Furthering and applying move/step constructs: Technology-driven marshalling of Swalesian genre theory for EAP pedagogy

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Abstract
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Keywords
genre analysis, move, step, genre-based writing pedagogy, automated writing evaluation, research writing

Disciplines
Curriculum and Instruction | Curriculum and Social Inquiry | Educational Assessment, Evaluation, and Research | Educational Methods

Comments
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Abstract

John Swales’ seminal work has inspired a wealth of research with important pedagogical implications for genre-based writing instruction. Continuing the prolific move analysis tradition in EAP research, this article presents empirically devised and validated cross-disciplinary IMRD move/step frameworks for the research article genre and demonstrates how Swales’ move and step concepts underlying these frameworks formed the foundation of innovative genre-based automated writing evaluation technology. Overall, this paper makes the relationships between genre theory, genre analysis, and genre instruction explicit, demonstrating that move analysis is a powerful and promising theoretical, analytic, and teaching construct. With that, we take Swales’ vision to a new dimension of conceptualizing EAP.

1 Introduction

John Swales’ work has immensely advanced genre-based scholarship, especially since the publication of Genre Analysis where he theorizes the concept of genre for research and teaching. The ‘move’ embodiment of communicative purpose, defined as a “rhetorical unit that performs a coherent communicative function” (Swales, 2004, p. 228-229), enabled the interpretation of genres as reflective of “language use in a conventionalized communicative setting in order to give expression to a communicative set of goals of a disciplinary or social institution” (Bhatia, 2004, p. 23). Swales’ conceptualization made headway for a vibrant research agenda with multi-level analyses of socially situated discourse, which intertwine a range of analytic trajectories from systemic functional linguistics (SFL), corpus linguistics, and English for specific and academic purposes (ESP/EAP). Arguably, Swales’ approach to genre analysis bridges these linguistic traditions with contesting rhetorical perspectives by conjoining genre, structure, communicative purpose, language choice, context, and discourse community.1 His rhetorical move framework is, thus, a major contribution to the understanding of genres, genre sets, genre systems, and meta-genres, as well as of the relatedness and variation within and among them.

Equipped with a conceptual framework of rhetorical moves, which encompass specific functional ‘steps,’ EAP/ESP researchers have investigated a range of academic and non-academic genres. Most extensively, however, move analysis has been applied to the research
article (RA) genre, and John Swales, who pioneered the ‘create a research space’ (CARS) model for RA Introduction sections, is rightfully called the father of RA studies (Atkinson, 2013). A myriad of studies have validated the CARS model through analyses of corpora in different academic fields (Chang & Schleppegrell, 2011; Crookes, 1986; Durrant & Matheus-Aydinli, 2011; Loi, 2010; Milagros del Saz Rubio, 2011; Ozturk, 2007; Samraj, 2002; Sheldon, 2011). In like manner, move frameworks have been devised for Methods sections (Chang & Kuo, 2011; Kanoksilapatham, 2007; Lim, 2006; Zhang, Kopak, Freund, & Rasmussen, 2011), for Results (Brett, 1994; Bruce, 2008; Lim, 2010; Nwogu, 1997; Swales & Feak, 2004; Williams, 1999), and for Discussion/Conclusions (Dudley-Evans, 1997; Holmes, 1997; Parkinson, 2011; Peacock, 2002; Yang & Allison, 2004). Cumulatively, these works demonstrate that RAs share similar communicative purposes and that academic discourse varies across disciplines (Anthony, 1999; Hyland, 2000; Nwogu, 1997; Posteguillo, 1999; Samraj, 2002).

This thrust of move analysis research, like Swales’ work - often motivated by teaching needs, has strengthened the relationship between linguistic inquiry and EAP pedagogy. Genre-based writing instruction (GBWI) (see Johns, 2011), in particular, has benefited from Swales’ modeling of how genre study results can be applied to materials development and course design. Academic Writing for Graduate Students, English in Today’s Research World, and the monographs in the Michigan Series in English for Academic and Professional Purposes co-authored with Christine Feak (e.g., Feak & Swales, 2009; Swales & Feak, 2009) are illustrative examples of the research-practice convergence informing GBWI. Explicit teaching of moves and steps to develop students’ genre awareness and rhetorical consciousness-raising (Swales, 1990) have been progressively endorsed in graduate writing courses that target the RA and other research-related genres. Such focus on rhetorical complexity carries considerable pedagogical promise (see Bianchi & Pazzaglia, 2007; Chang & Kuo, 2011; Charles, 2007; Cortes, 2007, 2011; Lee & Swales, 2006; Swales, Barks, Ostermann, & Simpson, 2001; Swales & Lindemann, 2002; Swales & Luebs, 2002).

Swales’ theory of genre is slowly but confidently entering the arena of computer-assisted writing tools. For example, the Type Your Own Script (TYOS) online writing tool was developed “to highlight rhetorical strategies and linguistic choices” in a small corpus of RA Introductions produced by L2 writers, which includes first drafts and their revised versions that were analyzed and pedagogically processed (Birch-Bécaas & Cooke, 2012, p. 242). Advances in technology also allow for developing intelligent tools powered by applied natural language processing (ANLP), where move analysis is viewed as a relatively robust analytic framework (Kent & McCarthy, 2012). Although to date there are very few instructional applications that are based on probabilistic computational models and semi-automated and automated analysis of RA discourse, the existing applications serve as encouraging proof-of-concept evidence for the potential of move analysis for instruction-driven computational investigations of discourse. For example, Sun (2007) created the Scholarly Writing Template (SWT), which provides students with an information template containing an outline of moves for the writing of research papers. Anthony and Lashkia (2003) applied machine learning techniques to developing the Mover, a software tool that presents learners with the move structure of RA Abstracts. Cotos (2009) took a step further, developing a genre-based automated writing evaluation (AWE) program called the Intelligent Automated Discourse Evaluator (IADE). This tool, grounded in second language and skill acquisition theories, translates the results of automated move analysis to move-level feedback, facilitating students’ focus on the functional meaning of the RA Introduction

These technological applications are reactive to pedagogical needs, which inadvertently pose challenges. While research in instructional settings has shown that explicit analysis of specialized corpora can be an empowering GBWI approach, there have also been reports of less successful endeavors, among which Swales himself reasons about experiences that he evaluates as educational “shots in the dark” (Swales, 2002, p. 162). Instructional missteps are not only due to certain limitations of a chosen pedagogical approach, but also to contextual factors. One such factor is disciplinary heterogeneity in the classroom, where students from a variety of majors need to learn the discursive practices of their particular fields. Limited individualized opportunities for genre learning and practice add an extra layer to the challenge of teaching writing in the disciplines. Motivated by this pedagogical conundrum, we marshal the move construct and AWE to provide GBWI with an intelligent interactive tool for teaching and learning disciplinary research writing.

