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READING CHALLENGES IN HIGHER EDUCATION: HOW SUITABLE ARE ONLINE GENRES IN ENGLISH FOR MEDICAL PURPOSES?

Abstract

The wide range of emergent genres characteristic of the medicine 2.0 culture pose a challenge to ESP instructors wishing to update their design of in-person, virtual or blended university courses with authentic resources. Our research motivation was the optimization of the teaching and learning process of English for Medical Purposes (EMP) via authentic materials. To ascertain the degree of suitability of four different online genres in an EMP course, the levels of lexical density, lexical diversity and readability of a corpus (199 texts) of research articles, editorials, responses to research articles and responses to editorials in peer review fora were estimated (i.e. we studied and registered their Standardized Type-Token Ratio [STTR], lexical density and their Gunning-Fog Readability Index). Differences among the four online genres were revealed (STTR), with responses to editorials displaying the highest levels of lexical variation and editorials revealing the highest levels of reading difficulty (Gunning-Fog Readability Index). The readability study concludes that editorials and research articles are adequate at postgraduate plus level, whereas responses are suitable for postgraduates. This suggests they are all appropriate for tertiary education but require facilitation to be introduced in courses pedagogically.

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Key words

English for medical purposes, online genre, lexical density, lexical diversity, readability.

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1. INTRODUCTION

Health care students are constantly exposed to the rapidly growing overload of medical information on the internet and in real life, e.g. internet searches, video lectures on health and medication issues, online research articles, health news and ads, media, *vade mecums*,¹ patient-oriented interactions, case-taking, diagnoses, medical and surgical treatment procedures, and international conference proceedings, among others. It has been observed in the English for Medical Purposes (EMP) classroom context that the language of these online written and spoken texts may reveal different levels of specialization and difficulty and pose a challenge to our students in tertiary education. On the one hand, present health care university students make up a relatively homogeneous group of individuals with similar educational backgrounds, medical literacy and research knowledge, but on the other hand, reflect a range of ages, abilities, interests, and reading skills. These students are likely to become professionals and interact with their peers as researchers, experts and peer reviewers in the medical world, an interaction which characterizes today's medicine 2.0 culture and involves being exposed to and producing online genres such as articles, editorials and peer responses to articles, or editorials in the virtual post-publication debates of papers.

Medicine 2.0 has been characterized as Web 2.0 technologies in medicine that enable user participation on a massive scale, such as web-based applications, services and tools for health professionals, biomedical researchers, health care consumers, caregivers and patients that use Web 2.0 technologies (social networks, wikis and blogs, among others) to enable and facilitate specific participation, collaboration, networking and openness (Eysenbach, 2008). In this interactive milieu, new genres and sub-genres of writing are being developed and employed where a good command of English is important. English not only opens doors for medical students and doctors to academic research, but also many contexts where the ability to read research or give presentations is particularly relevant (Skelton & Richards, 2021).

In this respect, medical education has undergone profound changes lately in parallel with recent innovations in health care practice and delivery aimed at creating better-educated and clinically competent health care professionals (Tseligka & Koik, 2021). Reading, in particular, is usually considered in undergraduate medical programs as a part of evidence-based medicine and "language issues in reading [...] are taken for granted, purely as the medium which allows students to assess the quality of a research paper" (Skelton & Richards, 2021: 15). As for the challenges faced by English for Specific Purposes (ESP) teachers, the difficulty lies in becoming aware of the wide range of written and spoken speech events available (Guest, 2021).

¹ Concise manuals or reference books providing specific information or instruction about a subject (e.g. pharmacology).

ESP programs in tertiary education offer major benefits for students' career development since they contextualize the professional terminology needed to develop soft skills for communicating in a global professional network (Diachkova et al., 2021; Irudayasamy, Souidi, & Hankins, 2020), and interacting successfully. There has been an increased use of the internet in the EFL classroom at universities in recent years, yet despite its acknowledged benefits in virtual and blended learning, certain issues regarding the use of authentic materials remain unsolved. Among these are how to incorporate authentic online texts of varying degrees of specialization and difficulty in the design of EMP courses. University students' contact with authentic language can rarely go unassisted and using authentic materials can be tricky without a carefully considered methodology. Authentic materials have to be carefully checked to match the learner's language level (Lesiak-Bielawska, 2015) and lecturers, rather than adapting texts, need to prepare students by providing them with "awareness and the necessary skills to understand how and what language (topical vocabulary) is used in their future professional communication" (Berardo, 2006: 60).

Consequently, university lecturers are constantly urged to adapt their professional practices to meet the emerging challenges of new cohorts, face-to-face and virtual teaching environments and worldwide events. Under these circumstances, how in-service lecturers manage to adapt and redesign courses, or their materials, becomes a key and strategic concern.

Of particular interest to this study is the possibility of using the online genres posted in the medicine 2.0 culture and its characteristic interactive peer reviews to design or adapt university EMP courses for language teaching and learning. Hence, this article explores a selection of authentic online text types or genres in present medicine 2.0 and attempts to characterize them in terms of lexical richness and reading difficulty.

