COMPREHENSIVE READABILITY ASSESSMENT OF SCIENTIFIC ARTICLES IN HEC RECOGNIZED JOURNALS USING FLESCH-KINCAID METHOD

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Abstract

Readability is an essential factor in the accessibility and impact of scientific research, influencing how effectively information is communicated to diverse audiences. This study presents a comprehensive readability analysis of scientific articles published in HEC-recognized journals using the Flesch-Kincaid readability method, an extensively used tool that evaluates text complexity based on sentence length and word difficulty. This study is focused on analyzing the readability of scientific articles published in journals that are recognized by the Higher Education Commission (HEC) of Pakistan. The HEC plays a significant role in accrediting and overseeing the quality of academic publications within the country, ensuring they meet high standards of scholarly excellence. Despite these standards, the readability of these articles can vary widely, influencing their accessibility to different audiences. The research analyzes a large corpus of articles across various disciplines to determine readability scores, identifying patterns and trends that influence the clarity of scientific writing. Results indicate that many articles exhibit high levels of linguistic complexity, potentially limiting their accessibility to readers outside the academic community, such as policymakers, educators, and the general public. By bringing attention to these readability challenges, this research advocates for improved writing standards and encourages journals to consider readability as a critical factor in the publication process. The study concludes with recommendations aimed at enhancing the clarity of scientific communication, ultimately making research more inclusive and ensuring that knowledge can be more widely disseminated and understood.

1. Introduction

The readability of scientific literature has become a vital area of focus as the demand for accessible, clear, and impactful research continues to grow. Scientific articles serve as the foundation for knowledge sharing within academic and professional communities, yet their complexity often limits the reach of key insights beyond specialists. Readability, defined as the ease with which a text can be understood, plays a crucial role in determining how effectively research is communicated. Factors such as sentence length, vocabulary, and overall text structure influence readability, and complex articles can hinder the dissemination of important findings.

In Pakistan, the Higher Education Commission (HEC) plays a vital role in regulating and ensuring the quality of academic publications. Journals recognized by the HEC are held to high scholarly standards, but these standards do not always translate to ease of reading. A comprehensive readability assessment of these journals is essential to understand how accessible the content is to

various audiences, including students, non-specialists, and researchers from other fields.

This study aims to calculate the readability of scientific articles published in HEC-recognized journals using the Flesch-Kincaid readability tests. By applying the Flesch Reading Ease Score (FRES) and Flesch-Kincaid Grade Level (FKGL), this research will systematically measure the complexity of articles and provide insights into how well these works meet the needs of a broader readership (1-28). The ultimate goal is to identify areas where readability can be improved, thereby enhancing the accessibility and impact of scientific research in Pakistan and beyond. (32) .

This study was motivated by the realization that improving the readability of scientific publications can yield significant benefits for both the academic community and the general public. The scientific community stands to gain as researchers can maximize the impact of their work by making it more accessible and easier to understand. By improving readability, accessibility, and clarity, researchers can reach a broader audience, including those outside their immediate field, fostering greater engagement and collaboration with their findings (26). This, in turn, can drive innovation and the application of research outcomes in practical, real-world scenarios. For the general public, increased readability of scientific literature demystifies complex concepts and makes scientific knowledge more approachable. This is particularly important in an age where informed decision-making on critical issues such as health, environment, and technology depends on public understanding of scientific principles and discoveries. By bridging the gap between researchers and the general public, enhanced readability contributes to a more scientifically literate society capable of engaging with and responding to contemporary challenges.

2. Methodology

Flesch Reading Ease formula was chosen along with other formulas, since it revealed that it associates with the Dale-Chall formula (1). Therefore, the Flesch-Kincaid readability formula has been selected. In this modern world, the two of these formulas are immersed in Microsoft Word's Spelling & Grammar and are hence simply measured. Know that the Flesch Reading Ease formula and the Flesch-Kincaid depend on the programming on the back end and that distinct implementations might produce distinct readability scores of these formulas on the similar text, which an analysis (2) has revealed. However, for this analysis, the aim was not to measure precise readability score of every single text but to look for any advances amid themb (25). It was presumed that any readability formula, even with little modicum within them, must be capable of doing that. It was presumed that the implementation in Word is more precise as compared to many other applications accessible on the Internet. (37).

