

Smart Grid Technologies: Communication Technologies and Standards

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Abstract

Purpose – The purpose of this paper is to outline how article genres, or article types, are classified and described in the disciplines of biology, education, and software engineering. By using the expression article genres, emphasis is placed on the social role of journal articles that, as such, accomplish specific communicative functions and are intended for a certain context and audience.

Design/methodology/approach – Drawing on this idea, the instructions to authors of the research journals cited in the Journal Citation Reports for each of the three disciplines are analysed.

Findings – The information provided by the instructions to authors of major publications in the fields studied allows one to describe the following article genres: major articles, theoretical articles, review articles, short articles, practice-oriented articles, case studies, comment and opinion, and reviews.

Research limitations/implications – Results show that article genres reflect the nature of research in each field to the extent that using them to describe items along with topic may improve management and retrieval of scientific documents. In addition, article genres perform specific communicative functions within disciplinary communities, which accounts for both emerging types of articles and variations in traditional types.

Originality/value – The paper summarizes the information on article genres available in the instructions to authors of scientific journals in the disciplines of biology, education and software engineering. It attempts to show how results can mirror the nature of research in each field as well as current debates within each discipline on the state and quality of research. Also it shows how article genres convey specific communication needs within disciplinary communities, which proves that genres are social and evolving objects.

Keywords Research work, Biology, Education, Software engineering

Paper type Research paper

Introduction

In this study we describe how research journal articles vary across and within disciplines. We describe and classify journal article types using the instructions to authors of major journals in three areas, i.e. biology, education, and software engineering. In so doing, we draw on the notion of genre, that is to say on the idea that document types, or document genres, are identifiable by their communicative purpose, their function, the audience they address, their expected content, as well as by

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The theory of genre is receiving increasing interest in information science (Beghtol, 2001; Hjørland, 1998, 2002). In particular, genres seem to have the potential to improve retrieval, especially from large collections of documents, including the internet. Crowston and Kwaśnik (2003, p. 348) explain that:

... enhancing document representations by incorporating non-topical characteristics of the documents that signal their purpose – that is, their genre – will enrich document (and query) representations in such a way that they resonate more truly with the information need of a user as situated in a particular context.

Because genre seems to be promising in refining internet searches, a major subject of research into genres is that of cybergenres. Several studies have been conducted on individual cybergenres, such as personal homepages (Dillon and Gushrowski, 2000), homepages (Shepherd *et al.*, 2004), weblogs (Herring *et al.*, 2005), or online newspapers (Ihlström and Henfridsson, 2005), whereas other investigations explore possible ways of classifying cybergenres. Lim *et al.* (2005), for example, show how a set of features (URL, HTML tags, word counts, sentence length etc.) may contribute, in different degrees, to classifying web documents as different genres. Roussinov *et al.* (2001) show that certain genres are better suited for some kind of user needs, and identify tentatively 5 major groups of web genres recognizable by a computer algorithm. Crowston and Kwaśnik (2004) propose a faceted-analysis with a bottom-down approach to genre classification. However, serious obstacles hamper progress in this area. In general, genres are unsuitable for traditional classification methods, which are mostly focused on topic (Crowston and Kwaśnik, 2003), and the proportions and nature of the web make research into cybergenres especially problematic. In addition, from the methodological point of view, many studies which aim at a classification of cybergenres are developed independently of a community of reference, but attempt at a general classification of the web. In other words, they take as a starting point the “individual” instead of the “specialty, discipline, domain, or environment” (Hjørland and Albrechtsen, 1995), either the individual user (Roussinov *et al.*, 2001), or the individual web page (Dillon and Gushrowski, 2000; Crowston and Williams, 2000). As consequence, no major results have as yet been achieved.

Article genres

A different case is true for the digital scientific article. If we describe cybergenres either as “novel” or “migrated” genres, i.e. adapted from the print environment (Shepherd and Watters, 1998; Crowston and Williams, 2000), the digital scientific article too can be considered a migrated genre with different degrees of adaptation to the electronic environment (King and Callahan, 2003, p. 134). In general, however, adaptation to the digital medium has left the scientific article as a genre practically unchanged. Even when articles are published in e-only journals, they present no extra-features over their printed counterparts, such as new forms of presentation and interaction (Mackenzie Owen, 2006). The scientific article is also a genre that is highly familiar to all scientists and presents a high degree of standardization across the disciplines. The literature acknowledges, though, that there are also variations which mirror the specific needs of scientific domains, as well as methodologically and epistemologically different norms (Hjørland, 2005), that most journals do not qualify the articles they publish in such a way.

Now that most scientific journals are available in digital form, scientists have at their disposal improved opportunities for access to scientific content. Indeed, the range of journal titles they read, as well as the time they spend reading have increased consequently (Brennan *et al.*, 2002; King *et al.*, 2003). Qualitative studies conducted on the topic, however, show that researchers are scanning and exploring more information as well as getting exposure to new sources online, without necessarily reading more articles (Palmer, 2005). In general, whether or not researchers read more than before, they are exposed to the inconvenience of having to manage an increased amount of information, both from organized sources such as electronic journals and from less structured collections of documents, such as Google Scholar and Scirus. In Voorbij and Ongerling’s (2006) survey users claimed that the improved availability of electronic journals had worsened the state of information overload they already suffered in the printed environment. In Nicholas *et al.*’s (2005) survey, authors complained that not only there are too many articles to read but that these are often uninformative. They have the impression that there has been an information explosion, while actually journal growth has been

consistent over the years. Then again, quality seems to be a more pressing concern than quantity for the researchers interviewed in Herman's (2004) study.

