Scientific articles in engineering: Constituent and distinctive elements of the genre

https://doi.org/10.56238/sevened2024.009-032

Valéria Angélica Ribeiro Arauz[1]

ABSTRACT

This research originated from the need to better understand the structure and composition of the scientific article genre, with an emphasis on the field of Engineering I. The objective was to analyze this genre in terms of its textual and discursive characteristics to aid researchers and students in writing their own articles. An exploratory and descriptive research was conducted, employing a methodology based on the rhetorical moves outlined in John Swales' (1990) CARS (Creating a Research Space) model, with further developments studied by Swales (1981; 1990; 2009), Motta-Roth and Hendges (1996; 1998), Santos (1995), and Berdanier (2019). The genre elements analyzed in detail included the discourse community, the statement of the research problem, the abstract, the introduction, and the methodology section. As a result, a mapping of the rhetorical moves and the main syntactic-semantic structures involved in each of the sections studied was created, based on their recurrence in 50 articles published in prominent journals in the fields of civil engineering, environmental and sanitary engineering, and transportation engineering.

Keywords: Textual genres, Engineering I, Scientific article.

[1] Associate Professor at the Federal University of Maranhão in the area of Academic Writing of the Interdisciplinary Bachelor's Degree in Science and Technology.
Interdisciplinary Bachelor's Degree in Science and Technology/UFMA – São Luís/MA
E-mail: valeria.arauz@ufma.br

INTRODUCTION

Among engineers, there is a recurrent opinion that there are persistent difficulties in writing and disseminating knowledge, and those who do so construct their texts intuitively, learning from the mistakes and successes of their peers. This scenario indicates the need to investigate the existence of a specific form of writing in the area of Engineering, so that students can get to know and join this discursive community of research engineers. It is hypothesized that, by knowing the reading requirements of a genre, students and researchers could meet the expectations in the production of texts in these discursive situations in a more proficient way.

Studies related to textual genres seem to be an effective means to investigate this reality that involves the reading and production of academic texts. By approaching the text both in its materiality and as a discourse, these studies encompass a broad understanding of the text, its production and reception.

Mikhail Bakhtin, who elaborated this notion of textual genres at the beginning of the twentieth century, established that genres need to be considered in their structure, composition, and style (BAKHTIN, 2003). According to him, because of the polyphony in interactions, no speech is original or dissociated from a context. In addition, genres are always changing, as the needs of users provoke new uses and the creation of new structures. He also devised a classification for discourse genres, dividing them into two types: primary discursive genres and secondary discursive genres. The primary discursive genres correspond to those that are simpler and used in everyday life, produced within groups of human activities, such as informal dialogues, notes or letters. Secondary discursive genres, on the other hand, are more elaborate and formal, usually produced in writing and commonly present in environments that require formality, such as the scientific environment, for example. (BAKHTIN, 2003).

The concept of textual genre is complex, however, and has led to different views among researchers who distinguish between text, genre and discourse, since their definitions complement each other. Charles Bazerman (2015, p. 59), for example, states: "genres are not just forms. Genres are ways of life, ways of being. They are frames of social action." Marcuschi (2008) also contributes to this understanding, differentiating between "textual genre", "textual type" and "discursive domain". According to him, textual genres are fixed forms of structural sequences, while textual types are combinations of these forms in specific contexts, resulting in an almost infinite variety of combinations, as also pointed out by Bakhtin (2003).

In all these definitions, the influence of a conception of language related to its use in enunciation is highlighted. Bonini (2004) presents another definition of gender, to which he adds a purpose previously conceived by the discursive community. Thus, "[t]he genre demarcates, through a purpose and form agreed upon in a discursive community, a textual unit that can be constituted by

one or more enunciative actions" (BONINI, 2004, p.06). This concept brings together the notions of genre and text, since, for the author, discourse constitutes a discursive activity composed of text, purpose, context and interlocutors.

In the sphere of academic texts, each genre is differentiated by the use of structures and terms specific to a particular community, where the authors seek to insert themselves by following communicative purposes already established by the more experienced members. Swales (2009) noted that identifying a genre solely for its communicative purpose is not enough; It is also necessary to consider the textual and contextual procedures involved.

To meet the main objective of this analysis, which is the exploration of scientific articles, it was useful to observe rhetorical movements in the study of genres as proposed by Swales (1981, 1990, 2009). Both Swales and Bakhtin (2003) see language as an inseparable part of a rhetorical action, always approaching texts in relation to their use. For this reason, Swales was taken as the theoretical axis for this work. It presents the following definition of gender:

> A genre comprises a class of communicative events, the members of which share some set of communicative purposes. These purposes are recognized by the expert members of the parent discourse community, and thereby constitute the rationale for the genre. This rationale shapes the schematic structure of the discourse and influences and constraints choice of content and style. Communicative purpose is both a privileged criterion and one that operates to keep the scope of a genre as here conceived narrowly focused on comparable rhetorical action. In addition to purpose, exemplars of a genre exhibit various patterns of similarity in terms of structure, style, content and intended audience. If all high probability expectations are realized, the exemplar will be viewed as prototypical by the parent discourse community (SWALES, 1990, p. 58).

In a more condensed form, genres can be said to be a "class of communicative events with a shared common purpose, the exemplars of which may vary within established limits." Thus, in this study, the genre Scientific Article in Engineering is analyzed in relation to two aspects listed in Swales' definition: the communicative event and its structural and stylistic patterns. For this analysis of the genre, the intended audience is also considered as part of the discursive community that legitimizes it.

THE SCIENTIFIC ARTICLE AS A TEXTUAL GENRE

With the development of science, the exchange of information between researchers has become increasingly supported by writing. Since the seventeenth century, with the emergence of the first scientific journals, scientists began to adopt an increasingly standardized way of presenting their findings to the scientific community and society (SWALES, 1990). The knowledge constructed and established began to be systematized through these publications, mainly scientific articles and other monographic works (books, reports, dissertations, theses).