2. AUTHENTIC VS. ADAPTED MATERIALS IN ESP AND EMP

Authenticity plays a major role in ESP and particularly in this study, an aspect which has been traditionally emphasized in the ESP literature (Torregrosa-Benavent & Sánchez-Reyes Peñamaría, 2011), so the aim and usefulness of achieving authenticity in the classroom have been considered strategic components in modern language teaching (Blagojević, 2013). However, there is also a bone of contention among language teachers, i.e. "the language learners' level and the age at which authentic language material should be introduced into the classroom in order to achieve the best results" (Blagojević, 2013: 115). Using these types of materials allows language instructors in scientific and technical learning scenarios to "reproduce an immersion environment and provide a realistic context for tasks that relate to learners' needs" (Torregrosa-Benavent & Sánchez-Reyes Peñamaría, 2011: 89). Furthermore, it has a positive effect on teaching methods such as problem-

solving, project-based learning, case-based learning, role-play, and simulation or gaming methodologies. Authentic materials can increase students' motivation and expose them to real language and cultures as well as to the different genres of the professional community to which they aspire.

ESP practitioners resort to authentic materials when they lack up-to-date ESP textbooks that meet the needs of their students (Bocanegra-Valle, 2010), especially when cutting-edge knowledge in the field of studies changes rapidly and requires constant updates (Lesiak-Bielawska, 2015: 20). Relying on traditional textbooks alone as materials for class could be detrimental to the aims and efforts by lecturers, as they might provide the learners with outdated information (Ciornei & Dina, 2015). Along these lines, a study was carried out at a European university (Martínez-Sáez, 2019) aimed at measuring the lexical density and level of readability of a corpus of opinion, review, and original articles as well as at analyzing students' needs and perceptions of authentic scientific texts. It was observed that the students showed higher levels of interest and even of motivation when the texts that they read in English acted as an additional source of specialized information about the latest scientific findings, as well as the major breakthroughs that continue to be made in their own fields of study and interest. In fact, teaching practices have shown that total avoidance of authentic topics demotivates students in the long run as the study content loses its immediate topical relevance when it is not directly related to the students' future professional objectives (Breeze & Sancho Guinda, 2017; Jernigan, 2017).

In this context, it is strategic to find a balance between authenticity and acceptability of study materials used in ESP courses, as authentic materials are preferred by students and teachers to excessively edited texts. Authentic materials not only entail engaging discussions, live or online, but also trigger unexpected reactions when dealing with controversial topics (e.g. questions raised in an editorial or the acceptability for publication of the method of a research paper). ESP courses, then, may encourage open discussion as a way of overcoming possible cultural and expectation differences and devising appropriate tasks for developing students' critical thinking skills (Tymbay, 2022).

In the context of EMP, authenticity and authentic materials have been defined as "original, true, and valid materials that help optimize the teaching-learning process of English for Specific Purposes by increasing the accessibility and acquisition level of specialized and content-relevant information" (Cazac, 2022: 10). Some of the advantages of using authentic materials include enhancing linguistic skills, linguistic knowledge and intercultural communication, among others (Cazac, 2022: 10). Authentic EMP materials have been identified and classified according to their type and content as audio/video, visuals, printables, realia and on-line (Cazac, 2022: 12), as illustrated in Table 1 below.

CLASSIFICATION OF AUTHENTIC MATERIALS	
Audio/video	TV shows/broadcast, radio, communications, spots, talk shows, documentaries, films, telephone messages
Visuals	Photographs, images, works of art, diagrams, maps, symbols, illustrations, graphs, drawings, brochures, flyers, companies' websites, flowcharts, infographies, CT scans, diagnostic imaging
Printables	Newspaper articles, completion sheets, medical records, description of case studies, magazines, journals, medical instructions/prescriptions, booklets, printed academic papers, letters to the editor
Realia	Medical instruments and equipment
On-line	Websites, questionnaires and medical tests online, social networks, online scientific conferences, blogs, interactive games, online simulations, electronically distributed scientific papers, online responses

Table 1. Authentic materials in EMP (translated and adapted from Cazac, 2022: 12)

Authentic materials are essential for teaching medical students since they (as digital natives) have to be able to manage and assimilate a plethora of specific professional information, develop professional communication skills, attitudes, autonomy as well as the capacity for self-training in their future career (Cazac & Armaşu-Canţîr, 2020). In an EMP context, the medical discourse to be learned provides specific scientific data and allows language instructors to offer their students the opportunity to gain access to original online medical articles and vocabulary (Cazac & Armaşu-Canţîr, 2020).

In the ESP/EMP contexts, the specialized literature (Vaičiūnienė & Užpalienė, 2010) has underlined some of the benefits of using online materials, e.g. providing educational opportunities and unlimited resources, offering relevance and coherence, facilitating communication interactivity and data exchange, promoting foreign language acquisition, and offering a wide range of text types and styles. Internet resources provide unlimited opportunities of accessing authentic language and specific and precise content, of interest to future physicians (Cazac & Armaşu-Canţîr, 2020).