2 Technology driven marshalling of the move construct

Despite the abundance of research on the structural interpretation and linguistic description of RAs, practitioners are still in wait for a comprehensive framework that would allow for cross-disciplinary analysis of the rhetorical composition of each IMRD section and would thus permit the development of instructional materials and technologies to adequately address discipline specificity. In a large-scale project, we set out to accomplish a two-fold purpose: (1) to devise and validate cross-disciplinary move/step IMRD frameworks, and (2) to computationally operationalize these frameworks in a genre-based AWE program, called the Research Writing Tutor (RWT). This tool is unique in that it analyzes students’ research articles, generates discipline-specific feedback based on the rhetorical conventions of this genre, and provides different forms of corpus-based scaffolding to foster learning and writing improvement. Our ultimate goal for the use of RWT in GBWI is to foster the writing of RAs as a dynamic construction of knowledge artifacts that are socially oriented and that reflect a constructionist dialog with a disciplinary community.

As teachers inspired by the move construct applied to corpora, we take Swales’ vision to a new dimension of conceptualizing EAP pedagogy to promote “technology-enhanced rhetorical consciousness-raising” (Lee & Swales, 2006, p. 72) of discipline-specific RA conventions. In this article, rather than reporting a single research study, we aim to illustrate how Swales’ rhetorical concepts can advance genre study and instruction by presenting a selection of results from our RWT development research. We first describe the methodological approach of our move analysis of RA corpora in 30 disciplines, and then introduce the cross-disciplinary move/step frameworks devised for each IMRD section. We also showcase findings in terms of cross-disciplinary genre conventions, disciplinary patterns and variation, and linguistic realizations. The next part lays out several examples of algorithmic move analysis results to further demonstrate how the corpus-based and computational analyses of moves have been operationalized in RWT features. To conclude, we call for inter-disciplinary research, which is imperative if this technological embracement of the move construct is to be carried over into effective pedagogical practice.
2.1 Cross-disciplinary IMRD move/step frameworks

2.1.1 The corpus

The Iowa State University Research Article (ISURA) corpus used in this project represents a broad sampling of 900 RAs from 30 disciplines: 8 in Humanities and Social Sciences and 22 in Natural and Applied Sciences, with each discipline being represented by 30 texts (see Appendix A). The articles were selected according to the following criteria that rely on Sinclair’s (2005) basic principles for building a corpus:

- Follows the IMRD structure
- Reports on empirical/experimental research
- Published in a high-impact peer-reviewed academic journal (3-5 journals per discipline)
- Published recent to the date of selection (2009-2011)
- Written by different authors

The compilation of the corpus was assisted by expert consultants, graduate faculty with active research agendas in their respective disciplines (N=30), who recommended journals in their field of expertise. The consultants holistically evaluated all the texts for the quality of research, writing, and visual presentation. In addition, each consultant provided a set of five exemplary articles to be included in the 30 RAs compilation for their discipline, which were used for the initial text analysis and segmentation.

2.1.2 Top-down corpus-based analysis of IMRD discourse organization

For a theoretically grounded analysis of the RA discourse, we employed the qualitative top-down approach proposed by Biber, Connor, and Upton (2007) assuming a functional-semantic focus, which emphasizes the importance of cognitive judgment for the identification of the global rhetorical purposes of moves as well as their local purposes accomplished through the functional meanings of steps (see Kwan, 2006). Devising the move/step frameworks for each IMRD section followed identical procedures. It must be mentioned that the analysis of Introductions was based on Swales’ work (1981, 1990, 2004) and mirrors the CARS model.

The first step was exploratory, involving an inductive analysis (Johnson & Christensen, 2004) of the five exemplary articles in each discipline to determine the possible “communicative/functional categories” (Biber et al., 2007, p. 13). This process of initial examination of each RA section’s discourse schemata entailed: (1) close reading of the sample of 150 exemplary texts; (2) distinguishing segments based on their global and local rhetorical purposes; (3) categorizing them into functional-semantic discourse units of analysis, which we tentatively labeled as ‘communicative intent’ and ‘functional type’; (4) addressing duplication and reducing the number of categories; and (5) grouping categories to create a tentative move/step schema, where the ‘communicative intent’ categories were translated into possible moves and the ‘functional types’ were translated into steps. It is important to note that this was not a one-to-one transformation; some categories were combined and some were integrated as definition descriptors.

The second step involved concurrent segmentation and classification by means of pilot annotation of the same sample of texts in order to test the tentative move/step IMRD schemas.
This testing phase combined individual coding with extensive discussion and recording of the linguistic realizations encountered during annotation, which generated specific descriptors used to further formulate functional definitions for the proposed moves and steps. At this stage, the IMRD schemas, along with move/step definitions and representative examples, were presented to the expert consultants, who provided feedback on their clarity and fit for the discipline. With this input, we addressed potentially confusing areas and refined our formulations. As recommended by Connor, Upton, and Kanoksilapatham (2007), we then developed a coding protocol with clearly defined discourse components as well as guidelines and examples for subsequent annotation training.