Among these genres, scientific articles are the most recurrent and impactful in the life of the scientific community, due to their timeliness and the ease of circulation of information. In the analysis of texts of this genre, structures and terms common to each area are used, fundamental for the understanding of activities and essential for communication between professionals in related areas. Therefore, it is a textual genre whose production must follow norms established by scientific writing. However, this is not always the case, raising questions about how researchers and academics elaborate their texts in comparison to the conventions of the discursive community of the genre.

In the textual procedure of analysis, the structure, content and style must be considered, covering the textual and linguistic aspects, as well as the communicative purpose, to define the genre. In the contextual procedure, gender recognition begins with the context, identifying the discursive community in terms of values, objectives, material conditions, work rhythms, expectations, genre repertoires, and norms of behavior. After identifying the genre according to the discursive community, the communicative purpose is redefined, characterizing its specificities.

The various approaches to textual genres show that, in addition to written textual manifestations, scientific articles also need to be considered for their communicative purpose and for the acceptance of the community that uses them. Writing an article is a discursive activity that presupposes the appropriate use of the genre, according to its composition, structure and style, to meet a purpose established by the academic community: to widely disseminate scientific information.

RHETORICAL MOVES

According to Swales (1990) and Aranha (1996; 2004; 2007), the elaboration of scientific articles arises from a need for researchers to disseminate their theses and seek recognition within the academic community to which they belong or in which they wish to join. The production of an article, however, depends on knowledge not only about the object of research, but also about the textual genres that comprise scientific writing and the author's discursive community. Swales (1990) states that individuals can belong to various discursive communities, varying only the shared genres. This means that each author needs to know the linguistic agreements of all the discursive communities of which he or she is a part, in order to move through them with ease and, in more restricted communities such as the academic one, to be included as a member.

According to Aranha (1996), the academic discourse is strongly influenced by the social factor, with each researcher seeking recognition for his or her work. In 1981, Swales presented his first model, known as *CARS: Creating a Research Space*[2] , in which he outlined movements that

[2] The CARS model was conceived from the observation of the structure of the Introductions of scientific articles, which were the part of the text in which the research was presented, its objectives, method and synthesis of the results. This structure was then applied to the elaboration and analysis of abstracts and expanded to other sections of the article.

could be used by the author of the article to structure the production of his abstract. These movements became known as rhetorical movements (SWALES, 1981). These movements were appropriately developed in Swales's later works, as presented in the following table:

Table 1. *CARS template* for the introduction section.

Movement 01	**Establish Territory**
Step 01 Step 02 Step 03	Claim of centrality and/or Production of thematic generalization and/or Review of previous research items
Movement 02	**Establish a Niche**
Step 1A Step 1B Step 1C Step 1D	Construction of counter-arguments or Indication of absences or Proposition of questions or Continuation of the tradition
Movement 03	**Occupy or niche**
Step 1A Step 1B Step 2 Step 3	Goal Outline Announcement of the research proposal Announcement of central findings Indication of the structure of the Scientific Article

Fonte: Adapted from Swales (1990, p. 141).

This was the milestone that encouraged several researches in this area. Subsequently, Swales (2009) improved the CARS model, from which each researcher sought to improve the analyses carried out in different areas of study.

A clear example of this was the model presented in Brazil by Santos (1995), in which, based on the CARS, the movements that guided the elaboration of academic abstracts were schematized. Santos' model was so well accepted in the academic community that it was also the object of study for other researchers, such as Motta-Roth and Hendges (1996), who, based on the analysis of abstracts in English and Portuguese, using the second model of Swales (1990) combined with the model proposed by Santos (1995), reworked the CARS model for abstracting research articles.

Table 2 and 3 show the model proposed by Santos (1995) based on the analysis of 94 abstracts of articles and the model of Mota-Roth and Hendges (1996):

Table 2: The five rhetorical movements of the summary, according to Santos

Movement 01	**Situating the research**
Submove 1	citing previous research
Submove 2	Presenting current knowledge
Submove 3	Extending Prior Research
Submove 4	Presenting a problem
Movement 02	**Introducing the methodology**
Submove 1	Indicating Key Characteristics
Submove 2	Indicating the main objective
Submove 3	Hypothesizing
Movement 03	**Describing the methodology**
Movement 04	**Summarizing the results**
Movement 05	**Discussing the research**
Submove 1	Drawing Conclusions
Submove 2	Making Recommendations

Source: Santos, 1995, p.40.

Table 3: Model reworked by Motta-Roth and Hedges

Movement 1	
Sub-function 1A	Establish professional interest in the topic
Sub-function 1B	Make generalizations on the topic
Sub-function 2A	Cite previous research
Sub-function 2B	Extend previous searches
Sub-function 2C	Counter-arguing prior research
2D sub-function	Indicate gaps in previous research -
Movement 2	**Present the research**
Sub-function 1A	Indicate the main characteristics and/or
Sub-function 1B	Present the main objectives and/or
Sub-function 2	Hypothesize
Movement 3	**Describe the methodology**
Movement 4	**Summarize the results**
Movement 5	**Discuss the research**
Sub-function 1	Draw conclusions

Fonte: Motta-Roth e Hedges, 1996, p.59.

In more recent research, Berdanier (2019) segmented the scientific article into 09 major rhetorical movements. For the study of the methodological section, we took as a basis movement 4, which refers to the description of processes and methods. In this section, you should be able to find the following steps:

Table 04: Rhetorical Movement for the composition of the methodological section

	Movement 04
Step 01	Identify research objectives or questions
Step 02	establish a justification, reasoning, or meaning related to the method
Step 03	List materials, tags, or resources
Step 04	cite established procedures and protocols
Step 05	detail research tasks, procedures, analyses, or instrumentation techniques
Step 06	Identify challenges and limitations
Step 07	explain the scientific mechanisms by which the method works.
Step 08	

Fonte: Berdanier, 2019.