To exploit and maximize the benefits of authentic online materials within EMP classes, their content must be evaluated considering the relevance of contexts, appropriate length, and adequate readability, since “before presenting authentic materials, teachers should ensure that the content is not difficult for learners or provide explanations for new vocabulary or more complex concepts” (Cazac & Armaşu-Canţîr, 2020: 265).

3. LEXICAL RICHNESS AND READABILITY LEVELS OF HIGHLY SPECIALIZED MEDICAL TEXTS

With regard to specialization, some authors have observed that there is a “clear-cut boundary” or even a “sharp line” which allows for “a fast and easy distinction between general and specialized language” (Edo-Marzá, 2011: 298). However, we use the label “highly specialized” for expert-to-expert texts in the way that it was previously used by Cabré (2002: 13). This is based on the classification of variables provided by Hoffmann (1987), i.e. level of abstraction, the linguistic form, the field, and the participants taking part in the communication process. According to Cabré (2002), the main criterion leading to vertical classification of texts is their level of specialization. Bearing this criterion in mind, texts may be classified into three main categories, namely, texts showing a high, medium or low level of specialization. This correlation would be mainly determined by the communicative function of a text and could be explained as follows: expert-to-expert communication, expert-to-expert learner communication, and communication established with a wider audience with no expertise in that particular field.

In this respect, some authors have also used the term “technicality” when examining, for instance, the notion of “explicitation” in specialized translation. Technicality is related to the “subject-matter competence which the discourse participants have with regard to the topic of their specialized discourse” and it is “one aspect of the sociological dimension in LSP research (along with age, social status, cultural background, etc.)” (Roelcke, 1999 as cited in Krüger, 2016: 98). Additionally, Krüger (2016) cited the study Möhn had conducted in 1979 concerning the perception and identification of symmetrical or asymmetrical communicative situations. According to this perception, a “symmetrical communicative situation” would take place between experts in the subject matter (expert-to-expert communication). Therefore, in this particular form of communication, when dealing with highly specialized texts, “all discourse participants can be claimed to have a similarly high knowledge with regard to the topic of the text” (Krüger, 2016: 98). On the other hand, an “asymmetrical communicative situation” would arise between experts and semi-experts concerning their knowledge area (Krüger, 2016: 98).

EFL learners’ vocabulary levels also play an essential role in the process of understanding academic texts (Romero, 2020; Tovar-Viera, 2022) and condition both text comprehension and production (Tovar-Viera, 2017). Therefore, in our attempt to make informed decisions when selecting the most appropriate specialized material used for reading comprehension practice in EMP courses, we have also focused on the levels of lexical density and lexical diversity as these are considered “statistical measures that gauge the lexical richness of texts” (Gregori-Signes & Clavel-Arroitia, 2015: 546).

Lexical richness has been previously studied and defined as the ability shown by writers to effectively use lexical items in particular texts (Lewis, 1993; Tovar-Viera, 2022). Johansson (2008: 62) pointed out that lexical diversity is “often used

as an equivalent to lexical richness” (e.g. by Daller, van Hout, & Treffers-Daller, 2003). Nevertheless, as stated by the same author, this would be one part of a more comprehensive and multidimensional feature of lexical richness (Johansson, 2008; Malvern et al., 2004; Martínez-Sáez, 2018, 2019), since other factors in the process are lexical sophistication, number of errors, and lexical density (Johansson, 2008; Laufer & Nation, 1995; Read, 2000). Recent studies on lexical richness have also incorporated the dimension of lexical sophistication, which concerns “the quantity of complex, advanced, and specialized terminology presented in a text” (e.g. Gregori-Signes & Clavel-Arroitia, 2015; Tovar-Viera, 2022: 226), a feature which is clearly present in the highly specialized genres published in renowned and standardized journals such as *The BMJ*. We agree with this group of researchers, as neither lexical diversity nor lexical density are the only measures. However, as also mentioned by Johansson (2008: 62), both dimensions are particularly useful, accessible and easy to apply to different kinds of corpora. In an attempt to narrow the scope, this study analyzes whether these two measures, lexical diversity and lexical density, as well as the level of readability, are sensitive to the four genres included in the corpus.

Lexical diversity is “a measure of how many different words are used in a text”, while lexical density “provides a measure of lexical items (i.e. nouns, verbs, adjectives and some adverbs) in the text” (Johansson, 2008: 61). When researching lexical density, previous studies have referred to the notion of “information packaging”, i.e. “a text with a high proportion of content words contains more information than a text with a high proportion of function words (prepositions, interjections, pronouns, conjunctions, and count words” (Johansson, 2008: 65). Gregori-Signes and Clavel-Arroitia (2015: 548) defined the concept of “lexical variation” to explain how it may be affected by differences in text length and how the results may be less stable or consistent when short texts are analyzed. Lexical variation is seen as “the ratio measured as a percentage between the different words in the text and the total number of running words (number of words x 100/ number of tokens)” (Gregori-Signes & Clavel-Arroitia, 2015: 548). Type-Token Ratio (TTR), also known as vocabulary size divided by text length, or the total number of unique words (types) divided by the total number of words (tokens) in a given segment of language, is a measure of lexical diversity, which has been used, for instance, in literary studies. Since the TTR measures vocabulary variations within a written text, the basic problem of TTR is that it is affected by the length of the text sample. Thus, several suggestions for improving this have been given, including standardizing the length of text samples (Kettunen, 2014).

