

PONTIFICAL CATHOLIC UNIVERSITY OF RIO GRANDE DO SUL  
SCHOOL OF HUMANITIES  
LETTERS

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**TEXT COMPLEXITY FOR ENGLISH LANGUAGE LEARNERS: TEXTUAL ANALYSIS  
TOOLS APPLIED TO HEINEMANN'S UNITS OF STUDY**

Porto Alegre  
2022

GRADUAÇÃO



Pontifícia Universidade Católica  
do Rio Grande do Sul

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Tools Applied to Heinemann's Units of Study

Monograph presented as a partial requirement for obtaining a Teaching Degree in Language Arts: English from the Language Arts: English course at the Pontifical Catholic University of Rio Grande do Sul.

Advisor: Asafe Davi Cortina Silva, Prof. Me.

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Porto Alegre  
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This work is dedicated to English as a second language students everywhere  
and their devoted teachers.

## ACKNOWLEDGMENTS

This paper stands on the shoulders of my English as a Second Language (ESL) teachers from Newman Smith High School. Their patience and dedication are what allowed me to learn English and have since made me wish to pay their deeds forward. At age fifteen, I was very wrongly told by someone who is not an educator that I was too old to learn English well. However, their continued work and care showed me repeatedly that not only was I capable of learning English but would also spark in me the interest to teach others.

To the homeroom teachers with whom I have had the honor of sharing a room, Ariana Perone, Kate Boyd, and Cecília Mezzomo. Thank you for allowing me to learn from you. It is a huge privilege to watch someone teach before having to do it yourself. But I am beyond privileged because, by being your teaching assistant, I have learned from the very best. I appreciate you, your patience, and your welcoming me with open arms into your classrooms.

Also, thank you to Mara Becker for being an inspiration and a guiding light.

To my classmates at PUCRS, who later became my friends: you have filled a gap I did not know I had with our shared love for Literature and instant passion for Linguistic studies. Thank you for your ongoing friendship. A special thanks to my pair in every project, Wiliam Giacomini.

My thanks to the excellent professors at PUCRS. I deeply appreciate your leadership in these four years. It has been an honor to be an apprentice under your guidance. Together, we have faced the challenge of fulfilling an academic curriculum amid a global pandemic. Through every hardship, you have led by example and proved to be lifelong learners.

To Professor Asafe Davi Cortina, you give meaning to the word “advisor”. Thank you for your patience, encouragement, and understanding. To Professors Aline Evers and Cristina Becker Lopes Perna, thank you for your support and recommendations. It is a great honor to have you on the panel.

I am grateful for being born into a family that understands the value of education. You have always encouraged me to pursue my dreams and kept me going whenever I needed an extra push. I appreciate the sacrifices my parents made so that I could attend prestigious schools, although I wish a good education did not have to come from sacrifices.

Thank you to the love of my life and hero since we were teens, Bruno Britto. None of this would have happened without you.

“Nothing of me is original. I am the combined effort of everyone I’ve ever known.”

- Chuck Palahniuk

“Children, in their own ways, teach us about the  
language of our classrooms.”

- Peter H. Johnston

## ABSTRACT

The purpose of this study is to provide a more comprehensive approach to the scripts in the reading lessons of Heinemann's Units of Study by investigating the potential complexity in said scripts, specifically the instructional portion of the mini lessons. This study is important because it advocates for the English Language Learners in the second grade of the international school of Porto Alegre. Although its main aim is to help these students have a better and more effective learning experience, the findings can be applied wherever Units of Study are used on non-native English speakers. The findings of this research bring forth a more thorough understanding of the linguistic features in the scripts. The methodology we used analyzed a *corpus* using Coh-Metrix and Readability Formulas, replicating methods used in earlier research on text complexity and accessibility. Results indicate that the instructions are potentially high in complexity for an audience of Elementary School students in the second grade, especially those whose English is not their native language. This work may be replicated to enable teachers and material developers to judge more accurately what is important when addressing additional language students.

**Keywords:** Text Complexity; Text Accessibility; Readability; Coh-Metrix; English Language Learners.

## RESUMO

O objetivo deste estudo é fornecer uma abordagem mais abrangente dos roteiros utilizados em aulas de leitura das *Units of Study* da editora Heinemann, investigando a complexidade desses roteiros, especificamente da parte instrucional das miniaulas. Este estudo é importante porque advoga pelos alunos aprendizes de inglês como língua adicional da segunda série da escola internacional de Porto Alegre. Embora seu principal objetivo seja ajudar esses alunos a ter uma experiência de aprendizado melhor e mais eficiente, as descobertas podem ser aplicadas sempre que as *Units of Study* forem usadas com falantes não-nativos de inglês. Os resultados desta pesquisa trazem uma compreensão mais aprofundada dos recursos linguísticos nas escritas. A metodologia adotada analisou um *corpus* utilizando o Coh-Metrix e Fórmulas de Leitabilidade, replicando métodos usados em pesquisas anteriores sobre complexidade e acessibilidade textual. Os resultados indicam que as instruções são muito complexas quando se trata de um público de alunos do Ensino Fundamental da segunda série, principalmente aqueles cujo inglês não é sua língua materna. Este trabalho pode ser replicado para permitir que professores e desenvolvedores de materiais julguem com mais precisão o que é importante ao abordar alunos de idiomas adicionais.

**Palavras-chaves:** Complexidade Textual; Acessibilidade Textual; Leitabilidade; Coh-Metrix; Alunos de Inglês como Língua Adicional.



## LIST OF ACRONYMS

ANLP	Applied Natural Language Processing
AOA	Age of acquisition for content words, mean
CLI	Coleman Liau Index
ELL	English Language Learner
FCW	Familiarity for content words
FOG	Gunning Fog Index
FRE	Flesch Reading Ease
IBGE	Brazilian Institute of Geography and Statistics
ISPA	International School of Porto Alegre
NA	Natural Approach
NLP	Natural Language Processing
NT	Text Easability PC Narrativity, percentile
RF	Readability Formulas
SMOG	Smoke and Fog Index
TA	Text Accessibility
TC	Text Complexity
TS	Text Simplification
TT	Type Token
TTR	Lexical diversity, type-token ratio, content word lemmas
WCP	Text Easability PC Word concreteness, percentile

## LIST OF FIGURES

FIGURE 1 - OVERVIEW OF A DAY'S READING OR WRITING WORKSHOP .....	20
FIGURE 2 – FRE LEVELS AND INTERPRETATIONS .....	27
FIGURE 3 - READABILITY FORMULAS MAIN PAGE .....	28
FIGURE 4 - READABILITY CHECKER TOOL.....	29
FIGURE 5 - EXAMPLE OF RESULTS FROM THE READABILITY CHECKER.....	30
FIGURE 6 - SMOG INDICATORS .....	33

## LIST OF TABLES

TABLE 1 – TEXTS FROM THE UNITS OF STUDY .....	21
TABLE 2 – LABELS FOR THE COH-METRIX INDEXES .....	25
TABLE 3 - FOG INDEX INDICATORS .....	32
TABLE 4 - DALE-CHALL INDICATORS .....	34
TABLE 5 – RESULTS OF THE TEXTUAL METRICS .....	35
TABLE 6 – RESULTS OF THE READABILITY METRICS .....	37
TABLE 7 – COH-METRIX REFERENCE TABLE .....	37
TABLE 8 – COMPLEXITY CLASSIFICATION BY TT .....	39
TABLE 9 – <i>TERTIO COMPARATIONIS</i> FOR AOC AND FCW ANALYSIS .....	40