From the use of these previously established models of the rhetorical movements present in the studies of the listed researchers, we sought to identify the presence of movements, functions and steps in the chosen articles. This observation also led to the detection of differences between the writing methods of foreign periodicals and those that circulate in the Brazilian context, as will be demonstrated in the analysis proposed in this work.

METHODOLOGY

To achieve the objective of knowing the structure and the discursive community that supports the genre Scientific Article in Engineering, an exploratory and descriptive study was carried out, with bibliographic and documentary research in primary and secondary sources. The linguistic corpus consisted of scientific articles from the area of Engineering I (Civil Engineering, Transport Engineering, Environmental Engineering and Sanitary Engineering). The choice was based on two main factors: exclusion and prioritization. Engineering is divided into four major areas according to Capes, with very different objects of study and research methodologies, which would require a longer and more voluminous work or a superficial treatment of the texts if one chose to approximate, for example, articles on Electrical Engineering with Environmental Engineering. The prioritization of this area occurred because it includes three courses offered contiguously to the BICT as Second Cycle degrees (Civil Engineering, Environmental and Sanitary Engineering and Transport Engineering), which have the highest demand among bachelor's students. This allows for greater efficiency and reach when meeting the demands of the students in the course.

The selection of abstracts began in online journals, with the help of the Sucupira Platform, in which it is possible to find the classification of scientific production within the scope of scientific articles (CAPES, 2017). On the platform, filters were applied to adjust the searches: area of expertise (Engineering I), classification (B1) and publication period (journals evaluated in the 2013-2016 quadrennium[3]). The result of this search provided journals with such qualifications, facilitating the use of another platform, the Web of Science, where we filtered academic texts based on the publishing institution.

The corpus was limited to texts in Portuguese due to the abundance of studies on academic writing in English and the need to more readily serve undergraduate students, most of whom have not yet mastered English. In addition, the specificities of the use of the Portuguese language by Brazilian researchers in the Scientific Article genre are still little explored. The initial sample consisted of 18 articles for the study of the discursive community, expanding to 50 articles for the study of textual structure and restricting itself again to 20 articles for the study of the abstract, in

[3] In the period when the *corpus* was selected, CAPES had not yet made the 2017-2020 quadrennial classification.

order to maintain proportionality between civil engineering and environmental and sanitary engineering journals.

The analysis of the texts, based on the studies of John Swales (1990), considered criteria such as length, references, syntactic and lexical characteristics, textual organization and sections. Priority was given to the sample of texts containing original material, excluding literature review articles. The textual analysis of the sections aimed to identify the specificities of the area in its interdisciplinary relations, using the idea of recurrence of patterns called Rhetorical Movements (SWALES, 1981; 1990). The categories listed by Swales (1990, 2009), Motta-Roth and Hendges (1996) and Berdanier (2019) supported the tabulation of the occurrences of rhetorical movements and structures in the articles analyzed.

Table 5: Articles selected to understand the discursive community – 18 articles.

MAGAZINES	**NUMBER OF ARTICLES ANALYZED**
AGRIAMBI Built Environment´ Tree	1 4 1
Sanitary and Environmental Engineering	4
School of Mines	1
IBRACON – Structure and Materials	1
Transport	6
TOTAL	**18**

Source: Elaborated during the research

Table 6: Number of articles selected per journal in the sample of 50 articles.

Magazine	**Number of items**
AGRIAMBI Built Environment Tree Ceramics School of Mines Sanitary and Environmental Engineering IBRACON – Structure and Materials Transport	3 21 1 4 2 6 2 11
TOTAL	**50**

Source: elaborated during the research

Table 7: Distribution of abstracts by area of expertise and journal, in the sample of 20 articles.

Area of Study	**Periódicos - Qualis B1**	**Number of Abstracts**
Civil engineering	IBRACON – Structures and Materials	2
	Built Environment	6 2
	School of Mines	
Sanitary Engineering	Sanitary and Environmental Journal	6
	Brazilian Journal of Agricultural and Environmental Engineering	3
	Tree Magazine	1

Source: elaborated during the research

RESULTS AND DISCUSSION

THE DISCURSIVE COMMUNITY IN ENGINEERING I

The analysis of scientific articles around Engineering I provided relevant information about several aspects of this textual genre, whether related to its production context or structural elements. For the observation of the discursive community, attention was paid to the way in which engineers access the vehicles for the publication of their articles, the degree of demand and specificity of the journals, as well as the stylistic-lexical preferences, according to the description of Swales (1990) about the characteristics of this type of community:

- Common Goals
- Participatory mechanisms
- Intercom mechanisms
- Specialized genres and terminologies
- Specialized terminologies
- Levels of expertise

From the observation of the journals analyzed, it was noticed that the delimitation of the researchers' access to the community occurs mainly through the recommendations for publication provided by the editorial teams. The main requirements are:

a) Originality: The articles must be unpublished, the result of original research, and must not have been submitted to other media outlets in parallel;
b) Length: There are restrictions on the size of the text. Some magazines limit you to a number of words (7000, 8000) or pages (maximum of 20);
c) Thematic adequacy: There are limitations as to the theme and/or area of knowledge to which each journal is dedicated, with no mention of the publication of thematic issues or special print runs;
d) Structural adequacy: The journals are specific regarding the publication instructions for the authors, mentioning, in some cases, NBR 14.724:2011 (ABNT, 2011) as a parameter for the writing, structuring and formatting of the text;
e) Evaluation: Even journals that charge a fee for publication in *the open access* format maintain a system of evaluation by reviewers with blind review (*blind review* or *double blind review*);
f) Other requirements: Timeliness of the references cited in the article and specific formatting of visual data such as diagrams, graphs and tables.