The initial version of the Flesch-Kincaid readability formula appears in Flesch's doctoral thesis (Flesch, 1943) and calculated based on the average number of words per sentence, the number of affixes, and the number of references to people. The formula was derived based on the McCall-Crabbs Standard Test Lessons in Reading (McCall and Crabbs, 1926), a regular test given to children in grades 3-7. The McCall-Crabbs test contains 376 passages with 8 reading comprehension questions per passage. Each lesson was labeled with its complexity as a grade level. Based on these texts, Flesch derived the formula to predict the grade of children in grades 3-7 who answered at least 75% of the questions properly about a given passage. The goal of the formula was to help students to know about their progress (35).

After Five years, he published a new formula: the Reading Ease Score (Flesch, 1948). He changed the original formula by recomputing the coefficients and replacing previous text measurements with the ones used today, the average number of syllables and the average sentence length (27). Like the original study, this new formula was validated with children and was based on the same method, McCall-Crabbs Standard Test Lessons in Reading (21).

Flesch-Kincaid Grade Level is a deviation of the Reading Ease formula with readjusted values and is the formula that has been widely used in text simplification evaluation (24). The formula was derived three decades later (Kincaid et al., 1975) specially to calculate the readability of technical equipment for military personnel. 531 Navy personnel in four technical training schools at Navy bases were tested for their reading understanding level according to the comprehension section of the Gates-MacGinitie reading test as well as their comprehension of 18 passages from Rate Training Manuals (26). Despite the fact that this formula was derived from Navy

personnel, with military-based material, and specifically for Navy use, it has been broadly used in a range of settings to evaluate the readability of text, for example, it is generally used to guide text creation by medical writers in the medical domain and Microsoft Word includes both the Flesch Reading Ease and FKGL scores.

2.1 Samples

Sr no.	Journal	Year	Volume	Issued	Website/URL
1	Transylvanian Review Special Issue	2016	Vol XXIV, No. 10,	2016	http://www.centruldestudiitransilvane.ro/
2	Asian J Agri & Biol.;	2017	5(4): 228-237	2017	https://www.asianjab.com/wp-content/uploads/2017/12/OA-AJAB-2017-07-069_OK
3	Italian Journal of Agronomy	2019	14:1413	2019	https://www.agronomy.it/index.php/agro/article/view/1413
4	Bacillus and Paenibacillus species improve the nutritional status in wheat	2020	. PLoS ONE 15(12)	2020	. https://doi.org/ 10.1371/journal.pone.0241130
5	Pol. J. Environ. Stud	2022	Vol. 31, No. 2	2022	10.15244/pjoes/140563
6	Adv. Intell. Syst.,	2023	5, 2300211	2023	10.1002/aisy.202300211
7	iJOE	2022	Vol. 18, No. 10	2022	https://doi.org/10.3991/ijoe.v18i10.31879
8	Sensors,	2023	23, 5204	23(11)	https://www.mdpi.com/1424-8220/23/11/5204
9	(IJACSA) International Journal of Advanced Computer Science and Applications	2022	Vol. 13,	5	http://www.ijacsa.thesai.org/

10	2nd International Scientific Conference of Engineering Sciences (ISCES)	2020	Vol 1076	2020	doi:10.1088/1757-899X/1076/1/012045
11	Digestive Disease and sciences	2015	60	2015	10.1007/s10620-014-3494-7
12	Curr Gastroenterol Rep)	(2015	17	(6):23	10.1007/s11894-015-0447-z
13	Annals of Microbiology	2019)	69	353–368	https://doi.org/10.1007/s13213-018-1423-2
14	Journal of Saudi Chemical Society	2023	27	101760	https://doi.org/10.1016/j.jscs.2023.101760
15	Journal of Saudi Chemical Society	2023	27,	5	https://doi.org/10.1016/j.jscs.2023.101716
16	Pakistan Journal of Applied Psychology (PJAP)	2023	, Vol. 3	No. 2, 328-336	https://doi.org/10.52461/pjap.v3i2.1120
17	Pakistan Journal of Applied Psychology (PJAP),	2023,	Vol. 3,	No. 2, 337-355	https://doi.org/10.52461/pjap.v3i2.1771
18	Pakistan Journal of Applied Psychology (PJAP),	2023	Vol 3	No 2 ,380-387	https://doi.org/10.52461/pjap.v3i2.1731
19	Pakistan Journal of Applied Psychology (PJAP),	2022	, Vol. 3	, No. 2, 388-409	DOI: https://doi.org/10.52461/pjap.v3i2.1887
20	IUB Journal of Social Sciences	2019	Vol. 1	2	https://journals.iub.edu.pk/index.php/jss