What emerges from these studies is that users need more means to select what is published both because it is too much and because what they find may often be below the required level of quality. Obviously, there are differences across disciplines in the search strategies, the assessment of relevance, and use and non-use of electronic resources, which may vary depending on the domain size or other factors (Talja and Maula, 2003). All the same, the question here is whether genre can have a role in helping scientists to better select the literature they come across in their searches. On the basis of the literature on genre cited previously, and conceiving of genre as a text reflecting specific communication patterns within discourse communities, we could answer: yes, genre may have a role in the retrieval, assessment and selection of scientific articles, with the understanding that the scientific article as a genre is distinct from many other genres. That users may rely on genre to select the relevant literature has been already mentioned. Voorbij and Ongerling (2006), for instance, found that users decide on the basis of "non-subject parameters", such as the approach undertaken in the research or the type of article, whether they want to print digital articles or not. The type or genre of an article, as a matter of fact, raises certain expectations as regards the methodology or the approach adopted in the research. Research articles summarize the whole research process and should mirror faithfully the way the research has been conducted. Sometimes, the method used to conduct the research and the genre of the corresponding article coincide. This is the case, for example, with "randomized controlled trials" in the medical literature, which alludes both to a research methodology and a type of research paper (McKibbin and Walker-Dilks, 1995; Glanville *et al.*, 2006).

If it is accepted that genre can help users select the items they are most interested in and discard others, it could also be the case that a better understanding of genre and sub-genre characteristics might help users to assess faster the informativeness and reliability of the articles they find. A better knowledge of article genres may be applied in scanning/exploring the literature, as suggested by Harmsze (2000), or in appraising its degree of conformity to the generally accepted standards of quality. In conclusion, genre could have a positive role in information retrieval and selection, and could help users alleviate the information overload they have become exposed to since the digitization of scientific information resources.

Purpose and methodology

Despite the potential advantages of a good understanding of article genres, however, we do not know of any systematic research into the topic in information science. With these premises, we decided to study the scientific journal article as genre in three different disciplines:

- a traditional but fast growing area such as biology (B);
- an area between the social sciences and the humanities such as education (E); and
- a younger engineering area, i.e. software engineering (SE).

Our aim is to emphasize the variations occurring inside each discipline and to describe the sub-genres of scientific journal articles in use in each of them. We also set out to identify similarities and differences between these disciplines. Considering the fact that electronic access to scientific journals has resulted in more interdisciplinary research being undertaken (Lally, 2001; Voorbij and Ongerling, 2006), it is likely that researchers are now venturing more than ever into unfamiliar fields. In such explorations, the sooner they are aware of how articles may vary (in structure, meaning, expected content, vocabulary, etc.), the better they can manage the information they find in their search.

In trying to achieve this aim, we wanted to take into account the point of view of those involved in the production and use of scientific articles and, at the same time, to draw on sources which mirror consolidated instead of incidental differences. Therefore, we wondered how scientists actually know how to write a specific type of article. It is often said that this is an implicit kind of knowledge that authors acquire with their experience as insiders in a particular scientific community. However, they can also rely on specific guides that help them to write good articles. Some disciplines count on publication manuals such as the *APA Publication Manual* for psychologists and other social scientists. But most

authors rely on the information available in the “Instructions to authors” of the journals they intend to publish in, that, being envisaged for a disciplinary use, also carry an epistemological meaning. It can be argued that hardly ever do authors bother to follow such instructions. Even so, the instructions to authors represent some kind of written agreement between different actors in a discipline or domain (the publisher, the editors who are in turn authors, etc.). Thus, for the purpose of this study, which is a preliminary and comparative classification, they are valid.

We decided to study a set of instructions to authors from highly reputed journals in the three fields of B, E, and SE, listed in the *Journal Citation Reports* (<http://portal.isiknowledge.com/portal.cgi?DestApp¼JCR&Func¼Frame>) of ISI Web of Knowledge in September-October 2005. A total of 64 journal titles were listed in the field of B, 91 in E, and 76 in SE. It was impossible to find pertinent information or any information at all for 2 E and 2 B journals that were included in the *Journal Citation Reports* (<http://portal.isiknowledge.com/portal.cgi?DestApp¼JCR&Func¼Frame>). Consequently, the instructions to authors studied are: 62 in B, 89 in E, and 76 in SE. The instructions to authors of the journals of SE and B were all available over the internet, while sometimes in E they had to be photocopied from their printed versions (in seven cases). In many occasions, the internet version of the instructions was an obligatory choice since such contents may be published by some journals exclusively online. Hypertext contents may be spread over several pages, which in turn can be updated independently of one another. The instructions to authors are almost always individual web documents, but it cannot be ruled out that relevant information is contained in other related documents. The information we analyse here originates primarily from those documents that were referred to as “Instructions to authors”, or “Guide for authors” and the like, and sometimes from the introduction to the journal explaining the scope and aim of the publication. However, it may be the case that, due to the kind of elusive nature of hypertexts, some relevant data were missed or have been updated.

The instructions to authors were searched to find all the information relevant to the description and understanding of the different article genres published. do not make any reference at all to the different types of articles. Significantly, there seems to be a tendency for those who comment at least on one type of article to have a higher position in terms of impact factor. It is impossible, however, to quantify this tendency for the limitations we commented on before.

All the information relevant to the research was first classified independently for each discipline, depending on the type of article it referred to. Later, the data obtained for each discipline were compared to the others. During the analysis, a considerable problem was the inconsistent use of terminology within each discipline. In particular, it happens that journals call with different names certain types of articles, which correspond to the same descriptions. In order to unify the terminology, we decided to opt for the most descriptive names or for the most coherent with the others, especially for the sake of clarity and comprehensibility. For instance, we decided to choose the name “short articles” instead of “short papers” or “short communications” since the term “article” was chosen for full-length manuscripts. It remains to be clarified, however, whether by using the term “paper” instead of “article” some differences are meant. Here, we use them as synonyms, since for our purpose there are no significant differences between the terms “article” and “paper”.