Regarding the periodicity of publication of the journals, the circulation can be monthly, bimonthly or quarterly, demonstrating the constancy in maintaining the information and the interest of the researchers in using the journals to publish their results and consult published materials. The

magazines' websites indicate a high number of visits, with "170,000 monthly visits" (ESCOLA DE MINAS, s.d.) or an average of "200,000 hits" (AMBIENTE CONSTRUIR MAGAZINE, s.d.), for example.

We did not find a minimum requirement for the researchers' degrees to publish the articles. An exploratory research was then carried out in the Lattes curricula of the authors of the articles to verify the degree of specialization of the members of the discursive community.

Table 8: Percentage of Researchers' Cumulative Specialization Levels

Graduation	Masters	Doctorate	Post-Doctorate
100,00%	87,10%	75,81%	22,58%

Source: elaborated during the research

Thus, although no degree is required for the submission of articles in the journals analyzed, all authors have at least a bachelor's degree in their curriculum and, among the members of the same work, at least one has a stricto sensu graduate degree. This demonstrates the need, even if implicit, to have academic qualifications to publish the articles.

With regard to the development of one's own style, the analysis of lexical marks reveals the construction of a specialized lexicon. This lexicon is characterized by the use of a recurrent terminology specific to engineering activities, as shown below:

> Sampling, structural analysis, systemic analysis, environmental assessment, shear, coefficient of expansion, coefficient of expansion, concrete compositions, compression, phytosanitary conditions, contamination, water bodies, water bodies, environmental degradation, mechanical performance, sustainable development, environmental diagnosis, elasticity, cracks, bending, transport infrastructure, survey, urban fabric, cementitious materials, mechanisms, mobility, modulus of Deformation, modulus of elasticity, new technologies, pavement, planning, product porosity, pressure, environmental problems, water resources, environmental impact reduction, reinforcement, abrasion resistance, compressive strength, tensile strength, compressive characteristic strength, mechanical strength, flexural strengths, asphalt coating, coating, basic sanitation, systems, tension, maximum tension, landscape typology, workability, traction, transportation stresses, and thermal variation (CAMPOS, 2020, p. 13-16).

THE ACADEMIC SUMMARIES IN ENGINEERING

Academic abstracts find a particularity in the composition of Scientific Articles. Although they take part in this analyzed genre, they also circulate independently in search engines as a means of quick access to the content of articles. Thus, in addition to containing the main information about the work, they need to be attractive to the appropriate readers to ensure that they will seek to have knowledge of the work in full. Given this characteristic, there is an increase in its relevance and greater care is needed in the preparation of this type of abstract, as this may be, in some cases, the only contact that other researchers will have with the published research, if the intended interest is not generated.

In the discursive environment of engineering, the abstracts in the analyzed articles are uniform, demonstrating how the data that would possibly be useful to the reader were obtained and the relevance of these data to their community. As the most recurrent elements, the presence of more technical elements is notorious, such as the presence of exact measurement values, for example, when outlining the methodology of the works. However, the absence of some movements, even without compromising the clarity of the text, denotes the lesser importance given to elements that could enrich the search for articles, such as motivation and contextualization of the research.

In Brazil, there are specific norms for the production of abstracts, such as NBR 6028/2003 (ABNT, 2003b), which denotes the concern to systematize and prescribe the writing of abstracts in detail, including the use of a single paragraph, acceptable verb tenses and even the number of words according to the type of document that the abstract will accompany. However, although there is this general norm that guides the work of Brazilian researchers, it is common for each technical-scientific means of publication to have a style or model of structure for the article to be published, based on the NBR or other foreign standards, and must be categorically followed to adapt to the editorial standards of each journal. This is because the editing process of a scientific journal is a crucial part of preserving the quality of the content disseminated and even influences its impact factor in a given field of study.

Basically, the abstract directed to publications in journals has a similar structure, both in size and content, and should respond to information about the original text, with cohesion and clarity of ideas. However, it is easy to see that in practice there is no detailed and prescriptive guidance in the submission rules of journals regarding the use of models or conventions, including those already provided for by the Brazilian standard. These indications, which are usually vague, do not allow the creation of a model for the authors that would actually lead the reader to perceive the content of the full text, clarifying doubts, so that he could decide whether the complete text would help him in his studies.

The analysis observed the articles according to the rhetorical movements listed by Santos (1995) and reworked by Motta-Roth and Hedges based on the CARS model, since the abstract would be responsible for disposing strategies that would help the author to express the content of the research for a broader reach. Regarding the model, the civil engineering articles, in general, obtained 72% of the movements present in the texts, which is a good percentage, since the only discrepancy occurred in movements 4 and 5 with 50%, which indicates the deficiency in results and more forceful discussion/conclusion at the end of the text. Tables 09 and 10 show the distributions of movements in the abstracts of the civil and sanitary engineering areas, respectively:

Table 09: Occurrence of rhetorical movements in 10 abstracts in the area of Civil Engineering.

Rhetorical Moves	Occurrences of movements	Percentage %
Movement 1	9	90%
Movement 2	8	80%
Movement 3	9	90%
Movement 4	5	50%
Movement 5	5	50%
Total occurrences	36	72%

Source: Prepared by the authors

Table 10: Occurrence of rhetorical movements in 10 abstracts in the area of Sanitary Engineering.

Movements:	Occurrence of movements	Percentage %
Movement 1	6	60%
Movement 2	10	100%
Movement 3	10	100%
Movement 4	7	70%
Movement 5	9	90%
Total occurrences	42	84%

Source: Prepared by the authors.

It was found in the abstracts analyzed in the area of sanitary and environmental engineering that all movements were well distributed, with the exception of movement 1, but the structure present in the abstracts shows enough information for the reader to decide if the entire work can be useful for reading in its conception.

Table 11 shows the number of words in the abstracts, according to the request of each journal:

Table 11: Average number of words in abstracts per journal and recommended amounts.