On the other hand, English for Academic Purposes (EAP) lecturers and researchers are aware that reading comprehension is a fundamental academic skill (Grabe & Stoller, 2019) for native and non-native English speakers at universities. In fact, the literature on reading comprehension has been the main focus of EAP reading pedagogy and research according to Hyland and Jiang (2021), revealing that undergraduate students face difficulties in meeting university reading requirements. At universities, students have to deal with reading course texts, reading strategically,

handling the reading load (Anderson, Krathwohl, & Bloom, 2001) and reading journal articles (St Clair-Thompson, Graham, & Marsham, 2018). Students are also required to read beyond general comprehension; readers' abilities are challenged in more cognitively demanding processes such as reading to learn from texts, reading to integrate information and reading to write, or to critique texts (Enright et al., 2000). The concept of readability can be defined as a measure of how easy a fragment of text is to read. A readability score makes reference to the familiarity and inner structure of a particular text, and this score can indicate the level of education needed to be capable of reading a text passage easily.

3.1. Medicine 2.0 genres included in the current study

Yates and Orlikowski (1992: 299) define genres as “typified communicative actions characterized by similar substance and form and taken in response to recurrent situations.” These authors (1994: 545) argue that “people produce, reproduce and change genres through a process of structuring,” which entails the genre repertoire of a community being both a product and a shaper of its communicative practices. With the advent of the new internet medium, some traditional genres have moved intact to the web (reproduced genres), whereas others have required modifications (e.g. to take advantage of linking or embedding information [adapted genres]). There are also new combinations of form and generally recognized purpose – social acceptance, emergence of new genres from old ones (Crowston & Williams, 2000: 203). As Herring (2013: 7) puts it, “there appears to be a trend over time for web genres to shift along a continuum from reproduced to adapted to emergent, with the seemingly paradoxical effect that as genres age, they move along the continuum in the direction of ‘emergence’. While drawing on Yates and Orlikowski’s definition of genre (1992), this study uses the definition of internet (online) genres proposed by Crowston (2010: 9) as “genres of digital documents found on the internet.”

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This article focuses on the following genres:

Firstly, the research article (RA) has “clearly identified writing conventions and norms, being primarily addressed to experts within a specific scientific community or to a professional audience” (Bellés-Fortuño, 2016: 56). Secondly, editorials in medical journals are also written by health professionals and are addressed to fellow doctors, “members of a well-defined community” (Carnet & Magnet, 2006: 247). Thirdly, online post-publication responses constitute distinct electronic medical review subgenres, instances of open peer-review written by experts from the medical community. They are openly accessible, complement the “occluded” peer review process and offer peer experts’ – other than journal editors or referees – perspective on research articles and editorials when they review them. The *BMJ* defines them as electronic letters to the editor which enable health professionals to debate online issues raised in articles published on their website (www.bmj.com).

These four medicine 2.0 genres constitute an interlinked set often found in e-journals. Editorials often provide a state-of-the-art of the issue raised in articles and introduce a specific article in a particular journal. Research articles study it, the responses posted to the article written by experts assess the article, while the responses to the editorial raise related issues and contribute to the relativization framework of the central issue.

3.2. Aims of the study

This study attempts to assess and measure (1) the degree of lexical diversity, (2) lexical density, and (3) readability of authentic electronic corpora in medicine 2.0 and its culture and focuses on four different online genres: (a) research articles, (b) editorials, (c) online post-publication responses to research articles, and (d) responses to editorials.

Regarding pedagogical and linguistic aims, the final compilation aimed to provide the students with the necessary tools for fostering their reading comprehension skills as well as acquiring specialized vocabulary in an ESP context. Students would also have these texts as models to make them aware of the structure and conventions of these four particular online genres. To identify the best way of teaching online reading to medical undergraduates, this article followed the three steps listed below.

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1. to estimate the Standardized Type-Token Ratio per online genre (as from our corpus);
2. to estimate the lexical density per online genre;
3. to estimate the readability levels of these online genres (using the Gunning-Fog Readability Index)

Furthermore, our study aims to infer pedagogical implications and suggestions for classroom practice.

4. METHOD

4.1. The corpus

The criteria for selecting the corpora were the relevance of the e-journal in the medical field, its accessibility on the web and its representativeness. The *bmj.com* electronic journal (<http://www.bmj.com>) is a professional refereed e-journal which is considered to be one of the most relevant and prestigious online journals in the field of medicine (impact factor 39.89; ISI Web of Science, 2021). The texts that make

up the corpus constitute authentic online discourse in medicine 2.0, are examples of expert-to-expert communication in English, and were written by medical professionals and peers. Experts were identified by specific indications of author, position and medical institution. As instances of authentic internet discourse in Medicine 2.0, research articles, editorials and post-publication responses to research articles and editorials are recognized communicative events in the worldwide medical community.

