT), as each of these pertain to different disciplinary clusters presented in the following section and shown in Figure 6. The images for each discipline depict the move structure of the 30 respective Methods sections. Each bar represents a text; the blue, red, and green colors (in web version) in each bar represent the moves; the beginning of a black strip indicates the end of the text.

Table 3
Step frequencies in Methods corpus.

Steps	Sentences	
	Number	Percent
Move 1, *Contextualizing Study Methods*		
1. Referencing previous works	8,064	37.7
2. Providing general information	6,259	29.3
3. Identifying methodological approach	293	1.4
4. Describing the setting	3,271	15.3
5. Introducing the subjects	2,672	12.5
6. Rationalizing pre-experiment decisions	838	3.9
Move 2, *Describing the study*		
1. Acquiring the data	4,300	6.4
2. Describing the data	2,522	3.7
3. Delineating experimental/study procedures	21,320	31.7
4. Describing tools	30,693	45.6
5. Identifying variables	2,055	3.1
6. Rationalizing experiment decisions	3,170	4.7
7. Reporting incrementals	3,277	4.9
Move 3, *Establishing credibility*		
1. Preparing the data	1,148	18.5
2. Describing data analysis	3,999	64.6
3. Rationalizing data processing/analysis	1,044	16.9

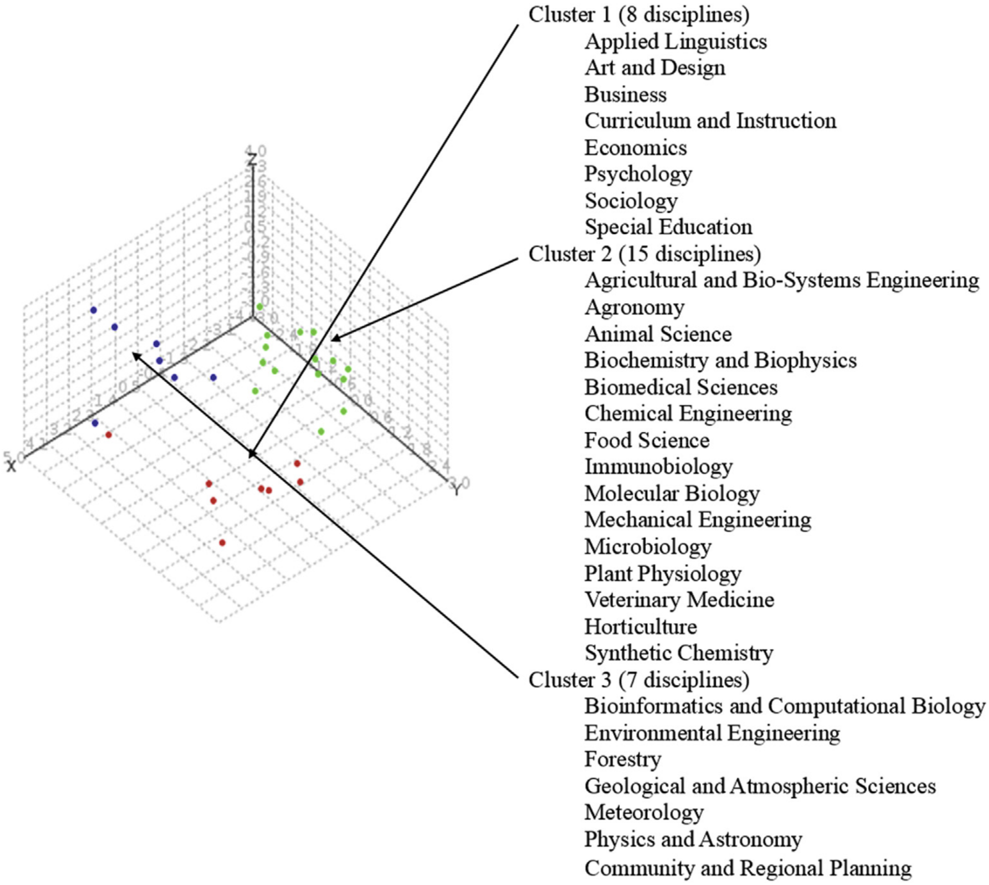

Figure 6. Clusters of disciplines similar in the use of steps.