## TABLE OF CONTENTS

<b>1</b>	<b>INTRODUCTION .....</b>	<b>10</b>
<b>2</b>	<b>TEXT COMPLEXITY, SIMPLIFICATION, AND ACCESSIBILITY .....</b>	<b>14</b>
2.1	TEXT COMPLEXITY .....	14
2.2	TEXT SIMPLIFICATION .....	15
2.3	TEXT ACCESSIBILITY .....	16
2.4	NATURAL LANGUAGE PROCESSING .....	17
<b>3</b>	<b>UNITS OF STUDY .....</b>	<b>19</b>
3.1	SELECTED TEXTS .....	21
<b>4</b>	<b>TOOLS AND INDEXES .....</b>	<b>24</b>
4.1	COH-METRIX .....	24
4.1.1	<i>Coh-Metrix indexes</i> .....	25
4.2	READABILITY FORMULAS - SOFTWARE .....	28
4.2.1	<i>Readability Formulas - RF Indexes</i> .....	31
<b>5</b>	<b>ANALYSIS .....</b>	<b>35</b>
<b>6</b>	<b>FINAL CONSIDERATIONS .....</b>	<b>41</b>
	<b>REFERENCES .....</b>	<b>44</b>

## 1 INTRODUCTION

Porto Alegre is home to some bilingual schools, but only one international school – which offers classes from Preschool to Twelfth Grade. Unlike most bilingual schools, English is the main language of instruction at the international school of Porto Alegre (henceforth ISPA<sup>1</sup>). Faculty staff comes from all over the world, but the student body is composed of ninety percent Brazilian students, and the remaining ten percent from fourteen different countries, according to the institution’s website.

It is possible to assume that most, if not all, of these Brazilian students speak Portuguese as their native language at home and in most places outside of school. According to the Brazilian Institute of Geography and Statistics (IBGE, 2022), Portuguese is the official language of Brazil, being the most spoken language, except for native indigenous groups and very specific communities of German and Italian descent in the South of Brazil. Also, with fourteen different nationalities represented in the foreign student body, not all foreign students come from English-speaking countries or are native English speakers. All of this makes it safe to affirm that most of the students at ISPA are English Language Learners (ELL). Considering Krashen and Terrell’s (1983) orientation about the steps of language acquisition, if considered that the earliest a student can enter the school is at the age of three, in most cases the most proficient ELL in second grade would have intermediate fluency at best.

As a teaching assistant at the school, I have been honored to work with four groups of Grade 2 students in the past four years and currently. The work of an assistant includes, but is not limited to, observing the lessons being taught by the homeroom teacher while assisting students wherever needed. As part of it, I have been able to accompany the students in all their classes, including their literacy classes.

Throughout the years, I started noticing a pattern during the literacy lessons in Grade 2. These lessons follow a workshop model, which is an instructional practice characterized by three components: mini-lessons, workshops, and debriefings (EMERICH FRANCE, 2020). One of the key aspects of the mini lesson part of this popular lesson framework is its brevity. As Chapter 3 will show, this part should take no longer than ten minutes. However, for Grade 2, they were taking much longer than proposed because the teacher had to stop multiple times during a mini lesson to explain isolated vocabulary. The only student in one of the groups who could comprehend such lexicon enough to explain it to others was a native speaker of

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<sup>1</sup> For legal and ethical reasons, we have decided not to mention the actual name of the school, nor any piece of information that would be linked to it.

English – not only that, but a high-skilled native speaker of English. That sparked the question that perhaps the curriculum program being used was made with native English speakers in mind.

To teach literacy, the school uses, among others, a curriculum program by Heinemann, a “publisher of professional resources and a provider of educational services for teachers, kindergarten through college,” as it is stated on their website<sup>2</sup>. The curriculum that is used for the second grade of Elementary School is written by Lucy Calkins and published by Heinemann. Calkins’ resumé is vast, and she is currently the Robinson Professor of Children's Literature at Teachers College, Columbia University, where she co-directs the Literacy Specialist Program. However, nothing could be found that tied Lucy Calkins’ work or Heinemann’s program to students with English as an Additional Language (EAL), which leads one to believe the program is created for native speakers of the English language.

Even though some old practices and methodologies advised against using the students’ first language to support additional language learning processes, a substantial number of scholars have highlighted the importance of considering the learners’ mother tongue not only in class, but when preparing supporting materials (COOK, 2001; MADRIÑAN, 2014; DE LA FUENTE, 2020). Thus, considering that materials written for non-native speakers should consider the students' linguistic background, this paper intends to analyze the language used in the instructional portion of the workshop lessons being taught at ISPA to determine if it is adequate for the ELL of ISPA.

It has long been established that ELL need differentiation. “[English Learners] are learning to read and write in English while learning the academic language of the content at the same time.” (GONZALEZ; MILLER, 2020, p. 12) Linguistic accommodations need to be implemented to increase English learners’ academic success. That is not to say that the language used should be basic, but adequate. “If a language learner receives no challenge at all, it is difficult to grow in language development. On the other hand, if the input is too challenging, the learner would not be able to understand.” (GONZALEZ; MILLER, 2020, p. 16) The chapter “Modification for Second Language Instruction” in the book *The Natural Approach* emphasizes this:

The Natural Approach applies both to foreign language study, that is, to study of a language that is not spoken in the country of the student (e.g. French in the United States), as well as second language study, the study of a language that is spoken in the country (e.g. English as a second language in the United States). Despite some

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<sup>2</sup> Available on <<https://www.unitsofstudy.com/>>

obvious differences between second and foreign language study, there is a fundamental similarity between them: both second and foreign languages need to be acquired if any reasonable level of achievement is expected, and in both cases language acquisition will occur via comprehensible input. The Natural Approach can supply this comprehensible input to both foreign and second language acquirers, input that may be unavailable outside the class in the case of students of a foreign language or may be difficult to obtain in the case of many students of a second language. (KRASHEN; TERRELL, 2000, p. 179).

This study will focus on the meaning of Text Complexity and how potentially complex the mini-lesson instructions are for the average Grade 2 student of ISPA. Chapter 2 will help the reader understand Text Complexity as well as Text Accessibility, and how they could help students when applied. We will lean on the studies produced by Plain Language (2004), DuBay (2004), McNamara (2014), Silva (2018), and Silva, Moll & Perna (2021). By understanding Text Complexity, we will be able to see if the instructions are, in fact, potentially complex.

Text Complexity is, in most cases, a linguistic analysis done with the support of a Natural Language Processing tool. Thus, still in Chapter 2, we will connect Natural Language Processing theory to the tools we use.

As mentioned, the literacy program used by ISPA in elementary school is called Units of Study. Chapter 3 will explore the program further and give an overview of the steps of a lesson. It will also explain how the *corpus* was created, the selected text that will be analyzed with the support of Coh-Metrix and Readability Formulas (henceforth RF).

Coh-Metrix is one of the programs this research will use to help determine the potential complexity of the text provided in different lessons from the Heinemann program, which - according to the software's website - is a "computational tool that produces indices of the linguistic and discourse representations of a text. These values can be used in many different ways to investigate the cohesion of the explicit text and the coherence of the mental representation of the text." Coh-Metrix defines cohesion as "characteristics of the explicit text that play some role in helping the reader mentally connect ideas in the text". More specifically, we will focus on the lexicon aspects of the instructional text, as that seems to be where the ELLs have the most trouble according to our experience, whose complexity can be measured through a series of indexes, which will be presented in Chapter 4. Having collected the data from Coh-Metrix and RF, Chapter 5 will present the findings.

The questions we intend to answer with the analysis of our *corpus* are: I. Are the Units of Study potentially complex to our target reader?; II. Which textual features indicate

potential complexity?; III. Among the selected metrics, are the ones related to lexicon the main disrupters of comprehension?