Magazine	Average Words Present	Quantity indicated according to the magazine
IBRACOM	153	300
Built Environment	168,86	100 a 200
REM :Revista Escola de Minas	181	150 to 250
Environmental Sanitary Journal	213,33	100 to 250
Brazilian Journal of Agricultural and Environmental Engineering	179,6	250
Tree Magazine	198	280

Source: Prepared by the authors.

The values show that the length of abstracts is already standardized and does not seem to be a problem for the authors. This is probably due to the strict limit of pages for publications and the explicitness of the rule through the editorial teams of the journals. No truncated or cut abstracts were found due to excessive text, but the averages point to a concern of the authors to stay within the word limit, writing texts much shorter than those required, which can lead to the suppression of movements, that is, the authors fail to describe sections of the article for fear of exceeding the word limit.

Table 12 presents an overall average of the use of movements in all abstracts, by area:

Table 12: Number and average of rhetorical movements in the abstracts by area of expertise

Area of Expertise	Quantity of Rhetorical moves	Average of rhetorical movements
Civil engineering	36	7,2
Environmental Engineering	42	8,4

Source: Prepared by the authors.

Based on the information obtained from each publication, it was found that, in relation to compliance with the requirements of the journals and NBR 6028/2003 (ABNT, 2003b), only the School of Mines, regarding the range of 150 to 250 words, and the Brazilian Journal of Agricultural and Environmental Engineering, regarding the total number of words, follow this standard.

In the abstracts analyzed, common structures were found that allowed the identification of most of the movements, except for movement 1, which is a preamble to exemplify a problem and elaborate a hypothesis. In movement 2, the occurrence of demonstrative pronouns to present the research was observed, as in "**This work evaluates". For the methodology, verbal expressions were used to describe actions, such as "identified**", "**used**" and "**verified**". The results presented sentences marked by expressions such as "**the results obtained**" or "**the results achieved**". In the discussion of the results, there was a mixture of linguistic structures of the other movements, with expressions such as "**verified**" and "**what is verified**".

The texts comply with the ABNT standard regarding clarity and conciseness: "The abstract must be composed of a sequence of concise, affirmative sentences and not an enumeration of topics. The use of a single paragraph is recommended" (ABNT, 2003b, p.2). Regarding the use of verbs, the norm is also followed: "The verb should be used in the active voice and in the third person singular" (ABNT, 2003, p.2). This ensures the objectivity of the data and makes it easier for the reader to decide whether to access the original text.

The predominance of movements 1 and 3 in civil engineering abstracts shows the authors' concern to contextualize the research and situate the reader in the methodological procedures. Contextualization serves the sub-functions of establishing professional interest and making generalizations on the topic. The richness of detail in the methodology demonstrates the authors' awareness that readers will be attracted by the methods adopted.

The sanitary engineering summaries focus on movements 2 and 3, indicating the need to expose the objectives and methodology in detail. The recurrence of structures that spell out the objectives shows that researchers believe in the importance of clearly communicating their objectives to readers. Often, movement 3 merges with movement 2, presented in a single sentence.

The analysis demonstrates that there is no shortage of space to present all aspects of the research in the abstracts. Most researchers understand the need to expound on the essential points of research, allowing abstracts to fulfill their discursive functions adequately.

THE INTRODUCTION SECTION IN ENGINEERING ARTICLES

The introduction study was based on Swales' (1990) original model, CARS – Creating a Research Space (see table 01). From the observation of the movements in the sample of 50 introductions, the rhetorical movements and steps found were presented in the form of a table. For better visualization, the data were separated according to the journal from which the articles were taken, but also show the overall result.

Table 13 – Rhetorical movements found in introductions of scientific articles in each journal.

MAGAZINES	MOVEMENT 1	MOVEMENT 2	MOVIMENTO3
AGRIAMBI	100%	100%	100%
Built Environment	95%	86%	90%
Tree	100%	0%	100%
Ceramics	100%	100%	100%
Sanitary and Environmental Engineering	83%	33%	67%
School of Mines	50%	100%	50%
IBRACON	100%	0%	100%
Transport	82%	64%	100%
TOTAL	**90%**	**72%**	**90%**

Source: MOTA, 2022.

Movement 1 was the most present in the introductions studied, thus demonstrating the concern to situate the reader in relation to what will be addressed in the journal. These intentions corroborate the orientation of Swales (1990), who emphasizes the need to contextualize the theme that the article addresses. However, it was noted the absence of Step 3, in which the review of topics present in previous research is made. On the other hand, Step 1, which concerns the establishment of the importance of the work, and Step 2, which points out facts or generalizes about the theme, make up the bulk of the characterization of Movement 1. Therefore, the authors of the engineering areas choose to present the context, exposing facts and the relevance of the content addressed.

Movement 2 is defined, essentially, by indicating the problem to be solved by the creation of scientific study. It is, therefore, an extremely valuable element for the formulation of a good introduction, but in comparison with the other movements, this was the one that showed the lowest number of occurrences. In this movement, Steps A and B are specified by elaborating counter-arguments and indicating absences, that is, verifying the flaws in the studies already carried out on a given topic. From another point of view, Steps C and D seek to highlight the problem in an indirect way, making the reader deduce the subject through questions.

In a specific phase of the research, observations were made on how to establish the research problems, that is, Movement 2 of the introductions of academic texts, which presents the research,

mentions the factors that motivated that study and generally induces relationships between problems and the search for solutions by verifying the form and presentation of the research.

In this case, it was observed that in most of the articles there was no explicit distinction between scientific research and technological innovation, except for some cases in which they mentioned research with similar themes or in situations of total pioneering in the area studied. In general, in fundamental research, the researcher obviously takes more time in explaining concepts due to the insertion of a new approach.

Regarding the interdisciplinary performance, it is observed that almost in its entirety there was interaction with several other areas and disciplines such as: Chemistry, materials, transportation, public policies and among others, with each area of knowledge contributing to the research according to the interest of the study.