Compared vertically, the heat maps exhibit perceptibly noticeable patterns distinguishing these disciplines. Writers in Immunobiology tend to open Methods sections with a brief contextualization of study methods (Move 1) and to close with even shorter credibility statements (Move 3), thus relying primarily on extensive description of the study (Move 2). Psychologists, while still devoting much content to Move 2, attribute more attention to Move 1 at the beginning. In many Geological and Atmospheric Sciences texts, Move 3 occurs not only at the end, but also throughout the section. While the extent to which these and other disciplines employ the moves varies, they seem to engage in Move 1–Move 2 cycles. Move 3, where present, tends to follow Move 2. Kanoksilapatham (2015) documented a similar cyclical patterning, suggesting that *Describing procedures* and *Featuring other methodological issues* are likely to be cyclical in engineering fields.

Compared horizontally, the heat maps show how the moves are distributed and sequenced in individual texts. In Immunobiology, most texts have a comparable composition, suggesting that there is more conformity in the discipline as to how methodologies are reported. Psychology, on the other hand, allows for a detectable variation; it can thus be inferred that authors may have more rhetorical flexibility, which is likely possible due to the diversity of research paradigms employed to study diverse populations. Intra-disciplinary variation also characterizes Geological and Atmospheric Sciences, where the studied sites may determine the extent to which methods need to be contextualized or justified. Using the IMRD corpus compiled for the larger study (Cotos et al., 2015) from which our Methods corpus was derived (see Section 3.1), we computed matrixes for step transition probabilities for all IMRD sections, demonstrating that there is a certain degree of structure in the order of steps. In Methods, *Referencing previous works* was very likely to be followed by *Providing general information* and by *Identifying methodological approach* (Move 1); *Acquiring data* – followed by *Describing data*, and *Delineating experimental procedures* – by *Describing tools* (Move 2); and *Preparing data*, *Describing data analysis*, and *Rationalizing data processing/analysis* (Move 3) were likely to both precede and follow each other. That study also predicted some step transitions as less likely or inexistent. For example, the probability of *Referencing previous works* (Move 1) being followed by *Introducing the subjects* (Move 1), *Delineating experimental procedures* (Move 2), and any of the steps of Move 3 was zero.

4.2.4. Step-level similarities

Our algorithmic analysis extended to comparing the disciplines based on differences and similarities in their use of steps. We identified sets of disciplinary clusters, which are mapped onto a three-dimensional space in Figure 6. In short, eight disciplines formed Cluster 1, fifteen disciplines formed Cluster 2, and seven disciplines clustered into a third group. Note that the Immunobiology, Psychology, and Geological and Atmospheric Sciences texts discussed above pertain to different clusters, which suggests that these disciplines differ not only in the organization of moves but also in the moves' step composition. Interestingly, the soft sciences all pertain to Cluster 1, while the hard sciences form Clusters 2 and 3. Cluster 2 contains life and applied sciences, and Cluster 3 also includes the physical sciences. Such clustering is likely indicative of a certain level of comparability of epistemological traditions and research approaches to scientific inquiry. This finding also confirms intuitive assumptions about disciplinary differences generally made in academic writing instruction.

These insights, while not unexpected, are particularly important for understanding the cross-disciplinary functions of IMRD discourse. In Cotos et al. (2015), we reported that some disciplines make similar use of IMRD steps in one section, but differ from that set of disciplines in their step use in other sections. For example, Sociology (Cluster 1 in Figure 6) stays within the same cluster across the IMRD sections, while Agronomy (Cluster 2 in Figure 6) uses Introduction steps similar to engineering and chemistry disciplines; Methods steps – similar to biological sciences; Results sections – similar to social sciences, and Discussion/Conclusions – similar to engineering and chemistry disciplines. We found that eleven disciplines were consistent in IMRD/C step use similarity to specific disciplines, and nineteen resembled the step use of different sets of disciplines depending on the section of the article. Certainly, the rhetorical steps that recur within these disciplinary clusters bear upon the type of phenomena being studied because the choices made to articulate aspects of the methodology are driven by the nature of disciplinary research. That is, to study a certain human or natural phenomenon, specific activities must be conducted and reported in specific ways to be viewed as credible and done dependably, so some of the moves and steps that recur within disciplinary clusters are directly related to the type of phenomena being studied, which may or may not bear epistemological similarities.

Another possible inference to be made from our cluster analysis is that the disciplines' comparability in the use of steps may be indicative of 'fast' and 'slow' Methods sections (Swales & Feak, 1994, 2000). 'Slow' refers to the density of discourse, in fact meaning 'extended.' For instance, social science disciplines that involve human participants tend to include a range of details, examples, and justifications. 'Fast' on the other hand stands for 'condensed.' Bruce (2008a, 2008b) examined this distinction, reporting that 'fast' Methods sections in the physical sciences generally employed a means-focused discourse structure, which was characterized by the *explanation* cognitive genre. The 'slow' Methods sections in his study combined chronological and non-sequential descriptive structures characterized by a combination of *recount* and *report* cognitive genres. Our DRaC model expands on the rhetorical focus of *explanation* through the descriptors of the steps of Move 2 and Move 3, which present information with an orientation on means for achieving a particular outcome (e.g., how the data was acquired, how variables were manipulated, how tools or materials were used, how data analysis was done, why certain actions were undertaken, etc.). *Recount* rhetorical features can be associated with the steps of Move 1, which provide relevant information necessary to foreground the explanation of procedural actions. It would be interesting to further explore how the speed or density of Methods in the three disciplinary clusters presented above is related to their use of steps.