Next, the refined IMRD move/step schemas were applied to the annotation of the entire corpus by three coders. Given that the application of move frameworks in general may be confined by subjective identification of functions and boundaries (see Crookes, 1986; Paltridge, 1994), the annotation process was not only preceded by training, but also continually informed by iterative calculations of inter-coder agreement on moves and steps and by adjudication of individual cases of disagreement. Cohen’s Kappa \( \kappa \) estimates of inter-coder reliability between pairs of coders were relatively high throughout the entire annotation process, ranging between .60 and .99 on moves. Reliability among the three coders was measured by Intraclass Correlation Coefficient (ICC) estimates, which also indicated a relatively high agreement among the coders both for moves (ICC = .86) and for steps (ICC = .80) (Saricaoglu & Cotos, 2013). Frequent reliability checks helped identify problematic categories, substantiate the understanding of move/step realizations in each section, improve the coding protocol, and consequently improve annotation consistency. Additionally, the coders regularly communicated with the expert consultants to better understand discipline-specific content and ensure appropriate classification.

Each text was manually annotated at sentence-level for moves and at phrasal-level for steps in Callisto, as this tool allows for multiple tagging. Thus, unlike other move-analysis studies where only the most salient functions of sentences were coded (e.g., Berkenkotter & Huckin, 1995; Brett, 1994; Bruce, 2008; Crookes, 1986; Holmes, 1997; Kanoksilapatham, 2005; Martinez, 2003; Nwogu, 1997; Ozturk, 2007; Parkinson, 2011; Peacock, 2002; Posteguillo, 1999; Yang & Allison, 2003), we captured the multifunctionality of discourse by assigning more than one move or step to stretches of text that combined different rhetorical strategies. In such instances, a tag encoding a full sentence indicated a primary move, and a tag encoding only part of a sentence indicated the step function of a secondary move (see Appendix B for an example of single and multiple annotation layers marked by move and step notation).

2.2 Corpus-based descriptions of IMRD discourse

In this section, we provide a comprehensive yet concise presentation of select results. We first introduce the IMRD frameworks, briefly elaborating on the principles underlying our move/step definitions. Then, we address insights from the frequency analysis examining general patterns and variation discernable in the annotated corpus data, followed by succinct specifications of the linguistic realizations of communicative functions. In each of these areas, we integrate examples from different RA sections instead of extensively reporting results per section and per discipline.

2.2.1 IMRD move/step frameworks
Table 1 summarizes the IMRD move/step frameworks, which follow Swales’ metaphorical approach to conceptualizing the RA discourse. The research space created in the Introduction is further enriched through the presentation of the reported study. The Methods discourse is rather descriptive, contextualizing the research approach and detailing the specifics of the study. The Results section delves into the niche, reminding the readers of how it was approached methodologically to ensure a more meaningful demonstration of how the study occupies the niche. In cases when authors choose to embed discursive elements in the Results section, their discourse contains elements of construing and perhaps even expanding the niche. These elements are similar to the functional realizations of the Discussion/Conclusion communicative goals, which canvass the findings from a broader ‘beyond the study’ perspective, as opposed to the Results, where authors tend to accord their findings meaning that is within the internal scope of the study. The Discussion/Conclusion, overall, re-establishes the territory in the targeted research space to ground the discussion, comments on the principal findings to frame the newly reported knowledge, references the literature to re-shape the previously covered knowledge territory, and establishes additional territory considering future prospects in view of the new findings. The moves and their steps in the IMRD frameworks do not imply a sequence of occurrence; rather, they reflect a logical cohesion in the scientific argument and suggest content pieces that need to be intertwined rhetorically. Overall, the frameworks provide a level of detail that is needed to enhance pedagogical explicitness and facilitate learning.

Table 1

<table>
<thead>
<tr>
<th>Move/step frameworks for IMRD research articles</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Introduction</strong></td>
</tr>
<tr>
<td>Move 1: Establishing the territory</td>
</tr>
<tr>
<td>Step 1: Claiming centrality and/or</td>
</tr>
<tr>
<td>Step 2: Providing general background and/or</td>
</tr>
<tr>
<td>Step 3: Reviewing previous research and/or</td>
</tr>
<tr>
<td>Move 2: Identifying a niche</td>
</tr>
<tr>
<td>Step 1: Indicating a gap and/or</td>
</tr>
<tr>
<td>Step 2: Highlighting a problem and/or and/or</td>
</tr>
<tr>
<td>Step 3: Raising general questions and/or</td>
</tr>
<tr>
<td>Step 4: Proposing general hypotheses and/or</td>
</tr>
<tr>
<td>Step 5: Presenting justification and/or</td>
</tr>
<tr>
<td>Move 3: Addressing the niche</td>
</tr>
<tr>
<td>Step 1: Introducing present research descriptively and/or</td>
</tr>
<tr>
<td>Step 2: Announcing present research purposefully and/or</td>
</tr>
<tr>
<td>Step 3: Presenting research questions and/or</td>
</tr>
<tr>
<td>Step 4: Presenting research hypotheses and/or</td>
</tr>
<tr>
<td>Step 5: Clarifying definitions and/or and/or</td>
</tr>
<tr>
<td>Step 7: Announcing principle outcomes and/or</td>
</tr>
<tr>
<td>Step 8: Stating the value of present research and/or</td>
</tr>
<tr>
<td>Step 9: Outlining the structure of the paper and/or</td>
</tr>
</tbody>
</table>

*Note: The inclusion of Move 4 here accommodates for RAs that integrate discussion in the Results section and have a separate Conclusion. Separate Conclusion sections generally fulfill the communicative goal of Move 4 and exhibit the respective steps.*
Our definitions of moves specify the communicative purpose and also include indications of content. For example, Move 3 of the Methods section is defined as follows:

*Move 3 – Establishing credibility – aims to foreground and warrant the quality of data analysis. It centers on processes of data preparation and/or manipulation (e.g., sampling, screening, cleaning, inclusion/exclusion, correction, tabulating, etc.) and on data analysis procedures (e.g., statistical techniques, coding schemes, etc.) The following steps can be used to establish credibility...*

The definitions of the steps specify the rhetorical function and the communicative intent that may underlie the function. In the following example, the function is to ‘justify,’ and the bulleted list introduced by ‘in order to’ exemplifies possible communicative intent that the author may want to impart with the scientific audience.