Results

Despite being neither exhaustive nor always comprehensible, the instructions to authors are still an indispensable source of information, at least as regards article genres published in scientific journals. The data collected in this study do not allow any quantitative generalization, i.e. the fact that certain types of articles are cited in the instructions to authors does not necessarily correspond to their actual presence and impact. Nonetheless, they can still convey an idea of the importance assigned to a certain type by the discourse community in question as reflected in the editorial policies studied.

Journal titles are quoted all along this article in their abbreviated form. When literal quotations are included or special names are mentioned, it is understood that such quotations come from the “Instructions to authors” in the version consulted for this research (September-October 2005).

The general division into journal sections tends to be similar across the three disciplines, as do the general types of

articles. Along with a main section dedicated to major articles (the names may vary from a journal to another), part of the publication is also devoted to short articles and to articles which usually focus on some kind of practical aspect related to the discipline (educational, legal, professional, etc.). In the three disciplines, besides, there are also sections devoted to reviews, letters, editorials and commentaries, and sometimes news. Differences become noticeable when one looks at the content and purpose of major articles and some of the others, as well as in the terminology used by the three discourse communities (see Table I).

Major articles in general

The way major articles may be called depends on the individual journals as well as on the discipline. In SE and B it is common to refer to them both as “regular papers” and as “original archival papers” (SE) or “original research articles” (B). The first case is probably due to the need to distinguish standard articles from those published in special issues; whereas, in the second case, it may be the opposition to conference papers to be stressed. Across the 3 fields there is a tendency also to call major papers “full-length”, as opposed to the short type of articles we will discuss further on.

A special case of major articles are those based on a previous paper presented in a workshop, a symposium or a conference. Only in SE journals, the publication of these articles is regulated. Among other conditions, at least one-third of the content must be new and original, and, authors must submit both versions and/or a description of the differences between the submitted manuscript and the preliminary version. Papers published as such must be “important” (*Theory and Practice of Logic Programming*), “outstanding” (*ACM Transactions on Database Systems*), and “of particularly high quality” (*Journal of Computer Science and Technology*). B journals, which sometimes allude to these reports, are not equally accurate in describing their content. Some B journals publish this type of article as “meeting reports” which, we understand, refers rather to abstracts or very short reports of scientific events. With no doubt, this type has a role only in SE. Normally in B journals, the body of a standard article, which is always preceded by an abstract and, almost always, by a list of three up to ten keywords, must follow the structure “introduction”, “material and methods”, “results”, “discussion” and, only in a few cases, “conclusion” or “summary”. In *Plos Biology*, however, this sequence is slightly modified with the materials and methods section coming at the end after the discussion. A standard format is intended to facilitate the experience of readers and users; however variations are admitted to best present research that does not fit in such a format. The *Faseb Journal*, for instance, suggests a different structure for review articles, i.e. “background”, “recent results”, “matters of controversy/unanswered questions”, “prospects and predictions”; and requests contributors to accompany the review with “schematic illustration(s) that depict the most important points that are described in the body of the text”. It is also possible to divide the article sections into sub-sections. The *Bulletin of Mathematical Biology*, for example, suggests two introductions for particularly theoretical papers. There is thus a general or biological introduction, where the background of the problem is stated in simple terms and without equations, and a theoretical introduction, to explain the theoretical background in fuller form. Aiming for brevity, some journals recommend attaching very technical material from the result section and the material and method section in a file to be published only electronically (e.g. *Plos Biology* and *Proceedings of The Royal Society B-Biological Sciences*).

The typical structure of a SE article is slightly simpler than in B, since it consists of only three distinguishable parts: an introduction, a results section, sometimes called simply “main body” (*IBM Systems Journal*), and a conclusions section. Such a structure is rarely further described, although the headings that mark it are reflected in the elements of content to be reported in abstracts. Nonetheless, there are sometimes indications of the required content of the different sections of articles. The introduction, for instance, should tell why the topic is important, and define a thesis or a problem. In *Computer*, “Articles must have sufficient introductory material; at least 15 percent of article length should be tutorial [...]. A brief literature survey does not satisfy this requirement. The tutorial section should include material describing the principles or techniques of existing approaches and their advantages and disadvantages.” In the conclusions, on the other hand, authors outline future goals and lessons learned. General expectations on the content of typical SE articles are summarized thus by the *Communications of the ACM*: “An article sets the background, defines fundamental

concepts, compares alternate approaches, and explains the significance or application of a particular technology or result by means of well-reasoned text and pertinent graphical material.”

Much emphasis is often placed on style and comprehensibility. “Articles should be understandable to a broad range of developers who want information they can apply in their daily work. Writing should be down-to-earth, practical, original, and comprehensible to all readers, regardless of their specialty. [...] Explain terms and concepts and avoid jargon and academic language.” (IEEE Software). “In other words, write the way you talk” (IEEE Micro). To improve comprehensibility, contributors should make use of examples and visual material, such as figures, tables, diagrams, charts and photographs, define technical terms and avoid jargon. For the same reason, detailed mathematical discussions, “long intricate proofs and proofs of minor lemmas and theorems needed to establish the main results” (*Journal of Mathematical Imaging and Vision*) would fit better in appendixes. Several publications remind their contributors that they are magazines and not journals; as a consequence, they publish neither abstracts nor lists of keywords.

This effort for making content comprehensible to as wide an audience as possible gets embodied in a particular article genre, the tutorial. Despite being published in several journals, tutorials are hardly ever described. They “should develop to an appropriate level of detail a significant topic that is of interest to, but not well known to, a significant portion of the Presence readership.” (*Presence: Teleoperators & Virtual Environments*).