The corpus comprised 199 instances of four electronic genres, i.e. 49 research articles, 50 editorials, 50 responses to research articles, and 50 responses to editorials. This is presented in Table 2 below.

MEDICINE 2.0 GENRE	NUMBER OF INSTANCES	TOTAL WORD COUNT	AVERAGE TEXT LENGTH
Medical research articles	49	124,257	2,535.85
Medical editorials	50	41,114	822.28
Responses to research articles	50	18,077	361.54
Responses to editorials	50	19,772	395.44
TOTAL	199	203,220	1,028.77

Table 2. Corpora for analysis

The online research articles, editorials and post-publication responses to research articles and editorials were downloaded from the *bmj.com* webpage and converted into text format for software convenience.

4.2. Tools of analysis

To achieve the objectives, we made use of software tools for quantitative data analysis. We first made use of *Wordsmith Tools 6* (Scott, 2015) to characterize the four electronic corpora (types, tokens) and estimate the degree of variability of the corpora with the calculation of the Standardized Type-Token Ratio (STTR) per corpus. The texts' STTR was calculated to make up for differences in text length in the four subcorpora. The type-token ratio is an extremely useful measure for analyzing a text to estimate its lexical diversity; however, this method has received some criticism over recent years because it does not work as effectively when longer texts are analyzed. The longer the text, the more likely we are to repeat function words and the less likely we are to encounter singular words. Function or grammatical words help hold the text together, instead of conveying meaning; these include words like pronouns, articles, conjunctions, and auxiliary verbs.

Then, we made use of *Textalizer* (<http://textalyser.net>) to estimate the texts' lexical density – to analyze what proportion of the text contains lexical words. Analyzing lexical density can be a useful way to better understand a text because it

can help explain its complexity and therefore whether it is suitable for certain language levels.

Finally, we used *Readability* – an online tool for quantitative data analysis – to estimate the readability of these electronic corpora and obtain their Gunning-Fog Readability Index. The index is a readability test for English writing, which estimates the years of formal education needed to understand a text on the first reading and is commonly used to confirm if a text can be read easily by the intended audience, in this case medical undergraduates (see Fig. 1).

Fog Index	Reading Level by Grade
20+	Post-graduate plus
17–20	Post-graduate
16	College senior
15, 14, 13	College junior, sophomore, freshman
11–12	High school senior, junior
10	High school sophomore
9	High school freshman
8	8th grade
7	7th grade
6	6th grade

Figure 1. Gunning-Fog Readability Index (Eleyan, Othman, & Eleyan, 2020)

5. RESULTS

5.1. *Wordsmith Tools*. Compared results for tokens, types, and Type/Token Ratio (TTR)

The data gathered in this study for the TTR (lexical variation) of the four online genres revealed differences. The TTR obtained appeared to suggest that responses to editorials gave the highest score (19.16) and research articles the lowest score (5.92), according to the data yielded by this research. This is shown in Table 3 below, implying that lexical variation was highest in responses to editorials and lowest in research articles, with responses to articles, and editorials falling somewhere in the middle.

MEDICINE 2.0	TOKENS	TYPES	TYPE/TOKEN RATIO
Medical research articles	124,257	6,953	5.92
Medical editorials	41,114	5,501	13.81
Responses to research articles	18,077	2,450	14.05
Responses to editorials	19,772	3,702	19.16

Table 3. Compared results for tokens, types and Type/Token Ratio

As TTR may be affected by text size, we estimated the Standardized Type/Token Ratio (STTR), which overcomes this difficulty. Once adjusted for corpus size, differences turned out to be smaller. Research articles were the online genres with less diversity (STTR=35.7), and editorials (STTR=43.7) and responses to editorials (STTR=44.24) produced the highest scores (responses to articles remained in-between, STTR=39.83) – as shown in Figure 2 below. This implies that editorials and responses to editorials are more lexically diverse than the other two genres.