*Move 3: Step 3 – Rationalizing data processing/analysis – justifies the choice of analytic measures or procedures in order to:*
  - demonstrate that the analysis yields valid results
  - establish overall trustworthiness of the study
  - acknowledge existing and/or pre-existing limitations
  - ward off criticism

Example: “We adjusted standard errors to allow for clustering of error terms by birth country.” (Economics_15) → justifies adjustments during data analysis

2.2.2 Patterns and variation

In addition to comprehensive functional descriptions of the IMRD discourse, the top-down corpus analysis yielded general patterns of RA structure and insights about cross-disciplinary and intra-disciplinary discourse composition tendencies. Figure 1 renders the distribution of moves across all the RAs in the corpus, exhibiting expected patterns of discourse organization that are in accordance with previous research (e.g., Anthony, 1999; Lim, 2006; Swales & Najjar, 1987; Yang & Allison, 2003).
To reveal some discipline-specific conventions, we exemplify findings from our Results section corpus data. Figures 2-4 illustrate the distribution of steps in the 30 disciplines included in the corpus, showing visible patterns across the disciplines. In Move 1 (Fig. 2), the Restating study specifics step is the most prominent in all the disciplines, followed by Providing general orientation (except Animal Science and Veterinary Medicine). The Justifying study specifics step occurs with a much lower frequency compared to the other two steps, but is nevertheless present across disciplines.

In Move 2 (Fig. 3), Reporting specific results is the most frequently employed step, traditionally accompanied by Indicating alternative presentation of results that directs the reader to tables, figures, graphs, etc.
Move 3 (Fig. 4) displays a similar pattern, with *Explicating results* occupying 34% to 74% of this move in different disciplines. At the same time, there appears to be more variation among disciplines here as to what the next most frequent step is. Some disciplines tend to compare different results obtained in the study (e.g., Chemical Engineering, Geological and Atmospheric Sciences, Synthetic Chemistry). Other disciplines prefer to account for their results by suggesting reasons that can help understand what may have determined the nature of the results (e.g., Agricultural and Bio-Systems Engineering, Animal Science, Curriculum and Instruction, Meteorology). Quite a few disciplines, especially in the humanities and social sciences, clarify expectations by reasoning about anticipated or unanticipated findings (e.g., Art and Design, Business, Psychology, Sociology, Special Education). Interestingly, *Acknowledging limitations* which one would expect to see in Discussion/Conclusion sections, though infrequent, seems to be relatively consistently used by most of the disciplines represented in the corpus, and Veterinary Medicine in particular stands out in this respect.
Although Move 4 (Fig. 5) is rare in Results sections (less than 2.5%), its steps appear in most of the disciplines except Animal Science and Veterinary Medicine. Some disciplines make relatively equal use of all the steps (e.g., Meteorology, Physics and Astronomy), and others prefer to include a few generalization (e.g., Immunobilogy), value (e.g., Molecular, Cellular and Developmental Biology), and implication (e.g., Agricultural and Bio-Systems Engineering) statements.
2.2.3 Linguistic realizations

The annotated corpus also served as a rich source for the linguistic description of the discourse units included in the IMRD move/step frameworks. This strand of inquiry follows the well-established EAP tradition of exploring linguistic features (including single words, collocations, lexical bundles, and other vocabulary-based discourse units) considered indicative of RA rhetorical moves (Brett, 1994; Cortes, 2004; 2008; 2013; Csomay, Jones, & Keck, 2007; Kanoksilapatham, 2007; Swales, 1981; Williams, 1999; Yang & Allison, 2003). Here, we only address linguistic realizations in terms of lexical signals that carry the functional meaning of steps, using for this purpose examples from the Discussion/Conclusion section.

The four moves of the Discussion/Conclusion sections can be developed with 14 possible steps (see Table 1). Some steps are descriptive and content-based while others are more rhetorically charged, and the rhetorical intent becomes explicit through language choices that are appropriate to the intended functional meaning. Consider the following examples extracted from different disciplines illustrating the functional distinctions among the steps of Move 4, Establishing additional territory.

The function of Step 1, Generalizing results, is to deduce general conclusions applicable to broader criteria, constructs, phenomena, and so on based on inferences derived from specific results. Authors make either confident or tentative generalization claims by summarizing or synthesizing the results in ways that expand the meaning of the findings outside the scope of the study – and for that they choose expressions like:

should be generalized to; are safe to apply; will vary across groups; permit us to make the following presumption; should be borne in mind when considering the transferability
of these results to; which proved to be the best for... will also be so in; we believe it is safe to generalize conclusions also to other; it is likely that... will out yield; etc.

The function of Step 2, Stating the value, is to demonstrate the noteworthiness of the study results. Value claims suggest the contribution of the newly-obtained empirical evidence to the existing knowledge space often using elevated language similar to the following expressions: the results of this study provide... with valuable information to; the findings of this article add to the debate over; advances comparative research on the link between; is innovative in its incorporation of; is also unique in; represents a push toward; offers a new perspective; highlight the significance of; contributes valuable knowledge; etc.

The function of Step 3, Noting implications, is to point out potential applications, effects, or impacts that the study may have on theory, research, or practice. As the implication statements are logical predictions, they often include modals to express tentative intent. For example: the understanding of... could be useful for; points to benefits for; provides several practical implications; may have potential to; could be considered as a potential option in; has promising implications for; can rapidly reduce; may be instructive to; could be effective for; is especially applicable to; may be useful parameters with which to; etc.

The function of Step 4, Proposing directions, is to assert the need to continue addressing the targeted niche and to further contribute new knowledge to the field by making recommendations for future work. In this step, authors select expressions like: it would be interesting to examine; is an avenue for future research; would be useful to understand; additional research would be required to; further research is needed to; is worthy of further investigation; other possible factors to consider are; remains to be tested; warrants further inquiry; additional... needs to be completed to determine; etc.