Throughout this study, four main aims guided the research:

1. To understand what Text Complexity is;
2. To evaluate how Text Simplification can be helpful to English Language Learners;
3. To analyze the potential complexity in the texts used in the Heinemann Program for second grade;
4. To present ideas for how the Heinemann Program lessons can be simplified.

The form teachers use language in the classroom matters; and it matters differently when the students are learners of an additional language (JOHNSTON, 2004). Our hope is that the information found throughout our analysis will be of service to teachers of language learners, especially those who use the workshop model for their literacy lessons.



## 2 TEXT COMPLEXITY, SIMPLIFICATION, AND ACCESSIBILITY

When it comes to analyzing texts in terms of complexity, we come across linguistic terms that can be, oftentimes, confusing: Text Complexity (TC), Text Simplification (TS), and Text Accessibility (TA). These terms, although related, are not synonymous. In this chapter, we will define each term and explain their importance to this study.

### 2.1 TEXT COMPLEXITY

Text Complexity (henceforth TC), sometimes called Text Difficulty, considers how a text can be perceived by a particular reader. “Text complexity refers to the level of relative difficulty in reading and comprehending a given text.” (DESE, 2017). It is the opposite of what one would call easy to read or to understand. “What we sometimes call comprehension easability is aligned with reading ease or readability, the other end of the continuum being text difficulty or text complexity.” (MCNAMARA *et al.*, 2014, p. 8). This study will use readability formulas to evaluate the TC of the *corpus* and some textual metrics that although are not meant specifically for readability estimation, may help us understand some textual features that may be complex.

It is essential to highlight, however, that a text complexity analysis is a multidimensional study (BIBER, 1988/1995) that must focus on the potential complexity in relation to the estimated reader of each text. As several scholars of TC have constantly emphasized (such as DUBAY, 2007; PLAIN, 2011; FINATTO, 2018; SILVA, MOLL & PERNA, 2021), the complexity [or accessibility] of a written text should not be estimated by observing only its features, but its features in relation to the person or group who will read the text. Therefore, according to the aforementioned authors, the first step when carrying out a text complexity analysis is defining its target audience and, when it is clearly narrowed and defined, the methodological approach(es) and the levels of the text that are going to be analyzed can be finally chosen.

To help estimate the complexity of texts, scholars of different fields have created statistical formulas that assess readability. One of those authors (and possibly the most-known scholar who developed formulas for text complexity analyses) is Rudolph Flesch, a pioneer in the field of TC and TS, whose readability formula “[...] was based on a count of three language elements: average sentence length in words, number of affixes, and number of

references to people.” (FLESCH, 1948, p. 221) The applied formula generates a number from zero to one hundred, with a score of one hundred meaning that the readability is high.

Other scholars (especially professors, linguists, and editors) have been concerned with creating formulas to help estimate complexity. In section 4.2.1 of this paper (“Readability Formulas - RF Indexes”) we present and explain some of them.

For our research, a comprehension of TC and the readability formulas was needed to attempt to show if our *corpus* is difficult to second grade ELLs.

## 2.2 TEXT SIMPLIFICATION

When a text is high in difficulty for its intended reader, simplification strategies may be applied. The process of choosing strategies according to the results of the complexity analysis is called TS, which has been successfully and concisely defined by Siddharthan (2014, p. 259):

Text simplification, defined narrowly, is the process of reducing the linguistic complexity of a text, while still retaining the original information and meaning. More broadly, text simplification encompasses other operations; for example, conceptual simplification to simplify content as well as form, elaborative modification, where redundancy and explicitness are used to emphasize key points, and text summarization to omit peripheral or inappropriate information.

A great analogy for TS is to think of it as reading glasses. If a person needs reading glasses, we understand that wearing them will help that person see better, and that expecting them to see something perfectly without glasses is pointless. It is not a matter of effort, but a matter of capacity at a given moment of a person’s language learning journey.

The reading glasses analogy (meaning, the adoption of TS strategies) is not new in Linguistics, and it has been advocated by Functional Linguistics for decades. In fact, Halliday (1994, 2001), for instance, uses this analogy when he explains ‘register’ - which is adapting a text<sup>3</sup> to make it adequate to the social context and interlocutors. We use register almost naturally when we choose the words we use and the form of communication we adopt for each situation in our lives; when it comes to applying TS techniques, on the other hand, the strategies must be well thought of and coherent with the target audience.

When TS strategies are properly applied, they can help ELLs understand what is being taught in class, among other uses. When teaching ELLs, “[...] the classroom teacher carries

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<sup>3</sup> For Functional Linguistics, a text is any type of verbal production, regardless of being written or spoken.

the dual responsibility for the students' subject learning and for their ongoing language development.” (GIBBONS, 2015, p. 1). The way a text is presented to the student is crucial to determine how the lesson will be received. “Therefore, what the teacher does before students begin to read the text directly impacts on how effectively students are able to access the meaning of the text.” (GIBBONS, 2015, p. 179). Applying TS is a form of reaching out to the student, once with TS strategies, we may attempt to adapt a text so it can meet the students' reading abilities more efficiently.

### 2.3 TEXT ACCESSIBILITY

When the TC is high and TS strategies need to be applied, as a result we get a text that is [possibly] accessible to the student. Silva, Moll & Perna (2021, p. 5) when explaining the differences between TC, TS, and TA, state that:

TC is an analysis – usually done by a linguist supported by a Natural Language Processing tool – that verifies components of a text that make it more or less complex for a given reader profile; TS are the processes and strategies adopted to make a text accessible to the stipulated reader, and TA refers to the resources used in a text (from the TS processes) so that it can be understood by the target reader.<sup>4</sup>

An accessible text is incredibly important when our target-reader is an ELL once “Both mother tongue speakers of English and EL learners face these increasingly complex language demands in school, but EL learners are learning to do this in a language that is not their mother tongue.” (GIBBONS, 2015, p. 7)

Making texts accessible to ELLs does not mean to reduce the intellectual capacity of the texts. As Gibbons (2015, p. 3) points out,

Treating EL learners as the people they can become means that we see students not in terms of what they lack—in their case, full control of academic English—but as capable and intelligent learners who, with the right kind of support, are as able to participate in learning and achieve academically as their English-speaking peers.

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<sup>4</sup> Author's translation. Original: “CT é uma análise – geralmente de um linguista apoiado por uma ferramenta de Processamento de Linguagem Natural – que verifica componentes de um texto que o tornam mais ou menos complexos para um determinado perfil de leitor; ST são processos e estratégias adotados para tornar-se um texto acessível para o leitor estipulado, e AT acena aos recursos utilizados em um texto (provenientes dos processos de ST) para que ele seja compreendido pelo leitor-alvo.”

As pointed out by Silva, Moll & Perna (2021), linguists commonly use a Natural Language Processing tool to determine the TC. The next section will explore this branch of Linguistics, and how it helped us achieve the results we needed for this study.

## 2.4 NATURAL LANGUAGE PROCESSING

In this study, we are not trying to determine whether the text in the mini lessons is grammatically correct or not, but rather how potentially difficult it is for an ELL to understand. We will consider the language used in the *corpus*, and all of the Units of Study for that matter, to be a natural language and to follow a set of rules. As Chomsky (1957, 2002, p. 20) stated,

This conception of language is an extremely powerful and general one. If we can adopt it, we can view the speaker as being essentially a machine of the type considered. In producing a sentence, the speaker begins in the initial state, produces the first word of the sentence, thereby switching into a second state which limits the choice of the second word, etc. Each state through which he passes represents the grammatical restrictions that limit the choice of the next word at this point in the utterance.