In E guidelines, information on the actual content of articles is also rare, since most journals simply refer to the pertinent publication manuals available (the *APA Publication Manual* (American Psychological Association, 2001), for example, or the *American Medical Association Manual of Style* (American Medical Association, 1998)). Nevertheless, some E journals furnish data on how research articles should be written, directly, when they describe specific types, or indirectly, when they are dealing with the accompanying abstracts. In this field, there is a clear division between data-based research articles and theoretical research articles, and, within the former, between qualitative research and quantitative research articles. Quantitative research articles closely resemble the typical structure of research articles in other disciplines, such as B, for example, but they also show some idiosyncrasies, especially on the methodological level. In *TESOL Quarterly*, for example, the following subsections are highlighted in the method section: “participants”, “measures”, and “procedures”, and inside this last subsection, “design”, “variables”, and “power and sample design”. This articulation is mirrored in the headings of abstracts to be prepared for the *Journal of Curriculum Studies*: “primary objective”, “research design”, “methods and procedures”, “experimental interventions”, “main outcomes and results”, and “conclusions”. On the other hand, other journals insist on the method section to be concise (*Journal of Research in Science Teaching*), and others remind the need for quantitative research articles to be not only descriptive but also analytical (*British Journal of Educational Technology*).

Reflecting the diversity of methodological approaches to educational problems, other types of major research articles are available in E. E journals often observe that they accept a variety of manuscripts or perspectives: “reports of original, rigorously conducted research employing diverse epistemologies, methodologies, methods, and disciplinary perspectives” (*Reading Research Quarterly*). *TESOL Quarterly*, for instance, spends several pages commenting on different report options for qualitative research. Describing the “critical” ethnography report – as opposed to the more traditional “descriptive” or “interpretive” ethnography report – it concludes that it is difficult to give definite guidance on such reports:

Established genres of the research article may not always be suitable for reporting ethnographic studies that practice a critical ethnography. [...] Other emergent genres of research reporting adopt greater reflexivity (in representing the personal shaping of the findings, in light of the changing biases, subject positions, and involvement of the researcher), narratives (for a more indirect, context-bound, personal form of theorization), multivocality (for textualizing the plural perspectives and voices – of different informants, researchers, participants – on the same culture), authorial collaboration (in involving the participants/informants in the representation of the findings), and open-endedness (in dramatizing the tensions in interpretation and data from the field, and encouraging the readers to form alternate paradigms of interpretation).

Similarly, authors are often left free to choose the most appropriate headings for their articles (*Reading Research*

Quarterly).

Across the three disciplines, slight differences exist in the maximum number of words admitted for major articles. In E this limit spans from a minimum of 1,500 words to a maximum of 15,000 words per contribution, in SE from 2,400 words to 11,000 words, and in B from 4,000 words up to 20,000 words. Relatively more E journals consider it necessary to provide special limits on length than in the other two fields. Specific limitations on the length of major articles are provided in 48 out of 89 E journals (54 percent), in 25 out of 76 SE journals (33 percent), and in 28 out of 62 B journals (45 percent), either in words or in number of pages. It is difficult to say to what extent length limitation can account for disciplinary differences, as often it depends on financial resources of individual journals. B and SE journals levy sometimes a voluntary page charge, whereas page charge in case of over-length is applied only by a couple of SE publications. Restrictions on the number of references, figures and tables are provided only in very few cases for major articles, but more often for short articles in the three disciplines.

Journal policies regarding illustrations depend very much on the publisher; suffice it

to say that the text regulating such features reads exactly the same in journals of different disciplines. Even so, some journals spend a few more words on the intended purpose of illustrations, making it possible to outline certain differences. Under the name of figures, different types of illustrations may be included, such as diagrams, drawings, photographs, and halftones. Each discipline has its own distinctive illustration: photomicrographs – photos taken with the help of a microscope – in B; screens shots in SE; and photographs of student work in E. The function that figures accomplish is explained mainly in E and sometimes in SE, but not in B. In SE they can give “visual presentation” to one’s ideas (*IEEE Software*), and can also “offer an opportunity to lure anyone looking through an issue into reading your article” (*Doctor Dobb’s Journal*). That figures can attract potential readers is also stressed by some E journals: “Illustrations are as important as the text, and should be as simple, relevant and clear as possible. A potential reader, after reading the title, often glances next at the figures [...].” (*Journal of Education Policy*). However, some E journals state that figures are published only if considered really indispensable; “Use figures only if they present concepts that cannot be conveyed easily in words” (*Journal of Economic Education*). The limitation to the number of figures to be employed in short articles is the only direction given on the use of figures in specific types of articles.

Theoretical articles

Among major articles, theoretical articles are scarcely commented on in most journals, and their writing is left to the initiative of authors. In E, for example, theoretical articles do not need to follow the standard format necessary for other data-based articles, but can replace the method, results, and discussion sections with appropriate headings, which remain undetermined (*Health Education Research*).

In B and SE, theoretical articles tend to be of a methodological nature. B methodological articles are preferably published as short communications (see later), but they can also appear as full-length papers. Methodological articles in *Biometrics* should be accessible to biologists and other subject-matter scientists. The journal also describes possible strategies to achieve this: authors should introduce properly the application and the scientific objectives of the method at stake, include real data wherever possible, and remove extensive mathematical derivations and proofs to an appendix. Another theoretical genre quite popular in B are hypotheses. They “should communicate succinctly the basis of the author’s hypothesis to encourage discussion and creative hypothesis testing by members of the scientific community” (*Astrobiology*). “As a requisite, they should be novel and relevant in the context of the most recent scholarship” (*Faseb Journal*).

SE theoretical papers are also mainly methodological, but often they can be included only if they are of practical value for application-oriented readers: “Articles on new theory, method or algorithm therefore deal with its objectives; its potential benefits; any experience gained; any innovation achieved through a specific approach” (*Simulation Practice and Theory*). It is therefore necessary to include applications and examples that demonstrate that any theoretical assumption is applicable to real-world problems. “Why the theory is relevant and how it can be applied, what is the

novelty of the approach and what are the benefits and objectives of a new theory, method or algorithm; what experience has been obtained in applying the approach and what innovations did results?" (*Simulation Modelling Practice and Theory*).