In the texts analyzed, common structures were found that allowed the clear identification of most of the research problems in the introductions, especially in the articles in the area of civil engineering, when they were presented, they almost always took into account the indication of standards and techniques or their inefficiencies.

Finally, Movement 3 generally promotes the completion of the ideas presented in the introduction and the *CARS model* designates 4 Steps that compose it. In general, the Steps are intended to expose the objective of the study, possible solutions to the problem indicated in Movement 2 or to show what was obtained and the structure of the scientific article. That said, there is a lower number of occurrences of Step 3 in relation to the others, so this demonstrates a lack of interest on the part of the authors in pointing out how the article is arranged, probably because it is a recurrent structure. On the other hand, most decide to employ Steps A and B.

It is understood that there is a predominance of the choice of objective and factual steps adopted by scientists. In view of this, Aranha (2007) states that the communicative purpose established by the introduction of an academic journal aims to contextualize the subject to be addressed as a whole, therefore, by suppressing the use of certain steps, writers consequently reduce the probability of writing a good introduction.

When analyzing the introductions, it was noticed the existence of common linguistic structures when identifying a certain movement. In movement 1, the author seeks to establish the territory, citing references and demonstrating mastery of the research topic (ARANHA, 2007). Frequently, when referring to previous research, conformative subordinating conjunctions were used, such as ***"Segundo",*** or the prepositional locution ***"According to".*** There are also several other structures, for example**, *"In the work done by", "In previous study", "The results obtained by",*** among others.

Movement 2 presents the relevance of producing the research, indicating the problem to be solved. A fundamental piece to perform such an act is the production of counterarguments, the structures found were, essentially, adversative conjunctions, such as, ***"However", "however", "In addition", "Although", "However", "In spite of", "In spite of", "In the meantime", "However", "On the other hand".***

Pointing out gaps in previous works is also part of the constitution of movement 2, being the most direct way to point out the research problem. The authors adopted sentences that indicate absences, for example: ***"there is, therefore, a gap", "little scientific evidence", "it is perceived that there is no study that", "causes of the inefficiency of", "no studies are observed in the literature", "difficulty is observed",*** and others.

Thus, it was noted that there was greater comprehensibility in recognizing the problem that would be addressed in the articles when, in their introductions, linguistic structures were applied. The same can be said of Movement 3, which will be exemplified below.

In the CARS model, Movement 3 is responsible for "Occupying the niche", that is, designating what the work will contribute to within the scientific community in which it is inserted. In view of this, it was possible to observe that most of the introductions analyzed when manifesting the Mov. 3 chose to do so when declaring the objectives of the research, in view of this, we have as an example: "**Thus, this research had as its objective...", "Thus, the present work aims to...", "In this context, this work evaluated...**". That said, it was found that the linguistic structures observed can facilitate the creation of better introductions, since they allow the establishment of a certain pattern. To elucidate this, it can be suggested that, when making counterarguments, the authors always start the sentence with some adversative conjunction, or, when announcing the objectives, use sentences, such as, **"Thus, this research aimed to..."** and derivatives.

THE METHODOLOGICAL SECTION IN ENGINEERING ARTICLES

Berdanier (2019) also developed, for engineering, a modified pattern of analysis of rhetorical movements, based on Swales' CARS (1990). This study revealed a few more steps and movements that help in the development of the genre, in addition to expanding more details about them and being concerned with developing them in a coherent and saturated way, in such a way that new movements are not necessary. However, although this research generated a total of 9 rhetorical movements, it was taken as the basis for this work only with regard to methodology, Berdanier's movement 4.

Movement 4 refers to the description of processes and methods. In this section, according to Berdanier's (2019) research, it should be possible to find the following steps:

- identify research objectives or questions;

- establish a justification, reasoning, or meaning related to the method;
- list materials, tags, or resources;
- cite established procedures and protocols;
- detail research tasks, procedures, analyses, or instrumentation techniques;
- identify challenges and limitations; and
- explain the scientific mechanisms by which the method works.

According to the study, these should be the characteristics present in a methodological section, and it is possible to see that they cover several characteristics, ranging from small "introductions" to the methodology in question, to explanations about problems that occurred or situations that delayed the research. However, in scientific engineering articles, this pattern is not always observed. The reasons for this derive, in general, from the fact that some steps shown in Berdanier's study are not used, and others are structured differently, thus generating differences between the foreign study and the Brazilian reality.

In this way, it was possible to analyze and make a comparison, at certain points, of the articles on Berdanier's research, indicating the steps not used by the Brazilian authors and what differences exist between them, not exclusively in the methodology, since, as it will be possible to see, some steps were expanded to other parts of the articles.

The following is a general table that shows in percentage how many steps were found in the 50 articles analyzed:

Table 14: Occurrences of the steps present in the rhetorical movement 4

Steps	Occurrences	Percentage
Justifications, reasonings, meanings, and introductions related to the methods. (Step 1)	29	58%
Cite and detail the procedures and methods, analyses or techniques used. (Step 2)	46	92%
Materials and resources used and their definitions/explanations (Step 3)	26	52%
Complete Structure of Materials (Step 3.5)	11	22%
Citations of the methods used (Step 4)	26	52%
Detail specific procedures or techniques of instruments used. (Step 4.5)	15	30%
Identify the goal of the project or what it will produce. (Step 5)	21	42%

Source: Elaborated during the research

With the data presented in Table 14, it is possible to see that step 1 obtained 29 occurrences, demonstrating a significant concern in situating the reader in the article. This part includes introductions, justifications, reasoning, and meanings in relation to the method. Compared to Berdanier's (2019) research, there is a divergence: 86% of the articles in the base research used initial justifications, while in Brazil, 58% of the articles analyzed included this step. Step 2, detailing procedures, methods, analyses or techniques, was the most present, fundamental for the creation of a good engineering article. In Brazil, 92% of articles included this step, compared to 58% in Berdanier's research, indicating a significant difference. Step 3 explains the materials and resources

used, often at the beginning of the methodology. In Brazil, 52% of the articles used this resource, similar to the 48% found by Berdanier. The existence of step 3.5, an expansion of step 3, was observed in 22% of the Brazilian articles. Citations of methods used are dealt with in step 4, with 52% presence in Brazil, compared to 58% in Berdanier's research. Step 4.5, detailing specific procedures, was found in 30% of the Brazilian articles, compared to 100% in Berdanier's research, possibly because details in Brazil are often found in the introductions. Step 5 identifies the objective of the project, which is present in 42% of the Brazilian articles, compared to 88% in Berdanier's research. Some steps, such as "identifying challenges and limitations" and "explaining the scientific mechanisms", were not sufficiently frequent for analysis.