4.2.5. Expert perceptions

The corpus-based findings were triangulated with the expert consultants' judgments, which added another piece of evidence for the validity of the DRaC model. Most of the consultants affirmed that authors in their field use all three moves: Move 1–78% of the consultants, Move 2–82%, and Move 3–87%. Percentages indicating their perceptions of step occurrences are provided in Table 4.

Table 4
Perceived occurrence of moves and steps.

Steps	Perceived occurrence		
	% present	% rare	% lacking
Move 1, *Contextualizing Study Methods*			
1. Referencing previous works	100%		–
2. Providing general information	96%	–	4%
3. Identifying methodological approach	84%	12%	4%
4. Describing the setting	72%	16%	12%
5. Introducing the subjects	56%	28%	16%
6. Rationalizing pre-experiment decisions	60%	28%	12%
Move 2, *Describing the study*			
1. Acquiring the data	96%	4%	–
2. Describing the data	84%	8%	8%
3. Delineating experimental/study procedures	92%	8%	–
4. Describing tools	84%	8%	8%
5. Identifying variables	84%	16%	–
6. Rationalizing experiment decisions	80%	16%	4%
7. Reporting incrementals	52%	40%	8%
Move 3, *Establishing credibility*			
1. Preparing the data	96%	4%	–
2. Describing data analysis	96%	4%	–
3. Rationalizing data processing/analysis	68%	24%	8%

Juxtaposing the corpus frequency data with the experts' perceptions provided informative insights. In some cases, expert perceptions coincided with our corpus observations. The Economics consultant indicated that Step 4 of Move 1 is likely lacking, and the Synthetic Chemistry consultant thought Steps 5 and 6 are lacking, which is in line with our corpus findings for these disciplines. On the other hand, while we found no instances of Steps 3 or 6 in Biophysics, Chemical Engineering, Molecular Biology, Mechanical Engineering, and Synthetic Chemistry, the respective experts mentioned that those rhetorical strategies may in fact be appreciated in their field and should be included in Methods writing instruction. In other cases, consultants' feedback helped re-shape some of our categories. For example, when commenting on Move 1, our Curriculum and Instruction consultant said, "*I understand that this analysis is only referring to the Methods section and not so much referring to the introduction or literature review sections. However, I would argue that a step on why the current work is addressing the gap is needed.*" Paired with our analysis, this and other similar comments emphasizing the need to justify methodological choices contributed to our inclusion of rationalizing as separate steps in each of the three moves (Step 6 of Move 1, Step 7 of Move 2, and Step 3 of Move 3). Yet in other instances, our categories helped disciplinary experts better understand some intricacies of Methods writing, which they perceived as inexistent. Here, it is worth noting that while Step 7 of Move 2 was identified in all 30 disciplines in the corpus (and by Lim [2006]), some experts believed that it was rare (40%) or lacking (8%). A consultant in one of the natural sciences, for instance, commented, "*Reporting incrementals – this is an interesting "gray" area in my field. Sometimes it is done, but mostly they are reported in the Results section and further discussed in the Discussion section. If there is reason to not use data, it is generally done in the Discussion section.*" In follow-up discussions of specific examples, however, this consultant and other consultants who marked this step category as rare or lacking confirmed that quantitative and qualitative notes not critical to study results are indeed included, and welcomed separating this step from Step 3 (*Delineating experimental/study procedures*), which is what they had initially attributed "incrementals" to. Interestingly, consultants' feedback on the steps with factual content realizations (Move 1, Steps 3–5; Move 2, Steps 1–5, Move 3, Steps 1–2) clearly reflected their disciplinary insider status. In their judgments of more rhetorically-charged categories (e.g., Move 1, Step 6; Move 2, Step 6, Move 3, Step 3), the consultants seemed to draw more on their general expectations as scholars, looking for convincing threads of argument needed to warrant research design decisions and resultant empirical outcomes. Overall, their comments resonated with Smagorinsky's (2008) discussion of how authors need to accomplish both descriptive and argumentative goals by being highly explicit in presenting procedural details and also accounting for their methodological decisions in sufficient detail to be persuasive.