Review articles

A type of major articles common to the three disciplines is the review article, whose names and characteristics may vary in the three disciplines as shown in Table II.

Two facts are noteworthy in relation to the review article:

The importance attached to this type by B journals (35 journals, approximately 56 percent, mention such a type and most of them devote a few lines to describing it), which reverberates in the sub-type of the "mini-review article".

The alternative designation of "survey" used in SE, and observable to a minor extent in B and E, where, however, the denomination "review" heavily prevails.

As would be expected, the variant term of "survey" reflects in fact a slight difference in the nature of this article genre in SE. In all the 3 fields the instructions insist that this is an article focused on a well-defined area, that implies a state-of-the-art report, and that addresses also future developments. However, in SE there is hardly any reference to the fact that such articles are based on an exhaustive literature review, which is particularly stressed by both B and E journals. Some B journals, for example, point to the fact that these articles should have a reference section comprehensive enough "to enable the reader to begin independent study of the topic" (*Bioelectromagnetics*), and to guarantee an unbiased coverage of "contributions from both collaborators and competitors" (*Faseb Journal*). On the contrary, literature reviews as a possible content element of survey articles appear in only one SE journal. Surveys can include "material that is difficult or impossible to find elsewhere" (*Presence: Teleoperators & Virtual Environments*), "can summarize prior literature on a theoretical or system researchtopic, or can explain approaches implemented in commercial systems." (*ACM Transactions on Database Systems*). The same is true also when the variant and more traditional designation of "review" is preferred (in six cases out of 27).

The publication of reviews in B journals is often by invitation and requires a certain level of authority in the area. Mini-reviews should quote literature published very recently, such as in the last three years. The fast rhythm of development in the field and the need for keeping abreast of the latest developments are probably the reason why review articles are so popular in B. In E, some journals consider review articles as data-based research, some others do not.

Short articles

The several names employed for this type of article and reported in Table III reflect the fact that short articles, like the major ones, allow for different methodological approaches and virtually any kind of topic included in the scope of the journals. In a certain sense, they are major articles in miniature.

In SE and, to a lesser extent, in E and B, short articles tend to centre around some sort of practical and/or technical application. In this sense, they may overlap with the practice-oriented "technical notes" commented on later in this study, a designation also adopted in a couple of B journals. In SE, short articles may also be "practitioner-oriented" (*IEEE Software*), describe "clever programming ideas" (*Journal of Functional Programming*) and "novel and/or topical applications" (*Journal of Research and Practice in Information Technology*), or present "problems on selected topics of computer science" (*Algorithmica*). In E, only *Teaching Sociology* assigns a practical function to short articles, which should be focused on teaching techniques. In B they may have a didactical (*Radiation Research*) or, more often, a methodological nature.

There are three cases in which a short article is appropriate:

when the research is in progress and a follow-up study is planned;

when a fuller report is available elsewhere, such as in the case of monographs or theses, in the case of replications and extensions of a previously reported study; and
and when meaningful research does not require a full-length manuscript.

There is a difference in the maximum length admitted for such type of articles between SE, on the one hand, and E and B, on the other. The maximum length admitted in B spans from 1,000 to 2,500 words, in E from 1,000 to 3,400, and in SE 2,000 to 5,000

words. If we consider that the maximum length admitted for major articles in SE is on average the lowest among the three disciplines, the difference between short and major articles in this field tends to be less significant.

The revision process is, as a general rule, as rigorous as for normal contributions, while the publication process may be shorter than for major articles. However, in many cases, especially in B but also in SE, it is stated that they are not necessarily processed faster than other categories of papers. On the other extreme, there are cases in SE in which such articles may be reviewed only by the editor in charge of the corresponding section (*Journal of Functional Programming*). Sharing several properties with major articles, short articles in B journals should have an abstract, which is included in the word counting. However, short articles may not need to be structured into sections, or they may combine the result and the discussion sections in one. Correspondingly, the number of references, figures and tables decreases in short articles, as precise limits are established by journals in the three fields.

Along with short articles, 3 B journals also include another type of article called “rapid communication”. No precise length limits are imposed. *Astrobiology* offers rather contradictory information encouraging authors to submit papers no longer than 15 journal pages, and imposing later a limit of four journal pages (3,000 words). The preferred subjects of this kind of publication are methodologies and techniques, but other scientific topics may be treated. These articles are published six weeks after acceptance online or in print.

Practice-oriented articles

The existence of sections oriented to practice and application in SE journals seems to be due to the readers’ feedback “reflecting a strong desire for “more practical content”, “more real world applications”, “more practice and usage”, more “implementation details”, “more experience-related information”, “more practical application of research results”, and “bridging the gap between theory and application”” (*IEEE Computer Graphics and Applications*). Despite their apparently less academic content, such articles are widely sought for by journals. They may present “the results of using a CDA [Computer Aided Design] in practice” (*Computer-aided Design*), or describe “the experience of applying functional programming to real problems” (*Journal of Functional Programming*).

In E there are several articles that deal with some kind of application into practice (see Table IV). First, there are those explaining teaching/learning activities with classroom applications (we adopted the designation “teaching techniques” employed by the *Journal of School Health*). Their aim is to provide instructors with pedagogical tools of immediate practical use. Teaching techniques may take into consideration the application of computers in the classroom, reviewing the existing software, and proposing “exemplary material for teaching and learning economics that is interactive or otherwise not conducive to traditional printed-page format” (*Journal of Economic Education*). Other application-oriented articles may deal with the development and evaluation of school programmes, as well as with professional issues and policies adopted by government, interest groups, school districts, etc. and their effects on teaching and learning (*Science Education*). Similarly, in B application-oriented articles deal with some educational or professional topic. “Features articles” in the *American Journal of Human Biology*, for example, should include clear illustrations and extensive bibliographies, since they have to prove useful as teaching material. The *Journal of Biological Education* is concerned with “innovations and developments, such as the use of teaching aids and the implementation of software packages”. On the other hand, some B journals take into consideration articles commenting on technical issues or reporting “a new technique that could have broad application” (*Radiation Research*). In many cases, in B as in SE

these technical manuscripts are published as short notes.