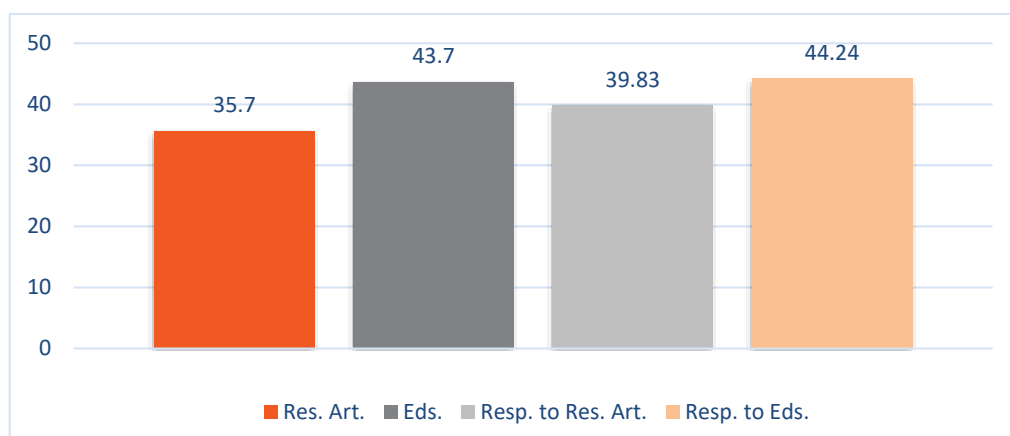


Figure 2. Standardized Type/Token Ratio per online genre

5.2. *Textaliser*. Lexical density

The data revealed that the differences among genres concerning lexical density were higher (see Figure 3 below). Responses to editorials scored highest (LD=38.1%), followed by editorials (LD=23.5%) and responses to articles (LD=23%), with research articles scoring lowest (LD=10.1%).

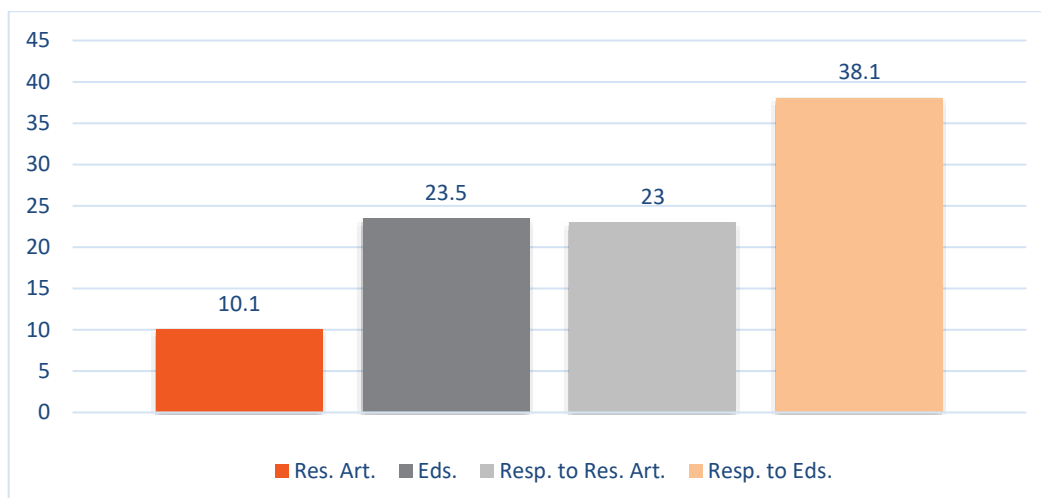


Figure 3. Lexical density per online genre

The data seemed to indicate that the proportion of lexical items (i.e. nouns, verbs, adjectives, and some adverbs) was higher in responses to online editorials and lower in online research articles. Thus, this study indicates that online research articles express lower levels of lexical density if compared to editorials and responses to editorials.

5.3. Readability. Gunning-Fog Readability Index

The Gunning-Fog Readability Index (GFRI) may help determine if online documents (our genres) are written at the correct reading level for their targeted audience (our university students); in general terms anything above 12 is too hard for most people to read. On these grounds we can state that all four academic online genres were difficult, or fairly difficult, to read; in other words, the four medicine 2.0 texts required a reading ability above 17th grade. Online editorials from the *BMJ* were the most difficult to read (GFRI=23.12); these editorials were closely followed by research articles (GFRI=22.00), while responses turned out to be slightly easier to read (GFRI=19.24 and 17.67 respectively). The use of technical terms or jargon in texts tends to increase GFRI scores, which is the case of our online texts. However, if technical terms are words that the audience are familiar with, the Index decreases. In this respect, we can assume university students may become progressively familiarized with the technical terms of their specialty in their university years (technicality level).