There is an equivalent predominance in the steps adopted by scientists, despite the differences between Brazilian and foreign contexts. Following these trends or developing the methodological section in a similar way can increase the quality of an article.

The analysis of the languages used in the texts showed that the writing of the methodology is marked by the use of recurrent expressions, as shown below:

- **Step 1**: Justifications, reasoning, meanings and introductions, using expressions such as "**second**", "**according to**".
- **Step 2**: Procedures, methods and analyses, explaining methods and instruments, with structures such as "**to perform the analysis**", "**for the intervention**".
- **Step 3**: Materials and resources used, with structures such as "**the materials used in the research are/were**", "**the following material was used**".
- **Step 3.5**: Expansion of step 3, with structures such as "**the following materials were used**", "**the materials used in this research**".
- **Step 4**: Citations of methods, with structures such as **"adopted", "the method used".**
- **Step 4.5**: Breakdown of specific procedures, with structures such as **"the procedures of", "have been prepared by the method".**
- **Step 5**: Identification of the project's objective, with structures such as **"had/aims to present", "in order to characterize".**

Linguistic models help to create textual structures that are better suited to each step, establishing useful standards for authors in the field of engineering.

FINAL THOUGHTS

In view of what was investigated, it was possible to perceive a high application of rhetorical movements in scientific articles, producing recurrent patterns considered relevant for scientific dissemination in the discursive engineering community.

As for the discursive community, there is an interest in establishing a standard of quality in publications. However, the low quality of the guidelines provided by the publishers is highlighted, as they are not always clear about the required standards and structures, leading researchers to follow their own intuitive strategies to organize data, problems, methodology, results, and discussions.

The application of linguistic structures that reflect the rhetorical movements in the sections studied was proven. Most of the observed expressions consisted of objective phrases and words, making clear the purpose of each part of the text. The recurrence of lexical and syntactic choices indicates a tendency to adopt safe forms of language to ensure clarity and objectivity.

The greatest difficulty faced by researchers in the area of Engineering I is to expose the research problem. The absence of a standard causes authors to present their work based on gaps or needs for a practical solution. Clear elucidation of research questions is crucial to improve writing and comprehension, elevating the quality of scientific products.

As for the other sections, most of the articles analyzed complied with the established norms, but they were insufficient from a theoretical point of view, not being supported by the models of structuring the scientific article genre (abstract, introduction, methodology) proposed by the authors studied. The lack of knowledge of the theoretical proposals and norms hinders the elaboration and understanding of the articles, due to the absence of necessary information in the text.

ACKNOWLEDGMENT

The researcher thanks the Foundation for Research Support of the State of Maranhão – FAPEMA for the financial support to project 01264/19 of the public notice 002/2019 – UNIVERSAL.

REFERENCES

1. Aranha, S. (1996). A argumentação nas introduções de trabalhos científicos da área de Química. Dissertação de mestrado, Pontifícia Universidade Católica de São Paulo, São Paulo.

2. Aranha, S. (2007). A busca de modelos retóricos mais apropriados para o ensino da escrita acadêmica. *Revista do GEL, 4*(2), 97-114.

3. Aranha, S. (2004). Contribuições para a introdução acadêmica. Tese de doutorado, Universidade Estadual Paulista, Araraquara.

4. Arauz, V. A. R., & Mota, L. G. (2022). A seção de introdução em artigos científicos na engenharia. In *Anais do Congresso Brasileiro Interdisciplinar em Ciência e Tecnologia*. Recuperado de https://www.even3.com.br/anais/cobicet2022/506524-A-SECAO-DE-INTRODUCAO-EM-ARTIGOS-CIENTIFICOS--NA-ENGENHARIA

5. Associação Brasileira de Normas Técnicas. (2011). NBR 14724: Informação e documentação: Trabalhos acadêmicos. Rio de Janeiro.

6. Associação Brasileira de Normas Técnicas. (2003). NBR 6022: Informação e documentação: Apresentação. Rio de Janeiro.

7. Associação Brasileira de Normas Técnicas. (2003). NBR 6028: Informação e documentação: Resumo. Rio de Janeiro.

8. Bakhtin, M. (2003). *Estética da criação verbal*. São Paulo: Martins Fontes.

9. Bazerman, C. (2015). *Teoria da ação letrada*. São Paulo: Parábola Editorial.

10. Berdanier, C. G. P. (2019). Genre maps as a method to visualize engineering writing and argumentation patterns. *Journal of Engineering Education, 108*, 377-393. https:/doi.org/10.1002/jee.20281

11. Bernardino, C. G., & da Costa, R. L. S. (2016). A introdução de artigos acadêmicos e as diferenças entre culturas disciplinares. *Revista Intersecções, 9*(18), 151-170.

12. Bernardino, R. A. S. (2018). Responsabilidade enunciativa em textos acadêmico-científicos: por um tratamento textual/discursivo das operações de citação. *Linha D'Água, 31*(1), 193-220.