Case studies

Case studies are a genre of qualitative educational research. They have a role in SE also, but with a different status (see Table V). This kind of research, explains *TESOL Quarterly*:

... has its origins in psychology and linguistics [...], with a focus on the development of L2 syntax, morphology, phonology, and so on, as analyzed by an ostensibly objective researcher. More recently, TESOL case studies have adopted the more subjective and interpretive stance typical of case studies in education and other fields.

Details and contextualization are paramount.

Despite an apparent similarity with first-hand experience articles, in SE case studies seem to imply a more objective perspective, whereas the term itself first-hand experience papers seems to point to a more subjective report. The *Communications of the ACM*, for example, comments that: "Case studies should maintain an objective perspective on the systems they describe, and should be both analytical and descriptive". In SE the inclusion of sufficient details, which is a requisite in E too, does not allow any kind of generalizations of the results achieved for other cases, even if it can alert one to similar possibilities: "Case studies should include enough detail so that readers can relate them to their situation" (*Computer*). Similarly, the intervention of human factors in E case studies suggests that "generalization to populations is not appropriate or desirable in most case studies." (*TESOL Quarterly*). The focus is on understanding particular instances of a determined phenomenon, and theoretical as well as practical links are admitted. Significantly, case studies in SE may also have kind of a persuasive nature. The *Journal of Visualization and Computer Animation*, for example, which is specialized in computer animation, encourages "submission of case

A similar number of B journals mention the opinion type of articles (eight including editorials, corresponding to 13 percent approximately), but these are usually published only from time to time and may have the purpose of complementing previously published papers. Opinions are personal, as some journals require, with single authorship. They have similar tones as in E. "A Commentary can be inflammatory but not defamatory, inflammatory in the sense that it may stimulate Letters to the Editors",

states *Radiation Research*; and they also may deal with "technical controversy" (*Bioscience*), or with "controversial issues" (*Radiation and Environmental Biophysics*). These contributions are in some cases peer-reviewed (in five cases). On the other hand, comments on previously published papers, which can also be expressed in letters, have a precise scientific role, because it is their objective to complement previously published papers. In this sense, *Bioelectromagnetics* remarks: "Comments will be reviewed for scientific content and appropriateness in furthering the goals of eliminating errors and enhancing understanding of published research". *Bioelectromagnetics* specifies that letters should be focused on a single idea or topic, whereas "technical comments on specific articles" and "new data or theories" would better use the Comments or the Brief Communications format.

In SE, there are opinion papers that discuss future developments and trends in an area, and comment on previously published papers. Only in the second case peer-review is alluded to. Opinion papers can be "provocative", or "serious, whimsical, or humorous" (*Sigmoid Record*), but no reference is made to controversy as in B and

E. An opinion paper "[...] aims at describing and challenging the status-quo of interactive computer graphics, and predicting its many opportunities by learning from the past, questioning the present, and anticipating the future that within a few decades evolved from the ideas and imaginations of researchers and scientists to become a commodity in all areas of our lives" (*IEEE Computer Graphics and Applications*). Items of correspondence in SE may have a technical nature. In B as well in SE opinions may be given on more or less recent "influential" articles. This section may be devoted to post-docs/graduate students (*Plos Biology*).

Reviews

The subtypes of this type of article tend to repeat similarly across the three disciplines, with the exception of the genre “Essay review”, which is present only in the field of E (see Table VII). If some journals with this alternative term seem to refer to the review article we commented on above, others include “essay reviews” under the heading of “book reviews” and indicate explicitly that they “review and comment on two or more related books” (*Journal of Teacher Education*). Along with the traditional book review, the 3 areas consider reviewing other kinds of resources, whose nature changes according to the different needs: software and Internet web sites in SE, and Film and Video in E. *Plos Biology* is the only journal in the field considering reviews of art works connected with biology.

E journals spend indeed more words than the other disciplines on describing the content and the requirements of this type of articles. The first line should report the complete reference of the book at issue, the tone of the book review should be evaluative and engaging, and its relevance for teaching should be stressed. In the other two fields, only vague indications are available on the content of reviews. Four (4) out of the 11 B journals that make a reference to book reviews, for example, require that reviews be published exclusively by invitation.

Discussion

Our analysis of the instructions to authors provided by B, E, and SE journals to potential contributors has proved to be useful in defining different types of the scientific article as subgenres, in terms of content, purpose, audience, and, to a minor extent, in terms of form. Indeed, form may be left to the initiative of authors, so that they can adjust it to the nature of their research, within, of course, a generally accepted structure. We have also seen that contributors, choosing a specific article genre (major article, short article, practice-oriented article, etc.), opt for a specific communicative act with the other members of their community, and that all such article genres contribute in different ways to the progress of the discipline. In the case of major articles, it is remarkable that the different genres coincide with the methodological approaches that can be undertaken. As such, they reflect the patterns of research in each field. From this point of view, the results achieved allow to refer to questions that go beyond the editorial policies of scientific journals. In particular, we would like to discuss in the next sections the way articles genres reflect both research in a field and the specific communication needs of a scientific community.

Limitations of the results

Before we go on, however, it is necessary to remind the reader about the limitations of this study. First, as commented in the methods section, our sources originate mostly from the Internet. There are thus chances that they have not been covered entirely, due to the nature of hypertexts. Nonetheless, the data reported here support each other to a large extent. It is to be expected that new information might enlarge the scope of the topics treated but not contradict the results achieved. Second, this study’s purpose was comparative and explorative, and more research needs to be conducted especially into actual articles. Finally, in the endeavour of classifying and comparing, some aspects may have been sacrificed for the sake of clarity. In short, the present study should be taken as a first attempt at investigating the topic and as a basis for generating new theories.