To analyze the complexity in the texts used in the Heinemann Program for Grade 2 in a non-intuitive form, an objective linguistic approach had to be used. The subfield of Linguistics that supported the analysis of our *corpus* is based on the Natural Language Processing theory (henceforth NLP). As Silva (2018) states, it is an area that goes beyond linguistic studies or mathematics, and it unites both humanities and exact studies, “Therefore, NLP practices deal with different components not only of language, but also of human knowledge.”<sup>5</sup> (SILVA, 2018, p. 78). Thus, NLP may assist us to examine texts with higher precision and linguistic knowledge.

NLP relies on technology to accurately extract information and generate analysis. NLP, or Applied Natural Language Processing (ANLP), encompasses many fields. McNamara *et al.* (2014, p. 170) explain that

Like discourse science, ANLP is inherently an interdisciplinary field, typically featuring contributions from cognitive psychologists, computer scientists, and linguists. Perhaps the main difference between the two fields is simply the focus of the particular project, with the focus of ANLP inevitably being the computational aspect that is analyzing the construct of interest. Thus, we could say that anyone who is applying Coh-Matrix in their research is doing ANLP.

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<sup>5</sup> Author’s translation. Original: “Portanto, as práticas de PLN lidam com distintos componentes não só da linguagem, mas também dos conhecimentos humanos.”

Section 4.1 of our paper (“Coh-Metrix”) will further address the use of the software – which is an NLP tool - for the purposes of TC analysis proposed by us.

The use of an NLP tool was necessary to remove the guesswork from what was causing misunderstandings in the mini lesson instructions. Therefore, with the support of NLP tools, we were able to collect textual features that can be used with high levels of accuracy to estimate complexity. As McNamara *et al.* (2014, p. 174) state,

The development and application of textual analysis tools can be placed in the field of ANLP, which is dedicated to identifying, investigating, and resolving language-related issues through automated approaches. Coh-Metrix studies form one of the most prominent areas of this field, and that central position looks likely to continue well into the future.

By submitting the texts extracted from the Units of Study (which we present in the following section) to NLP tools, we can gather information to help us narrow the TC of our *corpus*. Both Coh-Metrix and RF, which are NLP tools, will allow us to identify challenging features to then draw conclusions about the difficulty of the texts as a whole.

### 3 UNITS OF STUDY

The text analyzed in this study is extracted from Units of Study, the literacy program used by ISPA. Units of Study offers a workshop curriculum that covers grades from Kindergarten to Eighth. It is a reading and writing program that highly values independence and student agency. The authors' aim, according to the information found on their website<sup>6</sup>, is “to prepare students for any reading and writing task they will face and to turn kids into life-long, confident readers and writers who display agency and independence.” The structure of the lessons emphasizes this aim.

The form a workshop structure works provides a balanced literacy approach, where the lesson time is spread out in different sections. According to Gonzales and Miller (2020), the workshop structure is particularly beneficial to English Learners. The workshop structure allows the student to have less time sitting and listening to a lecture and more time reading or producing a written piece. It is designed so the teacher can spend less time lecturing, and more time conferencing with students individually. “The Reading and Writing Project’s approach to instruction recognizes that “one size fits all” does not match the realities of the classrooms and schools in which they work,” says the information on their website. Lessons are made of five different stages: the mini lesson, independent work, individual conferences, a mid-workshop teaching point, and sharing, as illustrated by the following image (Figure 1).

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<sup>6</sup> <https://www.unitsofstudy.com/>

**Figure 1** - Overview of a Day's Reading or Writing Workshop

Overview of a Day's Reading or Writing Workshop				
WORKSHOP COMPONENT	TIME FRAME	LOGISTICS	TEACHER	STUDENTS
<b>MINILESSON</b>	<b>Less than 10 min.</b>	The teacher gathers students in the meeting area next to their partners	Whole-group instruction <ul style="list-style-type: none"> <li>• Connection</li> <li>• Name the teaching point</li> <li>• Teaching</li> <li>• Active Engagement (guided practice)</li> <li>• Link to the work students will do</li> </ul>	Listening, then actively engaged in applying new learning
<b>INDEPENDENT READING AND WRITING CONFERRING AND SMALL-GROUP WORK</b>	<b>35–45 min.</b>	Students find comfortable spots to read or write	One-on-one and small-group teaching <ul style="list-style-type: none"> <li>• Circulate</li> <li>• Observe</li> <li>• Question</li> <li>• Listen</li> <li>• Coach</li> <li>• Demonstrate</li> <li>• Reinforce the minilesson</li> <li>• Encourage</li> </ul>	Practicing strategies learned throughout the unit, working independently or with partners
<b>MID-WORKSHOP TEACHING</b>	<b>3–5 min.</b> (during independent reading and writing time)	Students' eyes are on the teacher	Extends the minilesson or reminds students of ongoing habits	Pausing to reflect, then refocusing to resume reading or writing
<b>SHARE</b>	<b>3–5 min.</b>	The teacher gathers students in the meeting area or calls for their attention while they remain at their reading or writing spots	Sets students up to share and celebrate the work they did that day	Sharing their learning with partners or the whole group

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Download the Comprehensive Overview: <http://hein.pub/UOS/Overview>

Source: unitsofstudy.com

Even though the lecture portion of the lessons is minimal compared to a traditional literacy lesson, the language used in this portion is paramount for the comprehension of the students. Perhaps, it is more important than the other parts because it is shorter, and the teacher needs to be able to instigate the knowledge of the students with less instruction time. That is why it is so necessary to ensure that the target students are equipped for this program.

This paper will focus on the mini lesson portion of the workshop program, particularly the instructional language used in the mini lesson which, according to Gonzalez and Miller (2020, p. 26), is

a laser-focused 10 to 15 minutes of targeted, explicit instruction with the whole group. The teacher gathers students in front of the board or presentation area and introduces one specific skill, concept, or strategy. Students learn in a safe, guided setting while the teacher checks for understanding.

As the name suggests (mini lessons), these are not lengthy lectures. The mini lessons are made to provide meaningful instructional time that sets students up for success during independent time.

### 3.1 SELECTED TEXTS

The Units of Study collection for Reading in Grade 2 of Elementary school is composed of four units:

- Unit 1. Second-Grade Reading Growth Spurt
- Unit 2. Becoming Experts - Reading Nonfiction
- Unit 3. Bigger Books Mean Amping Up Reading Power
- Unit 4. Series Book Clubs

In Table 1 below, we present the texts of the instruction part of these units of study – which are the ones we will analyze:

**Table 1** – Texts from the Units of Study

Unit	Full text
Unit 1 Session 10, p. 54	<p>Readers, or shall I say <i>writers</i>, because in this session you will be both. Let’s set up our white boards to do some long vowel work. To set up your board, will you please draw a line down the middle, and write the word <i>beach</i> at the top on one side, and <i>head</i> on the other?</p> <p>We know that some vowels go together in words and make sounds, usually making the sound of the name of the first vowel. Those are vowel teams. When I was little, my second-grade teacher taught me, “When two vowels go a-walkin’, the first one does the talkin’.” But sometimes, those vowel teams are tricky! Sometimes the first vowel doesn’t do the talkin’! You have to watch out for those tricky vowel teams. Every time you see two vowels together, you can think to yourself, “Hey, I know you, you tricky vowels - and you’re <i>not</i> going to trick me!”</p> <p>Here’s a tricky vowel team that you probably already know about: <i>ea</i>. You are going to sort some words on your white boards. You’ll write all the words that make a long <i>ē</i> sound, as in <i>beach</i>, on one side. You’ll write all the words that make a short <i>e</i> sound, as in <i>head</i>, on the other side.</p> <p>Great work! Do you see how some vowel teams, like <i>ea</i>, can be super tricky? All of those words are spelled with <i>ea</i> and they look like they should all sound the same, but they don’t sound the same when we read them, do they? You might have to try one sound and then another to figure out a word. Take a minute right now to circle all the vowel teams. Do you notice something? Yes! You noticed it. These words all have tricky vowel teams right in the middle, where they are the hardest to spot! That makes them even trickier! Keep an eye out for those tricksters!</p> <p>Today I want to teach you that readers sometimes have to work extra hard to figure out the middle of a word. Readers keep an eye out for those tricky vowel teams that can make different sounds. Readers know they may need to try one sound and then another to figure out a word.</p>
Unit 2 Session 9, p. 47	<p>Yesterday, you learned that if you are reading along and everything is going smoothly and then - whoa - you get stuck on a word, you have keys to try unlocking it. You learned that you can roll up your sleeves and get to work. You can use the whole page and think about everything you know about the topic to unlock those keywords. Sometimes, though, all it takes is figuring out how to say the word because sometimes that tough</p>