The readability numbers were calculated with the Readability Calculator, a free online site utilized by current analysis to examine readability of Web content (3-4). The finalized content for every article was viewed by this website to count the sum of characters, words and sentences. The website also calculated five readability registers that show the school grade suitable for that reading complexity (18). The readability grade level readings were the Automated Readability Index, Coleman-Liau Index, Flesch-Kincaid Grade Level, Gunning Fog index and Simple Measure of Gobbledygook index (20). All these guides produce a result that estimates the grade 1evel (in the United States) important to comprehend the text (28). Every single one of them utilize a formula that is different from the other, specifically the Automated Readability Index and Coleman-Liau Index depend on character counts while the others depend on syllable counts (35). The Gunning Fog index was the commonly used index to find readability of journal articles (5), while the others were mostly utilized to test readability of journal articles and materials on websites targeting patients (6). An average reading grade level (AGL) was estimated by finding the mean of these five indices (7). Apart from the schoo1 grade indices, a Flesch Reading Ease (FRE) score too was calculated for every article. This score was also commonly used to examine readability of journal articles (8).

Flesch Reading Ease
The F1esch Reading Ease formula is:
Reading Ease Score = 206.835 – (1.015 x ASL) – (84.6 x ASW)
ASL = average sentence length (number of words divided by number of sentences)
ASW = average number of syllables per word (number of syllables divided by number of words)

(DuBay, 2006; Microsoft Office Online, 2010) [9]

3. Results
The goal of this analysis is to explain the result of the readability level of scientific articles of HEC recognized journals examined by utilizing Readability Formulas. The data present is gathered by examining the texts from the HEC recognized articles and the scores of the readability test were measured utilizing readability calculation platforms. The findings of this analysis are explained on the basis of text in general. As speculated, on average there is a succession of text intricacies from the college year from 11 to 12 in these articles. There happens to be a common sequence from texts that have easier levels to the ones with difficult levels. It is complex to give precise readability grade levels to the 20 scientific articles analyzed from this study alone (36).
Readability formulas are not a precise tool to examine (11).
Moreover, few manual corrections have been made in this analysis for deficiencies discovered in the formulas in Microsoft Word 2007 (14). The readability scores are modified to a certain degree due to this fact. It was presumed that the modifications will not influence the wide association amid articles and levels (29). Hence it is hard to compose any explicit judgements from the current analysis in concern to how comprehendible the texts really are. Even though, the interpretation from the current analysis is backed up by the purposefulness of readability formulas (DuBay, 2004) and their increased authenticity in common (12), that is specifically high for Flesch Reading Ease formula (DuBay, 2006). The analysis is supported by the truth that writings were examined completely, that as per Klare (13) provides a valid outcome.

Table 1 Readability according to Flesch Reading ease

Sr no.	Journal Name	Year	Flesch-Kincaid method Grade level	Flesch Reading ease Score
1	Transylvanian Review Special Issue	2016	7.42	54
2	Asian J Agri & Biol.	2017	8.5	45
3	Italian Journal of Agronomy	2019	8.57	46