Article genres and disciplinary research

Because each of the three disciplines studied here has recourse to different article genres or assigns to them a specific status, we can say that article genres characterize and distinguish each discipline from the others. From the results reported above, for example, it emerges that the variety of research approaches emphasized by E journals is larger than in both B and SE journals. In these two disciplines, there is indeed a tendency to distinguish, in different ways, between experimental research articles and expository and/or theoretical research articles in B, and between applied research articles and theoretical research article in SE, but one has the feeling that here major articles fit in a more circumscribed

set of types, especially in B. The division into “applied research” and “theoretical research” is never mentioned in these terms in SE journals. It is rather our attempt at making visible a major differentiation called by the literature with different names. Wieringa and Heerkens (2006), for example, explain that research can be applied to “knowledge problems” and “world problems”. March and Smith (1995) speak of two kinds of scientific interests in information technology, “descriptive research” which “aims at understanding the nature of IT”, and “prescriptive research” which “aims at improving IT performance”. In general, the contrast between applied and more abstract research is stressed. Just as the distinction between applied and theoretical research, the methodological options available for publishable articles as well remain implicit in SE journals. The instructions to authors report on a limited range of research approaches/methodologies, and refer somehow vaguely to experimental research articles. Similarly, the methodological section is hardly ever mentioned when it comes to describing the structure of major articles, which tend to be structured in only three sections (introduction, main body, conclusions). The same observation was made by Posteguillo (1999). This may be related to the fact that little recourse to proper validation methods is made in current SE research, and that SE researchers make use of limited sets of research methods and research approaches (Glass *et al.*, 2002). Zelkowitz and Wallace (1998) classified 12 different validation methods for SE research. Studying the types of validation methods used in 612 SE papers published between 1985 and 1995, they found that the most popular validation method remained the simple “assertion” – i.e. the “developers being both experimenters and subjects of study” – which accounted for almost 30 percent of all articles in 1995. Of the remaining 11 options only case studies and lessons learned papers had a considerable role, while the others had hardly any role at all. Both these facts, the few article types mentioned by SE journals and the dominant three-section structure of major articles, thus, seem to bear a relationship with research questions under discussion in the field.

The variety of research approaches in E seems to depend both on the diversity of questions to be answered and on the diversity of the underlying philosophical assumptions (Pring, 2004, p. 33). In this way, it poses to journals the problem of how to be inclusive, in terms of “sites, methodologies, and ontological orientations”, and exclusive, in terms of quality, at the same time (Editors of *RTE*, 1997). In some journals, clear requisites of genre are considered useful for reviewers to establish if an article is publishable or not (Editors of *RTE*, 1998). Concerns about the quality of published research are a general topic of discussion also among SE researchers, and, like in E, they often presuppose a comparison with medical research. In E, it is the insufficient impact on practice to be stressed when such a comparison is made (Pring, 2004, pp. 1-7), whereas in SE the lack of strong validation methods needs to be emphasized too. The growth of experimental research in SE (Kitchenham *et al.*, 2002; Wohlin, 2005) and the consequent need for increasing meta-analyses (Pickard *et al.*, 1998) poses the question of assessing the experimental quality of published studies. However, more assertively than software engineers, educational researchers recognize that, despite the similarities, “educational practice” is something different from “medical practice”. “Educational research cannot avoid the systematic reflection upon the controversial values which pick out what is significant to study, what constitutes an educational outcome, what is to count as value added” (Pring, 2004, p. 160). The question of what good educational research is and the ethical implications of it are reflected in the relevance assigned in E journals to opinion and position papers in comparison to B and SE. A further proof of such relevance is reported by Carolan and Natriello (2005). They observe that among the articles most highly connected in the network of articles read by the readers of *Teacher College Record*, none reported on original data but most were reviews or commentary pieces. In other words, assessing

quality of article genres seems to imply a disciplinary perspective, excluding appraisal by comparison with other disciplines.

No such emphasis on the need of quality of research articles is present among B researchers. In this perspective, B could

be seen as a “mature” science, and E and SE, by contrast, as “immature sciences” with more serious quality concerns, in the sense discussed by Hjørland in (1997, pp. 48-49). It may also be the case that, being journals and journal articles well established means of communication in the field, B researchers need to focus on some other information-related problems. MacMullen and Denn (2005), in a work on molecular biology, cite, among others, the lack of standardization in naming genes, the lack of gene database implementation, and the fragmentation of knowledge in the literature across sub-disciplines. In other words, information needs of biologists may be concerned with other problems/genres than traditional articles.

Article genres and disciplinary communication and information needs

New communication/information needs are nowadays related to an increasing tendency to conduct interdisciplinary research in all areas (Qin *et al.*, 1997; Palmer, 1999; Haythornthwaite, 2006), including those studied here. Interdisciplinarity is intrinsic to the nature of E, because it has to deal with the teaching of all disciplines. Molecular biology too, a subfield of biology, according to Hurd *et al.* (1999), settles on a multidisciplinary base of knowledge that reflects both its origins and diversity of applications. SE may rely on a “reference discipline” for theory and concept (Glass *et al.*, 2002), but has indeed multiple applications as stressed by editorial policies of representative journals. In SE, however, it is also appropriate to speak of intradisciplinarity. There are growing concerns inside the field of computing sciences, which includes, along with SE, computer science and information systems, for amalgamation, knowledge sharing, and education in integrated schools of computing (Glass *et al.*, 2004; Vessey *et al.*, 2005). Intradisciplinary communication between sub-disciplines is also a topic of interest in B (MacMullen and Denn, 2005).