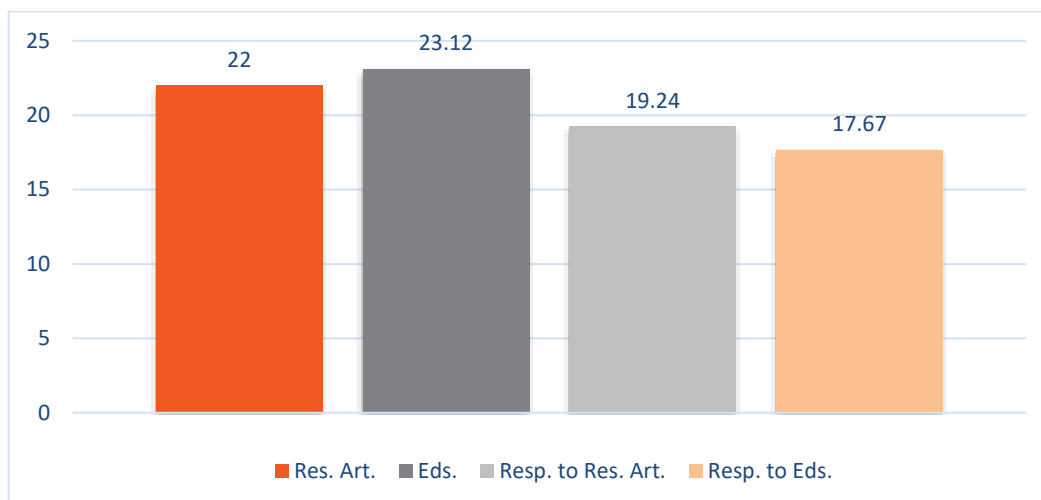


Figure 4. Gunning-Fog Readability Index per online genre

A close look at Figure 4 above revealed that research articles and editorials were very difficult for the average reader and were better suited to a university post-graduate plus level, whereas online rapid responses are not that rigorous, and suitable for the post-graduate stage. Our research revealed that editorials were more demanding and less readable probably because they constitute state-of-the-art articles covering a wide range of topics, i.e. research, related interpreting results and events – with more diverse vocabulary and lexical density. In these genres, the lexicon reference lies well beyond the individual piece of research. Responses constituted a lighter read, probably because they are more spontaneous pieces of writing which do not require article or editorial scholarship, and their sentences were shorter.

6. DISCUSSION

The data gathered in this study revealed relevant differences among the four genres. With regard to the STTR (lexical variation), it was observed that responses to editorials and editorials showed the highest scores, research articles showed the lowest scores, whereas responses to articles fell somewhere between – after adjusting for corpus size, differences turned out to be smaller. These findings are especially relevant, since research articles, which focus on a very specific field of enquiry, covering a narrow topic research area, may already constitute a challenge for less advanced students. This suggests that students with lower technical levels in the discipline may experience greater difficulty when reading these four online genres.

Editorials not only cover a piece of research but may also include references to several pieces of research while also dealing with their research context, validity

and implications. The same applies to responses to editorials, which also cover other spheres of knowledge in the discipline, which can explain their high lexical diversity. Responses to research articles and editorials undergo an editorial review process, which could also help to understand why their standards are high and can even be compared to editorials and research articles or show high results in terms of lexical variation.

Very similar results were observed after measuring the levels of lexical density in the four corpora. This part of the study also corroborated the finding that responses to editorials constituted the genre with the highest level of lexical density, whereas the lowest score was again obtained by research articles. These findings are in line with what was observed in one of the previous studies conducted at a European university (Martínez-Sáez, 2018), where research articles also demonstrated the lowest levels of lexical density when compared to opinion and review articles. The data generated in both studies appear to indicate that the proportion of lexical items, that is, nouns, verbs, adjectives and some adverbs, was lower in online research articles.

The clear and exact correlation between the results obtained after measuring both dimensions – lexical density and lexical diversity in research articles (the lowest) and responses to editorials (the highest) – imply that these are the two genres in our corpora which would be more likely to inform the lowest as well as the highest levels of lexical richness, respectively. Johansson (2008: 68) explored the correlation between lexical diversity and lexical density “given that both measures have been proposed to show lexical development.” Previous research has established that “as a rule, texts with lower lexical density are more easily understood” (Gregori-Signes & Clavel-Arroitia, 2015: 547). In this sense, according to the results revealed by this study, undergraduate students in our specific teaching context should have or acquire higher vocabulary levels to better understand responses to editorials and editorials. Nevertheless, to our knowledge, a very significant percentage of the studies developed in the field so far have addressed this issue from a different perspective, as these have explored the development of lexical density and lexical diversity in students’ oral and written production rather than in input genres as referent models.

This approach might also lead to a peculiarity which has not been observed in the present analysis, as there could be texts which could show higher numbers when measuring the level of lexical diversity (i.e. containing many different word types) and lower numbers when analyzing lexical density (i.e. including more pronouns and auxiliaries than nouns and lexical verbs) or vice versa (Gregori-Signes & Clavel-Arroitia, 2015; Johansson, 2008). This paradox was also taken into consideration in a previous study conducted by Martínez-Sáez (2019).

Interestingly, the higher readability of online responses to articles and editorials is probably due to their shorter sentence length,² and might be explained in terms of their online nature. As internet subgenres, they may echo the characteristics of internet discourse. Internet discourse – in forum discussion boards – has been considered as constituting a hybrid genre, fluctuating between written and spoken language, hence, reproducing a conversational style. In this regard, Jonsson (1998) employed the term “written speech”, Davis and Brewer (1997) named it “electronic discourse”, while Careca (2007) described it as “writing that stands in place of voices”. Responses to research articles are written by experts in their field who are used to research processes and the nuances of the research and focus on the single piece of research they review. They may have the “occluded” journal review process as a referent, therefore they might be trying to simulate the highly conventional process of producing a referee report but adapting it to the more conversational online context. The same can be said for responses to editorials. Their authors are high level experts and accomplished members of the medical community, who are likely to know each other also from papers and international congresses in their areas of specialty, where there is casual talk about medical matters over research and their virtual community. Thus, they are likely to echo these more informal talks in the context of these online fora.