	<p>word is one you already know.</p> <p>Today I want to teach you that when readers are stuck on a key word, they know how to play around with the word, like you might play around with a key in the lock, trying it one way and then another, and sometimes - presto! - they find the way to unlock it.</p>
<p>Unit 3 Session 6, p. 34</p>	<p>Readers, I have to tell you something. Last night, I got an email blast from the same three reading scientists who told us that second grade is the time when kids start reading silently, and that rereading, especially aloud, helps readers with their in-the-head voices. The reading researchers said again how important second grade is for growth in reading, but this time they were talking about something a little different. Listen to what they wrote.</p> <p>Research Bulletin about Second-Grade Readers</p> <p>Researchers have found that the books second-graders read often contain language that is used in playful and inventive ways. Second-graders who are especially skilled readers pay attention when a writer has used words in special ways because they know that those passages require extra thought.</p> <p>I started thinking about whether we have been paying extra attention to passages that use language in playful, inventive ways. Have we been reading right by those passages. not even noticing? I started to worry.</p> <p>Today I want to teach you that when authors use language in especially inventive, playful ways, it's kind of like they are pulling on a reader's sleeve saying, "Notice this!" Skilled readers notice when an author has done something special and think extra hard to make sure they understand what the author is trying to say or show.</p>
<p>Unit 4 Session 11, p. 64</p>	<p>My grandfather was a great storyteller. He would sit in a big chair and all of the grandchildren would gather around him and he'd tell us story after story. And we'd sit and listen for hours. In a way, he was just like the authors of your series books, except he didn't write his stories down on paper; he wrote them with his voice.</p> <p>You see, his stories were amazing and beautiful to listen to because of the way he told them. His voice would go UP and down, get LOUD and soft, speed up and s-l-o-w down. He used his voice to make his stories come to life, to make them sound the way authors want them to sound. Authors have ways to help every reader bring stories to life, just the way a storyteller would.</p> <p>Today I want to teach you that authors craft not just what the words they use, but also the way those words are placed on the page. Authors include signals in the print - like bold or italic font or large type or even teeny tiny things like commas and periods - to tell the reader how they want a story to sound.</p>

Source: the author based on CALKINS, L. *et al.* (2015)

To produce a fair analysis, the texts were selected observing only one criterion: all the selected texts are found about halfway through each unit. For example, Unit 1 has seventeen lessons, the lesson selected was Lesson 10, which is about halfway through Bend II, the second out of three bends in this unit. Each unit has seventeen to eighteen sessions.

The reason this criterion was established is because the students would have somewhat of a background knowledge built. By the time the teacher gets to the middle of a unit, the students have an understanding of what a reading lesson looks like, how much instructional time to expect, and that they will be invited to apply a teaching point to their reading time that follows a lesson.

The next chapter will explain what tools and which indexes from these tools were used to analyze our *corpus*.

## 4 TOOLS AND INDEXES

Two NLP tools were used to analyze our *corpus*: Coh-Metrix and Readability Formulas.

We have decided to use two tools because Coh-Metrix gives us textual metrics that are not specifically meant for TC analysis (but that have been frequently used for this purpose), and Readability Formulas gathers a vast number of readability formulas in a user-friendly form. Thus, by analyzing textual metrics and readability formulas, our research can present a more accurate and extended analysis.

In the following sections, we will explain each metric selected.

### 4.1 COH-METRIX

As readers, it is common to find texts more suitable or more complicated to read. But how do we prove, with evidence, that something is too complex for a certain reader? Fortunately, Coh-Metrix is a text analysis tool that provides us with textual indexes that can be used to estimate complexity. It comes as a “comprehensive tool capable of analyzing texts at multiple language and discourse levels.” (GRAESSER, MCNAMARA, & LOUWERSE, 2003, p. 60). By analyzing such characteristics, Coh-Metrix helps determine the multiple levels at which comprehension works.

To determine how potentially complex the mini lesson texts in the Units of Study are, we will run our *corpus* through Coh-Metrix and collect metrics that may support our analysis of textual features that we believe to be complex. Most of these indexes are meant not only to assist us to estimate the TC of the texts as a whole, but also to help us answer our third research question (“Among the selected metrics, are the ones related to lexicon the main disrupters of comprehension?”).

Coh-Metrix generates metrics that “can be used in many different forms to investigate the cohesion of the explicit text and the coherence of the mental representation of the text.”<sup>7</sup> With the data collected from this tool, one can estimate the complexity of written texts and observe how adequate they are for the target-audience.

The generated values will not immediately let us know if a text is too complex. As Silva (2018, p. 108) points out,

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<sup>7</sup> Information retrieved from the description of Coh-Metrix on [www.cohmetrix.com](http://www.cohmetrix.com)

Although these tools do not automatically conduct an analysis of the complexity of texts and notify the user if a text is complex (or not), the data collection about the collected texts allows professionals who work with textual accessibility to conduct research and cross data to verify which elements make a text complex and which simplification strategies change the indexes provided by these programs and, consequently, suggest that edited texts have, in fact, become simplified.<sup>8</sup>

Coh-Metrix is a tool that supports the estimation of textual complexity by allowing the collection of textual metrics that a linguist can use to interpret possible complexity taking into account the audience. There are over one hundred and eight metrics at our disposal on Coh-Metrix. The TC analyst must select the ones that best suit their analysis. In our research, we have selected six indexes from Coh-Metrix that help us comprehend the potential complexity of our *corpus*, especially regarding the lexicon. These metrics are presented next.

#### 4.1.1 Coh-Metrix indexes

To help us estimate the complexity of the texts from the Units of Study, we needed to define which indexes would support our analysis and provide us with information to corroborate or refute our hypothesis that the texts are potentially complex for our target-readers. Thus, after studying and debating about the metrics, we have narrowed them to six, some that focus on lexicon, and a couple that focus on semantics for contrast. The main reason to choosing these metrics instead of the several indexes that could be used to estimate complexity is the fact that they have been used in published research and because we have had prior experience with these metrics, and they have been corroborated as reliable for a TC analysis. The chosen indexes are as shown in Table 2 below:

**Table 2** – Labels for the Coh-Metrix Indexes

NT	Text easability   Narrativity
WCP	Text easability   Word Concreteness Percentile
TTR	Lexical diversity   Type-Token Ratio
AOA	Lexical complexity   Age of acquisition for content words
FCW	Lexical complexity   Familiarity for content words

<sup>8</sup> Author's translation. Original: "Embora essas ferramentas não conduzam, automaticamente, uma análise da complexidade de textos e notifiquem ao usuário se um texto é complexo (ou não), o levantamento dos dados a respeito dos textos coletados permite que profissionais que trabalham com acessibilidade textual possam conduzir pesquisas e cruzar dados para verificar quais elementos tornam um texto complexo e quais estratégias de simplificação alteram os índices dispostos por esses programas e, conseqüentemente, sugiram que textos editados tenham se tornado, de fato, simplificados."