It does not come as a surprise, thus, that SE journals insist on the need for authors to be comprehensible to as wide an audience as possible, since this may help intra- and interdisciplinary communication, but also because, as explained later, it allows practitioners and non-academics to access scientific literature. B journals too seem to be concerned with similar matters of accessibility even if they emphasize different aspects. New technologies can help relegating heavily technical material in appendixes often available exclusively online, for example, and facilitate the access to those who are not insiders nor specialized in the area. However, some B journals also refer explicitly to “interdisciplinary papers” (*Journal of Agricultural, Biological and Environmental Statistics*) and to “research communications that integrate one or more disciplines” (*Faseb Journal*). In addition to this, authors are often left free to choose the best structure for their papers, and sometimes they may be required to articulate introductions in two levels, one general and the other theoretical (*Bulletin of Mathematical Biology*). Considering that genres are social evolving constructs, an interdisciplinary type of article would be the logical consequence of increasing degrees of interdisciplinarity of current research.

This increasing tendency of modern research to cross disciplinary boundaries poses another problem in relation to genre. In the method section we commented that within each discipline different journals may call by different names what happens to be the same article. A terminological problem exists between disciplines but the other way round, since it happens that by the same names different types of articles are meant. In SE the medical and social science literature furnish many methodological approaches and relative names. However, when applied to SE research, they acquire different meanings. This study has come across two significant examples: case studies and surveys. Both types of terms are used in E and SE, but their meaning for the two scientific communities differs. The literature tells us that a case study in E “is an investigation of one entity, which is carefully defined and characterized by time and place”, whose objects may be “events, settings, programs, social groups, communities, individuals, or other ‘bounded systems’” (McMillan, 2004, p. 271). It provides an insight to fully understand a particular situation. Case studies in SE, on the other hand, provide a relatively inexpensive way to monitor a certain attribute (such as reliability or cost) in the development of a project (Zelkowitz and Wallace, 1998). In addition, researchers may often collect data from a class

of projects to build a baseline. Something similar can be said for surveys that in SE may have little to do with sending questionnaires like in the social sciences. Rather their role is to help coping with the pace of new developments and the increasing specialization of the field (Wasserman, 1984). Even if it is not addressed specifically in this study, considering its importance for information scientists (Hjørland, 2001), it is worth reminding that meta-analyses also tend to have different characteristics in SE and medicine. In medicine they are considered appropriate for combining the results of replicated studies, whereas in SE they rather combine the results of observational studies (Pickard *et al.*, 1998). Finally, these differences are especially important considering the tendency of contemporary researchers to explore resources outside the borders of one's field of specialization. Surprisingly, terminological differences exist where one would expect greater consistency even across disciplines.

Article genres may be involved in communication with actors other than researchers within a disciplinary community. In particular, the article genres described in this study reflect the fact that the expected audience of E and SE journals is wider and more diverse in terms of expertise than in B. For instance, in E journals opinions can be expressed through both actual papers authored by researchers, and letters written by the readers. Then again, special sections of the journals, often called in a way that reminds of some kind of dialogue, are reserved for those active in schools but not necessarily involved in research. Such differentiation is possible in E, where the journal audience is expected to include teachers, policy-makers, and practitioners besides the researchers. Similar examples are available in SE. Many SE journals publish a special type of article that is aimed mainly at practitioners, i.e. the tutorial. Its difference from the survey is in fact explained in terms of audience and emphasis (Goldberg, 1982; Wasserman, 1984). Tutorials assume their audience to be inexpert, and emphasize basic concepts of the field providing concrete examples. The practice-oriented types of articles that in E explain teaching techniques are something similar, in that they are intended for teachers.

We have previously seen that a factor causing article genres to change could be nowadays the growing tendency of modern scientists to interdisciplinarity. Similarly, digitization could account for other emerging article genres as well as for changes within more traditional article genres. Studying the progressive adaptation of newspapers to the digital environment in the period 1996-2002, Ihlström and

Henfridsson (2005) found that the Web allowed newspapers to bridge the gap between the two printed versions, increasingly often with contents specifically prepared for the digital version of the papers. Something similar is probably happening in the case of scientific journals. Rapid communications and those short articles that require a shorter reviewing process allow some journals, especially in B, to present as quickly as possible the results of recent research. Similarly, some contents, such as appendixes and highly technical material, may be published exclusively on the web. Digitization may be, thus, responsible for both expanding the range of article genres, and modifying the organization of contents within them.

Conclusions

In this article we have summarized the information on article genres available in the instructions to authors of scientific journals in the disciplines of biology, education, and software engineering. We have tried to classify and describe article genres as accurately as our sources allowed, despite the problems alluded to in other parts of this paper. From a methodological point of view, despite the obvious advantages of classifying article genres in comparison with other document genres and/or cybergenres, as mentioned in the introduction, this study has proved successful.

In the discussion, we have attempted to show how our results can mirror the nature of research in each field as well as current debates within each discipline on the state and quality of research. We have also seen how article genres convey specific communication needs within disciplinary communities, which proves that genres are social and evolving objects. The following points summarize what we consider as the most relevant conclusions of this research:

Reflecting the nature of research in each field, article genres can be characterizing of disciplines in a similar way to research topics. This means that article genres have the potential to improve management, retrieval and selection in collections of scientific documents that, at the moment, rely mostly on topical descriptions of items.

Article genres perform specific communicative functions within disciplinary communities. One of this is communicating research results to practitioners, actors other than researchers within the disciplinary community, or to non-expert researchers. Certain article genres are preferably addressed to less specialized audiences, audiences with practical needs or different needs from those of specialists. This is particularly important for those information services that provide resources exclusively to practitioners, or to a composite audience.

Different disciplines may refer with different names to the same article genres. Even those information services that deal with only one discipline should bear this in mind, considering the tendency of digital users to explore resources beyond their field of specialization.

Finally, article genres are slowly evolving, and two factors promoting such evolution may be, at the moment, digitization and an increasing tendency to conducting interdisciplinary research. Both digitization and growing degrees of interdisciplinarity may account for the existence of new article genres. Digitization, on the other hand, offers the possibility of reshaping articles so that longer and/or more technical contents can be included in only online appendices.

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