| 4	Bacillus and Paenibacillus species improve the nutritional status in wheat	2020	8.95	47
5	Pol. J. Environ. Stud	2022	11.7	51
6	IET Intelligent Transport Systems	2023	6.84	63
7	iJOE	2022	6.38	63
8	Sensors	2023	9.71	40
9	(IJACSA) International Journal of Advanced Computer Science and Applications	2022	7.06	58
10	2nd International Scientific Conference of Engineering Sciences (ISCES)	2020	8.37	50
11	Digestive Disease and sciences	2015	6.82	63
12	Curr Gastroenterol Rep	2015	8.61	51
13	Annals of Microbiology	2019)	7.31	58
14	Journal of Saudi Chemica1 Society	2023	6.15	69
15	Journal of Saudi Chemical Society	2023	5.58	68
16	Pakistan Journal of Applied Psychology (PJAP)	2023	8.96	44
17	Pakistan Journal of Applied Psychology (PJAP),	2023,	7.29	53
18	Pakistan Journal of Applied Psychology (PJAP),	2023	8.75	45
19	Pakistan Journal of Applied Psychology (PJAP),	2022	9.14	41
20	IUB Journal of Social Sciences	2019	10.2	36
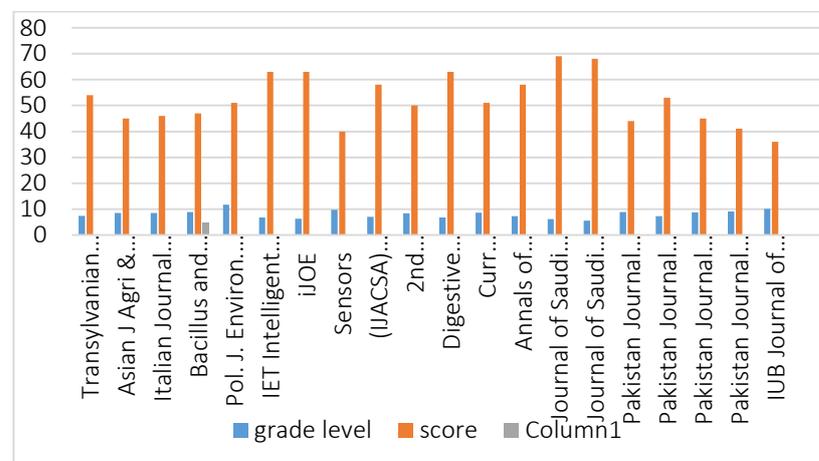
Figure 1.1 Average Flesch Reading Ease Grade Levels of the Articles
Table 2 Interpretation Table for Flesch Reading Ease Scores

4. Conclusions

Reading Ease score	Style description	Estimated US reading grade	Average sentence length	Average number of syllables per 100 words
90-100	Very easy	5th grade	-8	-123
80-90	Easy	6th grade	11	131
70-80	Fairly easy	7th grade	14	139
60-70	Standard	8th -9th grade	17	147
50-60	Fairly difficult	10th-12th grade	21	165
30-60	Difficult	13th-16th grade	25	167
0-30	Fairly difficult	College grade	29	192-

It has been discovered how readability influenced the favorable outcome of scientific writing and did a comprehensive analysis on various measures of Linguistic intricacy that impact readability. To determine a comprehensive analysis of scientific articles in HEC recognized Journals, the apprehension and notions from the analysis were utilized (23). MS Word and www.readabilityscore.com examines the text sample rigorously on different factors of linguistic intricacy and readability and provides an elaborate visualization of the research. This visualization facilitates the authors to doubtlessly hunt down the less readable articles of Journals. To make their writings more readable this observation can be used by the authors thus enhancing the chances of the paper/article being nominated for a journal and getting cited more. There are two conclusions that can be deduced on the basis of research outcomes and evaluation of the data in the prevailing chapter. Following are the conclusions:

1. The text under examination shows a high extent of intricacy, symptomatic of professional or academic critique**.** The obtained readability score associated with the assumption of content appropriate for readers at a 14th-grade level or higher. Such a classification arranges the text firmly within the field of specialized knowledge, requiring a sophisticated level of apprehension from its audience.

2. The definition of "professional" reading complexity underscores the text's alignment concerning individuals with latest educational backgrounds or particular skills in the subject matter (37-44). Therefore, the intended readers for this text are likely formed of professionals, academics, or specialized learners who are endowed with the stipulated vocabulary and cognitive capabilities to interact with the material (22).

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