2.3 Move analysis applied to ANLP

Bazerman (2010) notes, “the longer you work with genre, the more it reveals and the more it connects with” (p. xi). This is especially true when working with genre involves move analysis. The corpus data annotated using the IMRD frameworks opens new horizons for ANLP. As a look into the future possibilities for move analysis, we provide a few prospects that natural language processing affords for further application of this analytic construct.

2.3.1 N-grams

The identification of linguistic realizations that can be linked to moves and steps, which has traditionally involved manual analysis (e.g., Durrant & Mathews-Aydınlı 2011; Henry & Rosenberry, 2001), can be effectively accomplished programmatically. For instance, to identify which n-grams (or sequences of n lexical items) are better indicators of moves and steps, we used odds ratios (OR), which measure the probability that a certain n-gram will occur in a given step of a given move in each IMRD section. To adequately capture the frequency of occurrence, the n-grams were stemmed by means of reduction of inflected and derived words to their root form. Table 2 lists some of the most frequent bi-grams and tri-grams (or two and three-word combinations) found in the Introduction sections of our corpus. The choice of Introduction
examples here is intentional, as they resonate with the examples provided in other works, especially in Swales (2011) and in Swales and Feak (2012).

Table 2  
Examples of high-probability Introduction section n-grams in the ISURA corpus

<table>
<thead>
<tr>
<th>Move 1</th>
<th>Move 2</th>
<th>Move 3</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Move 1-Claiming Centrality</strong></td>
<td><strong>Move 2-Highlighting a problem</strong></td>
<td><strong>Move 7-Announcing principal outcomes</strong></td>
</tr>
<tr>
<td>n-gram</td>
<td>OR</td>
<td>n-gram</td>
</tr>
<tr>
<td>recent year</td>
<td>20.01</td>
<td>as a result</td>
</tr>
<tr>
<td>the past</td>
<td>19.53</td>
<td>due to the</td>
</tr>
<tr>
<td>wide us</td>
<td>16.52</td>
<td>becaus of the</td>
</tr>
<tr>
<td>interest in</td>
<td>15.50</td>
<td>the fact that</td>
</tr>
<tr>
<td>the last</td>
<td>14.13</td>
<td>have not been</td>
</tr>
<tr>
<td>import in</td>
<td>11.51</td>
<td>larg number of</td>
</tr>
<tr>
<td>bodi of</td>
<td>8.43</td>
<td>there is a</td>
</tr>
<tr>
<td>been studi</td>
<td>7.40</td>
<td>the major of</td>
</tr>
<tr>
<td>an import</td>
<td>7.28</td>
<td>to be a</td>
</tr>
<tr>
<td>of interest</td>
<td>6.95</td>
<td>a result of</td>
</tr>
<tr>
<td>plai an</td>
<td>6.88</td>
<td>the number of</td>
</tr>
<tr>
<td>ar import</td>
<td>6.70</td>
<td>lead to the</td>
</tr>
<tr>
<td>research have</td>
<td>6.43</td>
<td>a rang of</td>
</tr>
<tr>
<td>most import</td>
<td>6.40</td>
<td>on the other</td>
</tr>
<tr>
<td>over the</td>
<td>5.92</td>
<td>of the most</td>
</tr>
</tbody>
</table>

In addition to identifying the n-grams that are indicative of specific functional meanings, this approach is useful for distinguishing between discipline-specific language choices. The following are high OR examples of *Announcing present research purposefully* of Move 1 in three different disciplines. Note that along with the bi-grams based on lexemes like *objective, this, present, study*, and *was* there are n-grams reflecting the disciplinary nature of research. In Agronomy, the purpose of the study is often to determine, identify, assess, develop, or measure perhaps some effects, density, growth, yield, traits, etc. In Immunobiology, researchers work with patients, molecules, cells, treatments, receptors, responses, etc. In Environmental Engineering, research goals are concerned with approaches, processes, operations, relationships, changes, impacts, evaluations, contexts, ecology, efficiency, and the like.

**Agronomy**: the object; wa/were to; thi research; studi wa; thi studi; evalu the; to determin; the effect; densiti on; to studi; determin the; at differ; to measur; the yield; trait and; agronom trait; the field; growth and; assess the; to identifi; effect of; in resist; yield of; the growth; and composit; respons for; the relationship; to develop...

**Immunobiology**: object of; signal molecul; determin whether; present studi; patient receiv; from patient; treatment with; the role; studi we; cytokin receptor; abil of; expans of; cell from; role of; of cytoplasm; respons for; to induc; into the; Th cell; present by; by class; cell differenti; invol in; cell respons...
2.3.2 Algorithmic analysis of patterns and variation

Disciplinary discourse varies not only in terms of the language choices authors make to accomplish the communicative goals of the moves. Different disciplines also structure their discourse in different ways. For example, Figure 6 visualizes the Results sections in three disciplines as their ‘DNA’ structure showing the sequence of moves. The images for each discipline depict the move structure of the 30 respective Results sections in the corpus. Each bar represents a text, bar length signifies the length of the text (beginning of a black strip indicates the end of the text), the colors in each bar represent the moves: blue is Move 1, red is Move 2, green is Move 3, and orange is Move 4. Judging by these images, the Results sections exhibit discipline-specific patterns in their structural organization. Authors in Animal Science tend to predominantly employ Move 2, focusing almost exclusively on reporting the findings and sporadically including Moves 1 and 3. The variation among the texts in this sub-corpus is subtle. In Applied Linguistics, this move also projects a higher frequency compared to other moves, but it tends to occur in cycles with Move 1 and Move 3, where authors first show valid progression of findings by reiterating relevant study-specific information and then communicate the findings, providing explanation or interpretation whenever it is appropriate. Molecular, Cellular, and Developmental Biology authors not only use all the moves; they make more recurrent shifts between the moves and intertwine them more frequently, thus constructing rhetorically more complex arguments when reporting and making claims about their findings. An additional insight reflected in Figure 6 is intra-disciplinary variation noticeable in the lack of a precise pattern among the texts of the same discipline. This is not surprising, as the move structure of each individual text largely depends on the nature of the study and the way authors choose to present their scientific argument.
Figure 6. Results move distribution within and across disciplines: Animal Science (ANSC), Applied Linguistics (APLI), Molecular, Cellular, and Developmental Biology (MCDB)