13. Bhatia, V. K. (1993). *Analysing genre: language use in professional settings*. London: Longman.

14. Bonini, A. (2004). Gênero textual/discursivo: o conceito e o fenômeno. In V. L. L. Cristovão & E. L. Nascimento (Orgs.), *Gêneros textuais: teoria e prática* (pp. 3-17). Londrina: Moriá.

15. Caetano, J., & Marian, J. (2019). Uma análise dos movimentos retóricos da seção de introdução de artigos científicos baseados nos estudos de Swales (1990). *Caderno PAIC, 20*(1), 477-498.

16. Campos, J. G. S., & Silva, L. R. V. (2019). Resumos acadêmicos em engenharia: como escrevem os pesquisadores. Trabalho de Conclusão de Curso, Universidade Federal do Maranhão, São Luís.

17. Campos, J. G. S. (2020). A comunidade discursiva na área de engenharias I. Relatório de Pesquisa, BICT/UFMA.

18. CAPES. (2017). Tabela de áreas de conhecimento. Recuperado de https://www.capes.gov.br/avaliacao/instrumentos-de-apoio/tabela-de-areas-doconhecimento-avaliacao

19. Chandler, D. (2016). An introduction to genre theory. Disponível em http://www.aber.ac.uk/media/Documents/intgenre/Chandler_genre_theory.pdf

20. Curty, M. G., & Boccato, V. R. C. (2005). O artigo científico como forma de comunicação do conhecimento na área de Ciência da Informação. *Perspectivas em ciência da informação, 10*(1).

21. Figueiredo, D. C., & Bonini, A. (2010). Práticas discursivas e ensino do texto acadêmico: concepções de alunos de mestrado sobre a escrita. *Linguagem em (Dis)curso, 6*(3), 413-446.

22. Gibbons, M., et al. (1994). *New production of knowledge: Dynamics of science and research in contemporary societies*. Los Angeles, CA: SAGE.

23. Marcuschi, L. A. (2008). *Produção textual, análise de gêneros e compreensão*. São Paulo: Parábola Editorial.

24. Marian, J., & Babini, M. (2016). A estrutura da escrita acadêmica: artigo científico original. *Anais Simpósio de Pesquisa e Seminário de Iniciação Científica, 1*(1).

25. Miller, C. R., & Fahnestock, J. (2013). Genres in Scientific and Technical Rhetoric. *Poroi, 9*(1), article 12.

26. Motta-Roth, D., & Hendges, G. R. (1996). Uma análise de gênero de resumos acadêmicos (abstracts) em economia, linguística e química. *Revista do Centro de Letras e Artes, UFSM*.

27. Motta-Roth, D. (1998). Uma análise transdisciplinar do gênero abstract. *Intercâmbio. Revista do Programa de Estudos Pós-Graduados em Linguística Aplicada e Estudos da Linguagem, 7*.

28. Motta-Roth, D. (1999). A importância do conceito de gêneros discursivos no ensino de redação acadêmica. *Intercâmbio. Revista do Programa de Estudos Pós-Graduados em Linguística Aplicada e Estudos da Linguagem, 8*.

29. Mueller, S. P. M. (1994). O impacto das tecnologias de informação na geração do artigo científico: tópicos para estudo. *Ciência da Informação, 23*(3).

30. Rahman, M. R. (2001). Genre-based Writing Instruction: implications in ESP Classroom. *English for Specific Purposes World, 33*.

31. RBEAA – Revista Brasileira de Engenharia Agrícola e Ambiental. Disponível em http://www.agriambi.com.br/

32. REVISTA AMBIENTE CONSTRUÍDO. Disponível em https://seer.ufrgs.br/ambienteconstruido

33. REVISTA ÁRVORE. Disponível em http://revistas.cpd.ufv.br/arvoreweb/index.php

34. REVISTA CERÂMICA. Disponível em https://abceram.org.br/revista-ceramica

35. REVISTA ESCOLA DE MINAS. Disponível em https://www.periodicosdeminas.ufmg.br/periodicos/rem-international-engineering-journal-revista-escola-de-minas/

36. REVISTA IBRACON – Instituto Brasileiro de concreto. Disponível em http://www.ibracon.org.br/publicacoes/revistas_ibracon/riem/home.asp

37. REVISTA SANITARIA E AMBIENTAL - Associação brasileira de Engenharia Sanitária e Ambiental –SP. Disponível em: http://abes-dn.org.br/

38. REVISTA TRANSPORTES - Associação Nacional de Pesquisa e Ensino em Transportes - ANPET. Disponível em: https://www.revistatransportes.org.br/anpet

39. Santos, M. B. (1995). Academic abstracts: a genre analysis. (Dissertação de mestrado, Universidade Federal de Santa Catarina, Florianópolis).

40. Silva, A. de P. N., Bernardino, C. G., & Valentim, D. L. (2020). A construção socio retórica da seção de Introdução em artigos acadêmicos de Linguística Aplicada. *Trabalhos em Linguística Aplicada, 59*(1), 686-714.

41. Simpson, S., et al. (s.d.). Creating a Culture of Communication: A Graduate-Level STEM Communication Fellows Program at a Science and Engineering University. Recuperado de https://files.eric.ed.gov/fulltext/EJ1115736.pdf

42. Swales, J. M. (1981). *Aspects of article introductions*. Birmingham, UK: The University of Aston, Language Studies Unit.

43. Swales, J. M. (1990). *Genre analysis: English in academic and research settings*. Cambridge, UK: CUP.

44. Swales, J. M. (2009). Repensando gêneros: uma nova abordagem ao conceito de comunidade discursiva. In B.G. Bezerra, B. Biasi-Rodrigues & M. M. Cavalcante (Orgs.), *Gêneros e sequências textuais*. Recife: EDUPE.

45. Zinani, C. J. A., & dos Santos, S. R. P. (2007). A relevância da introdução para a escrita do texto acadêmico. *Revista Língua & Literatura, 9*(13), 11-28.