FRE	Text easability   Flesch Reading Ease
-----	---------------------------------------

Source: the author

**NT** is probably one of the first types of textual typologies that we learn. At an early age we start to tell stories to give information on something that happened. Narratives tell a story; the components of such story will determine how understandable it is to the reader/listener. NT, as an index, helps us estimate how close or far from a narrativity structure our analyzed text is. Guidelines from Coh-Metrix indicate that NT is a “robust component [that] is highly affiliated with word familiarity, world knowledge, and oral language. Non-narrative texts on less familiar topics lie at the opposite end of the continuum.” Therefore, when we have children as our target-audience, it is interesting to have high values of NT (which displays a percentile number from zero to one hundred, being the texts with NT values closer to one hundred the most similar to narrativity structures and, consequently, potentially more accessible).

**Word concreteness** (WCP) considers how tangible the meaning of a word is. Once again, guidelines from Coh-Metrix give us an explanation of the index, saying that “Texts that contain content words that are concrete, meaningful, and evoke mental images are easier to process and understand. Abstract words represent concepts that are difficult to represent visually. Texts that contain more abstract words are more challenging to understand.”

Once language is not only composed of concrete words, and that even concrete words can be used metaphorically, we must consider the appropriateness of the use of metaphors when addressing a group of children, specially knowing that “At the age of 7-11 years old, children can understand metaphors that are based on similarity. According to this theory [Inhelder and Piaget (1969)], children’s competence in comprehending metaphor fully develops at least by the age of 11.” (SONG, 2020, p. 95) Therefore, comprehension may be strongly dependent on concreteness for our target-audience.

The **Type-Token Ratio** (TTR) is an index that calculates lexical diversity using content words<sup>9</sup>, not function words<sup>10</sup>. It considers each content word as a token and calculates how many times each token is repeated. “As the type-token ratio decreases, words are repeated many times in the text, which should increase the ease and speed of text processing.” The more words are repeated, the easier it becomes to understand, since a higher presence of different words requires from the reader a greater vocabulary control.

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<sup>9</sup> Content words: nouns, verbs, adjectives, and adverbs.

<sup>10</sup> Function words: pronouns, prepositions, conjunctions, determiners, and qualifiers/intensifiers.

The **Age of Acquisition for Content Words** (AOA) considers that children learn certain words earlier or later than other words. To illustrate AOA, Coh-Metrix explains that, for example, “(...) cortex, dogma, and matrix (AOA= 700) have higher age-of-acquisition scores than words such as milk, smile, and pony (AOA =202)”. This metric is calculated with native English speakers in mind, while the average student of ISPA has Portuguese as their main language. Therefore, if AOA indicates high complexity for a native speaker, it is highly likely that the texts will be even more complex for a non-native speaker.

**Familiarity for Content Words** (FCW) is a rating that aims to rate how familiar the word of a text is to the reader. Coh-Metrix explains that FWC works with “Raters for familiarity provided ratings using a 7-point scale, with 1 being assigned to words that they had never seen and 7 to words that they had seen very often (nearly every day). The ratings were multiplied by 100 and rounded to integers.”

It is important to point out the ratings are calculated for adult readers, while the target-audience for our *corpus* is composed of second-grade students, usually aged from seven to eight years. Thus, similarly to the conclusions that can be drawn from AOA, if FCW indicates high complexity for an adult, it will most likely indicate higher complexity for a child.

The **Flesch Reading Ease** (FRE), as the name suggests, tests the readability of a text taking word and sentence length into account. Coh-Metrix guidelines explain that “The output of the Flesch Reading Ease formula is a number from 0 to 100, with a higher score indicating easier reading.” FRE was firstly developed as part of a duo of formulas, one to calculate reading ease, and another to estimate the school levels that would be ideal for someone to understand a text. Nowadays, most NLP tools merge both formulas and provide us with a number that can classify the texts for both criteria. Figure 2 below organizes the values of FRE according to their indication of complexity:

**Figure 2** – FRE levels and interpretations

Index	Scholastic level (USA)	Scholastic level	How to interpret the score
100 – 90	Fifth grade	Elementary school	Easy to understand for an eleven-year-old child
90 – 80	Sixth degree	Middle school	Easy to read, on par with a conversation
80 – 70	Seventh grade	Middle school	Fairly simple
70 – 60	Eighth and ninth degree	High school	Easy to understand for 13-15 year olds
60 – 50	Tenth to twelfth grade	High school	Fairly difficult
50 – 30	College	University	Difficult
30 – 10	College (upon graduation)	Graduate or Post-graduate	Very difficult
10 – 10	Professional	Graduate or Post-graduate	Extremely difficult

Source: Messina (2022, p. 1)

To make our research more comprehensive, we also adopted another NLP tool, which we present in the following section.

## 4.2 READABILITY FORMULAS - SOFTWARE

ReadabilityFormulas.com (Henceforth, RF; Figure 3) is a free website that presents calculators for text complexity analyses and instructions on readability formulas and writing tips to make texts more accessible. The page was first developed in 2003 and supplies tools and resources to: I. estimate complexity; II. observe the grade level necessary for understanding texts, and III. calculate the age group to which a material would be indicated.

**Figure 3** - Readability Formulas main page

**Readability Formulas**  
Free readability tools to check for Reading Levels, Reading Assessment, and Reading Grade Levels.

Monday, November 14, 2022 | [What's New?](#) | [Automatic Readability Checker](#) | [About Readability Formulas](#) | [Contact Us](#)

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• Are your documents too hard to read?  
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Welcome to [ReadabilityFormulas.com](#), a free website to help you: **1)** score your texts (documents, books, policies, technical materials, etc.) and **2)** find the reading level and grade level that readers need to read and comprehend your text.

Our [Automatic Readability Checker](#) will analyze your text and calculate the number of sentences, words, syllables, and characters in your sample. Our program takes the output of these numbers and plugs them into seven popular readability formulas. These readability formulas will yield the reading level and grade level of your text and help you determine if your audience can read your materials.

Source: ReadabilityFormulas.com

Because the website offers access to seven text complexity index calculators in one tool, pieces of research that propose extensive analyses of TC can be extensively supported by it – especially due to the user-friendliness of the page that not only provides the calculators (which are NLP tools), but also presents accessible information about the indexes and their indicators.

The formulas presented on RF include: The Flesch Reading Ease formula, The Flesch-Kincaid Grade Level, Gunning FOG, SMOG Index, Coleman-Liau Index, Automated Readability Index, and Linsear Write Formula.

By copying and pasting a text into the automatic readability checker on the webpage (Figure 4), the software shows a summary of the above-mentioned indexes.

**Figure 4** - Readability checker tool



Paste a sample of plain text in the box. Your sample can be between 150-3000 words. We do not store or reuse your text in any way.

Security check - Are you human?  Yes. (Click the box)

Source: ReadabilityFormulas.com

The results display not only the numerical index (as shown in Figure 5 below), but also a brief explanation of each index (which are explained in detail on their readability formulas sections).