Statistical processing of lexical realizations of steps can also provide valuable insights into potential sequencing patterns. Figure 7, for example, displays visual representations of matrices that encode the probability of transitioning from one step to another in each IMRD section. Black indicates high probability, and white indicates low probability. According to the matrix for Introductions, where the first row shows probabilities for step 1, Claiming centrality, a step 1 sentence is very likely going to be followed by another step 1 sentence. The next most likely step to follow step 1 is step 2, Providing general background. Similar interpretations can be made for the rest of the steps in the Introduction and for all the steps in the other sections. Overall, what these figures suggest is that there is a certain degree of structure in the order of the steps. Some steps are more likely to follow specific steps, while some step transitions are almost non-existent (e.g., the probability of step 1 being followed by steps 16, Stating the value of present research and 17, Outlining the structure of the paper is zero). The same matrices can be computed for individual disciplines, and some of our preliminary results indicate the presence of discipline-specific sequencing patterns.

Interesting similarities and differences among disciplines across the IMRD sections can also be gleaned from the step-level annotation of the corpus. The graphical representation given in Figure 8 was generated using the k-means clustering algorithm, which clustered the disciplines based on how authors use the steps in each section. Some disciplines stay within the same cluster across the IMRD sections, being similar to each other in terms of the frequencies of specific steps; others cluster with some disciplines in one section and with other disciplines in other sections. For example, Sociology, which belongs to cluster 1, is similar in terms of the frequencies of specific steps with Applied Linguistics, Art and Design, Curriculum and Instruction, Psychology, Sociology, and Special Education (also in cluster 1). Agronomy, on the other hand, uses Introduction steps similar to engineering and chemistry disciplines (cluster 3); Methods steps – similar to Biomedical Sciences, Immunobiology, and Molecular Biology (cluster 2); Results sections – similar to social sciences (cluster 1), and Discussion/Conclusions – similar the disciplines in cluster 2. Of 30 disciplines in the corpus, 11 are consistent in their step use similarity to specific disciplines, and 19 fluctuate between clusters resembling the discourse conventions of certain disciplines depending on the section of the article.
3 Computational operationalization for pedagogical use

Corpus and computational analyses of the moves and steps in disciplinary discourse are finding direct application for GBWI through the ongoing development of an innovative AWE program called the Research Writing Tutor (RWT). Using the annotated corpus data and the statistical properties of n-grams in our corpus, probabilistic language models for predicting the occurrence of moves and steps were built to generate rhetorical feedback (Babu, 2013; Cotos, Gilbert, & Sinapov, 2014). RWT’s analysis engine approaches the identification of these discourse units as a supervised classification problem (see Burstein, Marcu, & Knight, 2003; Pendar & Cotos, 2008), where each sentence in a text is considered an independent unit of analysis to be classified into two categories – one corresponding to a move and the second corresponding to a step within the identified move.

3.1 The Research Writing Tutor

RWT is a pedagogical tool intended to assist students in their learning of RA genre conventions and to provide a platform for applying them in their own writing. It integrates three modules: Analyze My Writing, Explore Published Writing, and Understand Writing Goals – all grounded in the IMRD move/step frameworks.

3.1.1 Analyze My Writing

Motivated by the challenge of providing students with discipline-specific feedback, this ANLP-based module was designed to analyze research articles and generate multi-level rhetorical feedback, aiming to help students develop strong scientific arguments and academically compelling texts as expected by their disciplinary community. Here, students designate the RA section and their field of study and submit their draft for analysis. The output of the analysis engine is translated to color-coded sentence-level feedback, with a particular color representing a particular move (move 1 – blue, move 2 – red, move 3 – green, move 4 – gold), thus visualizing the rhetorical composition of the draft. Metalinguistic feedback is also provided for each sentence; it is operationalized as interactive comments that encourage students to think about the rhetorical functions of their sentences by suggesting how the computer interprets their functional meaning, so that the students revise their writing to make their communicative intent more
explicit where necessary. Figure 9 exemplifies a screenshot of these two types of feedback on a Discussion/Conclusion student draft.

In addition to providing sentence-level feedback, RWT cross-analyzes the draft with the respective annotated section texts in the same discipline and operationalizes this comparison through numerical feedback in the form of bar graphs and pie-charts meant to make the focus on discourse structure more pragmatically meaningful and to enhance goal orientation. In Figure 10, the first pie-chart represents the move distribution of a student’s draft, and the second – the move distribution, on average, of the target section in the student’s discipline.

The range-bars in Figure 11 display the percentages of published authors’ move distribution compared to the percentage of the student’s move distribution. The colored portion of the bar indicates to what degree the student has achieved a move along a spectrum showing minimum, average, and maximum distributions for that move in the target discipline.
Figure 11. Move-level comparative feedback as range-bars in RWT

This move-level feedback is accompanied by feedback on the use of steps in the form of a dropdown menus for each move, which display what steps students have successfully incorporated into their draft and what steps seem to require further work (Fig. 12). Here, the comparative feedback is again metalinguistic rather than numerical in order to allow students to make connections with the sentence-level feedback.
These visual depictions and metalinguistic feedback were designed to help students uncover discrepancies with the move and step distributions in published writing and, thereby, prompt them to iteratively revise their draft considering the norms conventionalized in discipline-specific scientific argumentation.