On the other hand, authors of online editorials and online research articles are aware that they are producing medical genres for academia, with the traditional characteristics of written medical discourse, creating “reproduced” genres, which will eventually be made available online. This seems to be supported by the fact that the sentence length results in our online articles fell within the interval found by Piqué-Angordans and Andreu Besó (2000) when studying scientific articles in general. This span widened from 18.07 to 32.04 (SD=11.95) and near the values found by Piqué-Angordans and Coperías (1999) in their study of printed research articles in health sciences. These results indicate that the sentence length in our corpora is associated with readability; the longer the length of the sentence, the more difficult it is to read, which makes editorials the genre that is most difficult for students to read. This is probably due to editorials being state-of-the-art texts that deal with complex matters and not only cover aspects of a research article, but also knowledge of the state of the art and related aspects in the field.

These data prove the presence of symmetrical communicative situations between experts in the subject matter (authors, editors and peer readers of the texts in the corpora). Reading and studying them would enable students to familiarize themselves with the reading and writing conventions of this highly specialized communicative, academic, and scientific context and eventually participate in these open fora. In line with what has been explained in the previous paragraphs, if the technical terms in the genres studied are words known by our readers/students –

² The sentence length of online responses to research articles and editorials was 23.4 and 22.04 respectively, whereas the sentence length of research articles (29.17) and editorials (32.5) was higher. This contributes to explaining the higher levels of readability found in responses.

which is commonplace in the university context – the level of difficulty experienced by the readers may decrease and these texts would be adequate at an undergraduate level. This would be in accordance with the natural learning process followed progressively by undergraduate students in their university years. In fact, the four academic online genres included in our study are very or fairly challenging for the average reader.

The need for implementing a logical and effective reading path arises when academic and highly specialized texts come into play and echoes the metaphor of a journey that would enable students to move progressively from an “asymmetrical communicative situation”, i.e. between experts and semi-experts regarding their knowledge area (Krüger, 2016: 98), to a more symmetrical communicative scenario, which would be our target.

7. CONCLUSION

Years of observation and research at different education levels have proven that reading scientific texts requires the use of different strategies, methods, and skills.

Our research has focused on lexical density, lexical diversity and readability levels of English online corpora in medicine 2.0 and a consideration of the challenge a wide range of online genres poses to undergraduate students. University undergraduates have to master reading skills in English to become accomplished members in the medical community worldwide, and bearing in mind that these online genres are instances of standard academic English, the research has shown that they can all be considered fairly difficult to read and constitute a challenge at university level.

We can conclude that the obtained results might be a valuable source of information in the pre-selection of texts for EMP classes in virtual or blended environments and that the data collected on these online genres could be used in the teaching process to adapt it to state-of-the-art medicine and the interactive nature of medicine 2.0. This research has also revealed that online responses to research articles and editorials, while constituting a lighter read, are adequate in university contexts. However, they are more challenging from a lexical perspective (higher lexical density and diversity). This implies that they can be introduced in EMP classes but are likely to require a thoughtful pedagogical approach. Research articles are difficult for our intended readership but have the lowest density and diversity levels. Editorials are the most difficult to read but have intermediate levels of lexical density and diversity compared to the other genres. These aspects could be taken into account by EMP lecturers while estimating the particular statistics of each text.

EMP teachers may enlighten understanding of high-density texts by aiding their reading with the explanations of concepts, vocabulary activities, noun clusters, collocations and word order activities. If difficult texts were to be introduced, it

would be advisable to employ pre-reading and post-reading activities favoring images such as diagnostic imaging, photos, CT scans, flowcharts or infographies, or accompanying lexical activities such as translation into L1, use of term definitions in L2, use of online dictionaries and applications so as to approach challenging vocabulary. The research review tasks present in online responses could be introduced easily in the course syllabus.

When compiling texts for use in EMP classes, it would be important to use a range of texts in diverse media, with varied lengths and formats to provide rich language experiences. It is the EMP teachers/lecturers' decision to opt for a more meaningful approach, in view of, and adapting to, their students' level of expertise, motivation and particular circumstances surrounding the university teaching-learning process, bearing in mind that it would be advisable to use the new genres and design the aforementioned accompanying activities to foster their students' awareness of medicine 2.0 culture.

Additionally, the use of these four corpora in EMP classes may be very relevant to explore the "differences between intensive and extensive reading, reading for gist and detailed information, and reading for action and for content," since these are all "valuable in the construction of the text-task sequences central to a genre-based approach" (Swales, 1990: 13-14). The individual study of particular texts in terms of their readability and diversity would be essential and add value and information towards their introduction in medical English courses.

Finally, the overall exposure of students to these four online genres throughout their university years will not only make them aware of the conventions of each specific genre, but also of the interactive nature of the medical English culture of medicine 2.0 nowadays. Real-life assignments "encourage students to be their authentic selves, thereby increasing confidence and enthusiasm for learning" (Jernigan, 2017: 281) and have a positive motivational impact (García-Pinar, 2019), exposing students to natural language and problems, making them part of their future professional medical community.

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