**Figure 5** - Example of results from the Readability Checker

**Your Results:**

Your text: My grandfather was a great storyteller. He would s... ([show all text](#))

---

**Flesch Reading Ease score: 80.8** (text scale)  
 Flesch Reading Ease scored your text: **easy to read.**  
 [1] [a.] [L]

---

**Gunning Fog: 9.6** (text scale)  
 Gunning Fog scored your text: **fairly easy to read.**  
 [1] [a.] [L]

---

**Flesch-Kincaid Grade Level: 7**  
 Grade level: **Seventh Grade.**  
 [1] [a.] [L]

---

**The Coleman-Liau Index: 5**  
 Grade level: **Fifth Grade**  
 [1] [a.] [L]

---

**The SMOG Index: 5.4**  
 Grade level: **Fifth Grade**  
 [1] [a.] [L]

---

**Automated Readability Index: 7.2**  
 Grade level: **11-13 yrs. old (Sixth and Seventh graders)**  
 [1] [a.] [L]

---

**Linsear Write Formula : 10.9**  
 Grade level: **Eleventh Grade.**  
 [1] [a.] [L]

Source: ReadabilityFormulas.com

Although the six formulas mentioned above are the main ones provided on their primary readability checker, the webpage also presents calculators for other readability

formulas<sup>11</sup> (more specifically, for readability related to school grade), such as Fry Graph, Raygor Estimate Graph, Spache Formula, and the New Dale-Chall Formula.

We have chosen RF because it gathers the most well-known readability formulas, and because we wanted to present to our readers a tool that can be easily used for the purpose of calculating text complexity (therefore, allowing replication of our research).

In the following section, we present the formulas we have chosen for the purposes of our research.

#### **4.2.1 Readability Formulas - RF Indexes**

In this section, we explain the readability formulas adopted for our research. As previously explained, most indexes presented in section 4.1.1 (“Coh-Metrix indexes”) are textual ones that can be used for TC analysis, but they are not strictly readability formulas. On the other hand, the RF indexes that we present in this section are specifically readability formulas which help estimate complexity using different criteria, as we explain next.

**I. Gunning Fog:** The Gunning Fog Index (FOG) was developed in 1952 by Robert Gunning, a former educational books publisher. FOG estimates the school level a reader needs to have in order to fully understand a text. Once Robert Gunning was an editor of an educational publishing house, one of his tasks was adapting texts to make it more appropriate for each school grade. Based on his experience, he realized that long sentences and words are usually difficult to process.

Once a substantial number of English words are monosyllabic, words that are not monosyllabic indicate a more advanced morphological knowledge which, in consequence, makes the processing and understanding of words more complex. Gunning names these non-monosyllabic words as ‘hard words’.

When a text is submitted into a FOG calculator, it results in a number that indicates the grade (according to the American Educational System) for which the text would be suitable, as shown in Table 3 below:

---

<sup>11</sup> Available on <https://readabilityformulas.com/free-readability-calculators.php>.

**Table 3 - FOG index indicators**

FOG INDEX	READING LEVEL BY GRADE
≤ 6	6 <sup>th</sup> grade
7	7 <sup>th</sup> grade
8	8 <sup>th</sup> grade
9	High school freshman
10	High school sophomore
11	High school junior
12	High school senior
13	College freshman
14	College sophomore
15	College junior
16	College senior
17+	College graduate

Source: Readability Formulas, adapted from Gunning (1952)

Gunning named his formula ‘Gunning FOG’ because he passionately believed that daily texts were usually full of “fog” and unnecessary words (for aesthetic reasons), and these words would affect the size of the text and, in consequence, cloud the readers’ understanding of the messages.

Although FOG is often adopted to estimate complexity, it has limits. We cannot affirm that every non-monosyllabic word is complex. The words ‘problem’ and ‘family’, for instance, are two and three syllables long, but they are part of most English native speakers’ vocabulary since an early age. Therefore, when taking FOG into consideration, it is always essential to cross the results with other indexes to ensure a more efficient interpretation.

**II. Coleman Liau:** The Coleman Liau Index (CLI) is a readability test developed by Meri Coleman and T. L. Liau to estimate the complexity of texts. Similar to other readability tests, the output of this index gives an estimation of the American school grade thought to be necessary to understand a text.

The formula was designed taking into consideration the number of characters of words (unlike other formulas that use syllables). The reason for choosing characters instead of syllables is because when the formula was developed, it was easier for NLP software to calculate characters instead of syllables (making the calculation more reliable). According to Coleman and Liau (1975, p. 283),

Existing computer programs that measure readability are based largely upon subroutines which estimate the number of syllables, usually by counting vowels. The shortcoming in estimating syllables is that it necessitates keypunching the prose into the computer. There is no need to estimate syllables since word length in letters is a better predictor of readability than word length in syllables.

According to the authors, since readability formulas started being developed, Computer Science has evolved. CLI, then, proposes a method that would facilitate the use of NLP programs to estimate complexity (or, in the words of the authors, “an economical method for measuring readability”, p. 283).

**III. SMOG:** SMOG was created in 1969 by G. Harry McLaughlin, an editor of a newspaper in London and scholar of Applied Psychology, and the formula estimates the years of formal education someone needs to understand a text (similar to the ones presented before). McLaughlin developed his formula as an improvement of readability indexes that had been designed with the objective of offering a simpler form of calculating readability.

The formula focuses on polysyllabic words, and it was firstly designed to calculate texts with over thirty sentences (although, current calculators present adapted alternatives). SMOG counts the number of sentences and the number of polysyllabic words in each of them estimates the grade level that is needed to comprehend a text, as shown in Figure 6 below:

Figure 6 - SMOG indicators

SMOG Conversion Table	
Total Polysyllabic Word Count	Approximate Grade Level (+1.5 Grades)
1 - 6	5
7 - 12	6
13 - 20	7
21 - 30	8
31 - 42	9
43 - 56	10
57 - 72	11
73 - 90	12
91 - 110	13
111 - 132	14
133 - 156	15
157 - 182	16
183 - 210	17
211 - 240	18

Source: (Readability Formulas<sup>12</sup>)

SMOG has been widely peer-reviewed and it is frequently used as a reliable text complexity estimator, especially in the healthcare sector. One of the main reasons why SMOG is often adopted is the fact that, as stated by McLaughlin (1967), the formula was tested

<sup>12</sup> Retrieved from < <https://readabilityformulas.com/smog-readability-formula.php>> Accessed on November 14<sup>th</sup>, 2022.

through a 100% correct-score criterion (whereas other readability indexes usually test for about 50% to 75%).

**IV. Dale-Chall:** Dale-Chall was created in 1948 by Edgar Dale and Jeanne Chall – both well-known American scholars (Dale, a professor of Education at Ohio University, and Chall, founder of Harvard Reading Laboratory).

Unlike other readability formulas, Dale-Chall estimates complexity by cross-examining the word presented in a text with a list of common familiar words that a fourth-grade student understands. Its original version calculated text complexity using a list of 763 words; however, in 1995 the formula was revisited, and now most NLP software use the newest version supported by a list of over three thousand words (CHALL, 1995). The results presented by the Dale-Chall formula can be interpreted as shown in Table 4 below:

**Table 4 - Dale-Chall indicators**

<b>DALE-CHALL SCORE</b>	<b>NOTES</b>
4.9 or lower	easily understood by an average 4th-grade student or lower
5.0 – 5.9	easily understood by an average 5th or 6th-grade student
6.0 – 6.9	easily understood by an average 7th or 8th-grade student
7.0 – 7.9	easily understood by an average 9th or 10th-grade student
8.0 – 8.9	easily understood by an average 11th or 12th-grade student
9.0 – 9.9	easily understood by an average 13th to 15th-grade (college) student

Source: Readability Formulas, adapted from Chall (1995)

It is important to note that the indexes from Coh-Metrix and RF estimate text complexity for native speakers. If they indicate high complexity for a native speaker, it is possible to assume that they are even more difficult for non-native speakers. Furthermore, when using readability formulas, it is interesting to use more than one index to cross-examine the results and produce a fairer analysis.

In Chapter 5 we will attach the results obtained from the tools and comment on the findings.

## 5 ANALYSIS

We start our analysis with the readability indexes presented in section 4.2.1 ('RF Indexes'). The table below (Table 5) displays the results of the selected textual metrics of our *corpus*.