### 3.1.2 Explore Published Writing

The second module is meant for corpus explorations of IMRD discourse structure and language use. For enhanced revision, it offers corpus-based scaffolding, which can also be used as a learning resource employed by teachers for classroom activities before draft writing. In the revision scenario, the students are given the opportunity to consult the annotated corpus with the help of a function-based concordancer that can be queried for authentic examples of moves and steps from relevant published writing in the students’ fields. This may be especially useful when students are attempting to improve a step in the Analyze My Writing module, where they can click on Examples (see Fig. 12) and access all the examples of that step displayed as concordance lines (Figure 13). This feature is expected to both help students develop a better understanding of rhetorical functions and to connect rhetorical steps with their linguistic realizations (encircled in Figure 13 is the language signaling the function of Rationalizing data processing/analysis of Methods Move 3). Demonstrating how published authors accomplish specific steps models best practices in cogent and communicatively explicit research writing.
Figure 13. Concordancer examples of rhetorical steps in RWT

Because the larger context is often needed to better understand the step functions, the source text is also available by clicking on an example sentence (Figure 14). The texts are color-coded and glossed with moves and steps, which appear when hovering the cursor over each sentence. The annotated texts thus demonstrate how authors in the discipline organize their discourse and, at the same time, make salient the features of the genre that are otherwise likely to remain undiscovered by students. This representation of the annotated corpus does not simply make students aware of which or how often particular moves are achieved by published authors, but also gives them a visual exposition of discipline-specific structural patterns and variation in the accomplishment of communicative moves. Through this affordance, RWT also seeks to establish an indirect, epitomized connection to the practices of the target discourse community.

Figure 14. Example of annotated text in RWT
3.1.3 Understand Writing Goals

The third module contains instructional scaffolds developed based on the IMRD move/step frameworks, which can be used for learning as well as teaching purposes (Cotos, Huffman, Link, Paben, & Suvorov, 2012). Similar to the Examples link, clicking on Learn More in the analysis module takes students to multi-modal renditions including definitions, explanations, and short video lectures of particular rhetorical concepts that they need more clarification for. Otherwise, a dropdown menu lets students select which section of the RA they wish to learn about. Upon clicking on a particular RA section and move, students can watch a lecture along with an accompanying slideshow presentation, which introduces the section framework and showcases the functions of that move (Figure 15). Additional resources available in this instructional Module provide language focus materials, which highlight some lexico-grammatical patterns distinctive to the particular RA section. In the classroom activity or homework scenario, the resources in this module can be used for material presentation and consolidation.

![Figure 15. Screenshot of a video lecture in RWT](image)

4. Conclusion

In this eclectic article, we have attempted to bring together various research excerpts that show a progression from (1) conducting corpus-based analysis in order to expand and refine move analysis as a theoretical construct, to (2) applying move analysis as an analytic construct in computational analysis in order to garner new insights about disciplinary genre conventions, and to (3) combining qualitative and quantitative methods connecting these research strands in order to develop the RWT exemplar of genre and corpus-based writing technologies of the future. Based on our study of the ISURA corpus, we believe that despite undeniable variation within and across disciplines, the concept of moves is relevant for developing comprehensive genre models generalizable across multiple disciplines. Moreover, we posit that the move/step concepts are not only valid analytical tools for genre analysts, but also offer a range of possibilities for unexplored relationships between genre theory, genre analysis, and genre instruction. Computational operationalizations informed by discourse descriptions like those sampled from our large-scale corpus analysis as well as by linguistic descriptions of discourse units, including those obtained
through bottom-up multi-dimensional analyses of specialized corpora (e.g., Jones, 2007), promise to equip students and teachers with technologies that could have significant impact on genre-based curricula.

While emphasizing potential, it is important to consider implications relevant to the choice of approach, especially when the end goal is instructional application. The work we describe here is not without limitations, some of which are a result of affordability and others are intentional choices justifiable in view of the teaching and learning needs in the target context. More specifically, it would have been ideal to compile a corpus as representative of epistemologically experimental disciplines as of writing-based humanities disciplines (e.g., philosophy, history). However, the disciplines included in the ISURA corpus reflect the participation of faculty consultants who responded to our recruitment efforts, indicating commitment to collaborate on this project. Additionally, the focus of this institutionally funded study was determined by a campus-wide needs analysis, the results of which suggested that reporting experimental research, which generally takes the IMRD shape, tends to be most challenging for graduate students, especially for students in applied, natural, and social sciences.

Choosing to draw from such a strictly-structured corpus may raise legitimate concerns regarding foregrounding standardization rather than variation in genre analysis. For example, writing in the disciplines may seem to be treated as rigid and formulaic, thus contradicting the beliefs of scholars and practitioners who prioritize exploring alternative ways of meaning making in discourse community contexts over textual structures. However, what may indeed suggest standardization can in fact serve as a fruitful foundation for pedagogically-driven studies of multi-disciplinary corpora. In our case, the corpus provided the rigor and consistency necessary to devise an explicit cross-disciplinary move/step framework, and our annotation method enabled the study of both patterns and variation in the use of moves and steps in discipline-specific discourse – all informing EAP materials design.

Arguably, the standardization concern can be either amplified or attenuated depending on how the research outcomes are applied to address pedagogical objectives and learner needs. Our methodological choices yielded results expected to inform what Hyland (2007) refers to as “visible pedagogy” (p. 151) for developing L2 writers. Johns (2011), cogitating about directions for GBWI, recommends that novice L2 writers’ initiation to genres begins with text structures. This can reduce genre complexity to a level of explicitness that can help students acquire a conscious understanding of the implicit relationship between rhetorical goals and textual features. The general focus on IMRD does not necessarily mean constraining one’s writing. Rather, analyzing texts systematically, drawing on structural, rhetorical, and lexico-grammatical patterns that represent the anatomy of the RA genre, promotes critical analysis (Hammond & Macken-Horarik, 1999) and provides students with the formal knowledge necessary for the acquisition of the multi-faceted genre knowledge (Tardy, 2009). According to Hyland (2004), exploring alternatives derived from the identification of certain patterns is particularly helpful and reassuring for novice L2 writers.