5. Conclusions and implications

This study focused on devising the Demonstrating Rigour and Credibility (DRaC) move/step model indicative of the spectrum of rhetorical strategies in relation to the communicative goals realized in Methods discourse. This model helps explicate the general role of Methods sections, which represents a whirlwind of information that is rhetorically reinforced and strategically organized. Investigating the rhetorical composition and structure of Methods sections allowed for intra- and cross-disciplinary comparisons and valuation by experts in the disciplines.

In terms of theory, the corpus-based descriptions underlying the DRaC model lend support to the view that social genres exhibit features of various cognitive genres. Given that rhetorical structures can be operationalized as cognitive genres, the model provides a more detailed descriptive framework for a Methods-specific cognitive genre model that can be fine-grained based on the functional descriptors of the rhetorical steps. For Methods discourse in particular, Bruce (2008a) pointed out three types of cognitive genres specified by Pilegaard and Frandsen (1996): *report*, *recount*, *discussion*, and *explanation*. The DRaC steps suggest a wider array: *orientation* (referencing previous works, providing general information), *description* (of setting, subjects, data, tools, variables); *demonstration* (of experimental procedures and data analysis); *argumentation* (when rationalizing decisions); and *persuasion* (when rationalizing data processing/analysis). In fact, each move can be viewed as a fusion of different cognitive genres integrated in its step functions. Further research applying our model needs to explore this relationship and to corroborate this interpretation.

A much needed contribution, in our view, lies with the applicability of the DRaC model to genre-based writing pedagogy. Teachers can adopt and adapt the move/step descriptors to facilitate students' comprehension of how every piece of text contributes to achieving a communicative purpose. Informed about the distribution of steps within and across disciplines, they can present some steps as obligatory and others as optional. Then driven by the rhetorical exigence of their research results, students can 'piece' their own Methods section, integrating appropriate rhetorical strategies. At the same time, it is important for teachers to acknowledge that it is the nature of research, not the rhetorical conventions, that determine how the students should articulate aspects of their methodology. The phenomenon they study, whether human or natural, conditions specific research actions that, in turn, must be reported in specific ways to be accepted as credible and reliable.

The move/step annotated corpus can be used to actively engage students in 'genre-deconstructing' corpus explorations, thus expanding the potential of top-down corpus analysis from research to practice. Exploited as an instructional tool, the annotated corpus (accessed through Callisto or other platforms) can help students picture the discourse structure and observe the distribution of rhetorical functions as well as the intricate ways in which functional meanings complement each other. Extensive exposure to genre conventions can also draw students' attention to the content schemata realized through moves and steps, at the same time facilitating their noticing of linguistic features associated with particular rhetorical shifts. Unlike traditional approaches that draw students' attention to frequently occurring linguistic features, this approach can help them uncover functional meanings that may be rare but carry a strong communicative message. Furthermore, integration of social and cognitive genre perspectives in genre writing instruction can be achieved by combining discussions of disciplinary contexts, epistemologies, and target audiences with activities disentangling cognitive genre resources in authentic texts. Bruce (2008b, p. 164) describes the teaching focus on cognitive genres, modeling questions for student enquiry (e.g., "What are the different micro-level communicative aims of sections of this text? How is information or argument structured in relation to these aims? Are there patterns or types of writing which relate to these aims?"). The definitions of DRaC move/step categories and the descriptions of their patterns of occurrence provided by this study can scaffold students' enquiry into the features of cognitive genres within Methods as social part-genre.

Given the laborious process of manual corpus annotation, this study did not complete an important component of the BCU approach – the analysis of the linguistic characteristics through which the moves and steps are realized. Therefore, further analyses of lexico-grammatical features are needed to inform pedagogy about the range of language choices writers make to achieve Methods-specific communicative intentions (e.g., Harwood, 2005). We call for a synergy of move analysis and other epistemologically different methodologies. For instance, combining the BCU linguistic analysis of moves with the analysis of knowledge structures outlined in Mohan's (1986) Knowledge Framework rooted in Systemic Functional Linguistics would be particularly appropriate. The latter focuses on language and content by analyzing what discourse does relative to thinking, and would therefore also allow for generating theoretical interpretations pertinent to cognitive genres. Additionally, Flowerdew (2009) maintains that a function-first approach can be very powerful for student learning, especially if move-tagged corpora allowed for queries that would yield examples of functional roles of texts. The corpus annotated for this study has already been used to build a move/step functional concordancer. An even greater leap forward is computational operationalization of genre constructs, and the first advancement in this direction is using move-annotated corpus data to train genre-based automated writing evaluation and feedback technology (Cotos, 2016).

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