With regards to implementing compatible genre-based technologies like RWT, it is important to recognize that it is not the technology per se that shapes genre-based pedagogy (Ellis, 2004, p. 231). The teacher’s role is paramount in making appropriate use of technological affordances to
scaffold students’ learning. The instructional process with RWT, for instance, contains corpus exploration tasks using the *Explore Published Writing* module, which aim to facilitate students’ identification of patterns, noticing of variation, and engagement in critical analyses of the textual practices of their disciplinary community. Instructional highlights emphasize rhetorical flexibility through discussions of multiple authentic examples of how authors exploit a variety of functional meanings without organizing their moves and steps in a linear fashion. This allows the students to not only become aware of the rhetorical strategies expected in their discipline, but also realize that it is ultimately the writer who decides how to intertwine them in ways that most appropriately present the specifics of their research study. When introducing their students to the *Analyze My Writing* module, teachers make sure to explain their students how to interpret the numerical feedback, emphasizing that it is orienting rather than prescribing a “right way” to articulate scientific arguments.

Albeit RWT’s conceptual design relies on a model that is based on target learning needs and combines theoretical and operational frameworks (Cotos, 2009, 2014), its development is only the first step towards advancing GBWI. Instructional success will require effectiveness-driven inter-disciplinary inquiry combining methods in applied linguistics, computational linguistics, computer science, human-computer interaction, and education. Establishing such a dialogue will lead to acquiring an understanding of how to create optimal conditions for computer-assisted writing improvement, but, most importantly, will span Swales’ move construct across multiple scientific domains and leverage complementary yet never previously intersecting perspectives, as a result revolutionizing EAP practice.

1 Unlike the linguistic approaches that focus on texts in contexts, the New Rhetoric, New Literacy, and Academic Literacies traditions focus on writers in contexts; i.e. on socio-rhetorical climates, audiences, purposes, and conditions of text use that may influence writers’ choices and the rhetorical structures of genres.

2 Applied natural language processing is defined as an area of study that applies computational techniques to linguistic data to investigate and identify solutions to real-life language-related issues (Brunelle & Boonthum-Denecke, 2012). Here, discourse analysis adopts a functional emphasis on what language does, and, in that sense, it assesses the function of a text in view of move analysis (McCarthy & McNamara, 2012).

3 The acronyms for each discipline are used in the file names that comprise the corpus and will appear in our examples of results.

4 Callisto is an open-source annotation software developed to support linguistic annotation of texts in any Unicode-supported language.

5 Each entry in the matrix encodes the probability that a step $i$ is followed by another step $j$. The probabilities were estimated by computing $ij$ values (number of sentences of step $j$ that follow step $i$ divided by the total number of sentences that follow step $i$) using a Java program. Computing values for all $i$ and $j$ steps in a given RA section resulted in a square matrix. MATLAB’s *imagesc* function was used to visualize the matrixes for each RA section.

6 The figures included show the clustering embedded onto 3D using Principle Components Analysis.

7 These color assignments are consistently maintained throughout all three RWT modules.

8 To protect the teacher’s identity in the screenshot of the video, the picture in Figure 15 covers the teacher’s image.
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Appendix A

Disciplines included in the RA corpus

<table>
<thead>
<tr>
<th>Humanities and Social Sciences</th>
<th>Natural and Applied Sciences</th>
</tr>
</thead>
<tbody>
<tr>
<td>n=8 (23%)</td>
<td>n=22 (77%)</td>
</tr>
<tr>
<td>• Applied Linguistics (APLI)</td>
<td>• Immunobiology (IMMU)</td>
</tr>
<tr>
<td>• Art and Design (ARTD)</td>
<td>• Mechanical Engineering (MECE)</td>
</tr>
<tr>
<td>• Curriculum and Instruction (CURI)</td>
<td>• Meteorology (METE)</td>
</tr>
<tr>
<td>• Economics (ECON)</td>
<td>• Microbiology (MICR)</td>
</tr>
<tr>
<td>• Business (BUSS)</td>
<td>• Molecular, Cellular and Developmental Biology (MCDB)</td>
</tr>
<tr>
<td>• Psychology (PSYC)</td>
<td>• Physics and Astronomy (PHAS)</td>
</tr>
<tr>
<td>• Sociology (SOCI)</td>
<td>• Plant Physiology (PLPH)</td>
</tr>
<tr>
<td>• Special Education (SPED)</td>
<td>• Synthetic Chemistry (SYCH)</td>
</tr>
<tr>
<td></td>
<td>• Urban and Regional Planning (URRP)</td>
</tr>
<tr>
<td></td>
<td>• Veterinary Medicine (VETM)</td>
</tr>
<tr>
<td></td>
<td>• Agricultural and Bio-Systems Engineering (AGBE)</td>
</tr>
<tr>
<td></td>
<td>• Agronomy (AGNY)</td>
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<tr>
<td></td>
<td>• Animal Science (ANSC)</td>
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<tr>
<td></td>
<td>• Bioinformatics (BINF)</td>
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<td></td>
<td>• Biomedical Sciences (BMSC)</td>
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<td>• Biophysics (BIOP)</td>
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<td>• Environmental Engineering (ENVE)</td>
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<td></td>
<td>• Forestry (FORE)</td>
</tr>
<tr>
<td></td>
<td>• Geological and Atmospheric Sciences (GEAT)</td>
</tr>
<tr>
<td></td>
<td>• Horticulture (HORT)</td>
</tr>
</tbody>
</table>

|                               | • Food Science (FOOD)        |
|                               | • Immunobiology (IMMU)       |
|                               | • Mechanical Engineering (MECE) |
|                               | • Meteorology (METE)         |
|                               | • Microbiology (MICR)        |
|                               | • Molecular, Cellular and Developmental Biology (MCDB) |
|                               | • Physics and Astronomy (PHAS) |
|                               | • Plant Physiology (PLPH)    |
|                               | • Synthetic Chemistry (SYCH) |
|                               | • Urban and Regional Planning (URRP) |
|                               | • Veterinary Medicine (VETM)  |
Appendix B

Example of layered annotation in Callisto

Explanation: In the multifunctional example sentence shown below in a simplified output format, move and step notation is marked at the beginning and closed by the assigned move notation at the end, where the primary function is that of Move 3, Step 2; “using the Nash Sutcliffe Efficiency (NSE)” and “(Nash and Sutcliffe, 1970)” have secondary tags for Move 2, Step 5 and Move 1, Step 2 respectively. (See move/step names in Table 1)