**Table 5** – Results of the textual metrics

	UNIT 1	UNIT 2	UNIT 3	UNIT 4
Gunning Fog	6.94	11.76	10.34	9.73
Coleman Liau	5.04	6.88	11.08	5.65
SMOG	7.14	10.42	10.75	8.20
Dale-Chall	5.6	6	6.8	5.7

Source: the author

Once the Gunning Fog (FOG) results can be interpreted as grade levels, it is possible to observe that the texts of our *corpus* are classified by this index as being appropriate for sixth grade and up. Unit 1, for instance, has a FOG result that classifies it as a text that can be understood for someone who has almost concluded sixth grade. Units 2, 3, and 4, on the other hand, have results of FOG that are much higher, being considered appropriate for the end of eleventh grade, middle of tenth grade, and end of ninth grade, respectively. Once our *corpus* is meant for second graders, FOG suggests that the texts are potentially complex for our target audience, especially considering that the students are non-native speakers.

An example of why the texts would be more fit for sixth grade and up is the following excerpt from Unit 1, which reads “To set up your board, will you please draw a line down the middle, and write the word *beach* at the top on one side, and *head* on the other?” In this one phrase, the students are asked to perform over four extremely specific tasks. 1. They are setting up their whiteboards, 2. they need to draw a line, and it needs to be a vertical line, and it needs to be in the middle (a three-step direction), 3. they need to write a word, and it needs to be at the top on one side, and 4. they need to write another word on the other side. There are so many different steps being asked from our audience of seven to eight-year-olds. And this example is from the lowest ranked unit in difficulty.

The Coleman Liau index – which can also be interpreted as classifying complexity according to grade levels – shows results that are very similar to the Gunning Fog levels in the sense that they confirm that Unit 1 is the easiest out of the four units (however still beyond our target-audience’s expected level of comprehension), with Units 2 and 3 being the toughest. Be that as it may, this index shows that Units 1 and 4 would be appropriate for students of the fifth grade, and Unit 3 received a mark as high as eleventh grade. It would be

difficult to convey any of these lessons as appropriate for the levels of our audience, a second-grade group composed of mostly - if not all - ELLs.

Since the Coleman Liau index calculates the level based on the number of characters a word has, rather than the syllables, it is understandable why Unit 3 has received such a high mark. It presents to the students words such as “researchers,” “silently,” and “rereading.” Many words contain affixes, some contain both prefixes and suffixes. To understand this lesson, students are required to know not only the root words, but also the meaning of several different affixes. Students start to understand morphological cues early on when learning a language, but learning about affixes is not a standard until Grade 3 in the United States. (COOK, 2016). How can we expect a second-grade ELL to be at the same level as a native speaker in third grade?

The SMOG indicators show appropriateness for sixth graders on all units. As mentioned before, SMOG calculates the number of polysyllabic words in a given text. Words such as “especially,” from Unit 3, which contain four syllables, are probably what contributed to ranking the lessons appropriate for four grades above that of our target audience. Based on their rankings, it is possible to assume that children in second grade would benefit from the use of shorter words and shorter sentences in instruction.

The Dale Chall index results were also considered indicators of high complexity for our students. Having in mind that this index is based on words a native-speaker of English in fourth grade likely understands, we can explore the following snippet from Unit 2 to understand the results: “Yesterday, you learned that if you are reading along and everything is going smoothly and then - whoa - you get stuck on a word, you have keys to try unlocking it.” Aside from using a metaphor, which stirs away from concreteness, it is longer than it needs to be. The teacher could say “you are reading” instead of “you are reading along” and “everything is fine” instead of “everything is going smoothly” and still convey the same meaning as in the original text. One of the strategies frequently suggested by scholars of TC, TS, and TA is the removal of any unnecessary words (PLAIN, 2004; SILVA, 2018).

While there are mixed results when it comes to grade level appropriateness, **all indexes**<sup>13</sup> indicate that the instructional texts on the lessons from Heinemann’s Units of Study are seen as high in complexity for our target-audience, with some levels reaching high schooler levels. It is extremely important to keep in mind that these indexes were created with

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<sup>13</sup> Our highlight.

native speakers in mind. So, if they indicate high complexity for native speakers, it is possible to conclude the complexity is even higher for ELLs.

To further our analysis, we present a table (Table 6) with the results of the indexes obtained from running the *corpus* through Coh-Metrix. It is important to remember that most of the indexes collected with the support of Coh-Metrix are not specific for testing readability, but can be used for this purpose. Therefore, we have decided to start our analysis with the readability formulas (presented above) and narrow the interpretation of complexity to metrics that can be used to make more specific conclusions on how easy or difficult a text (or levels of the text) is.

**Table 6 – Results of the readability metrics**

	<b>NT</b>	<b>WCP</b>	<b>TTR</b>	<b>AOA</b>	<b>FCW</b>	<b>FRE</b>
Unit 1	77.040	53.980	0.380	276.958	586.873	90.902
Unit 2	98.260	88.880	0.251	275.300	584.325	71.582
Unit 3	71.230	51.200	0.315	335.043	582.889	61.235
Unit 4	89.970	79.390	0.328	351.150	578.158	82.623

Source: the author

The results were compared to the reference table provided by Coh-Metrix as follows (Table 7). The numbers are divided among the grade levels the scholars judged appropriate, starting from K, meaning Kindergarten, all the way to eleventh grade.

**Table 7 – Coh-Metrix Reference Table**

	<b>K- 1</b>		<b>2-3</b>		<b>4-5</b>		<b>6-7</b>		<b>8-9</b>		<b>10-11</b>	
	MEAN	SD <sup>14</sup>	MEAN	SD	MEAN	SD	MEAN	SD	MEAN	SD	MEAN	SD
NT	88.17	10.28	83.84	13.57	72.19	21.75	64.11	22.02	58.45	21.30	41.64	21.47
WCP	55.74	27.50	66.44	24.68	71.99	26.87	74.25	24.35	70.56	25.40	59.45	29.01
TTR	0.62	0.11	0.73	0.07	0.77	0.07	0.81	0.06	0.82	0.06	0.82	0.07
AOA	256.83	26.21	273.22	24.08	288.26	27.70	309.53	29.47	325.36	30.10	356.05	34.86
FCW	583.86	6.24	578.78	8.41	576.09	7.96	571.92	8.36	570.10	8.35	564.82	9.00
FRE	95.49	3.85	87.91	3.89	80.50	5.29	70.20	5.87	62.29	7.79	51.09	9.25

Source: cohmetrix.com

<sup>14</sup> Standard deviation.



When comparing the narrativity percentile (NT) to the references we found that the NT all are appropriate for second grade students (highly similar to narratives). The results indicate that the texts have logics that are easy for our target-audience to follow. The NT values indicate that our readers should be comfortable identifying the subjects of the narratives, the actions, and the logical development. However, NT is just a syntax analysis. It may have a narrative-like structure, but the lexicon – based on our experience – is highly complex. It is also fundamental to highlight that even though the NT results indicate low complexity, the results are calculated having a native speaker as reference; therefore, it is still possible that for some instances, the NT results do not represent low complexity for our target readers. Hence, it is valid to check other indexes to have a more accurate analysis.

Unit 1, from where we extracted the following passage, had the second lowest NT: “We know that some vowels go together in words and make sounds, usually making the sound of the name of the first vowel. Those are vowel teams. When I was little, my second-grade teacher taught me, “When two vowels go a-walkin’, the first one does the talkin’.” The instructions are to teach the phonetic scheme in the first sentence, then name the spelling pattern in the second sentence, then circle back and teach about the sound in a different form.

When analyzing the Word Concreteness Percentile (WCP), we found that Units 1 and 3 have an average concreteness of words – indicating that almost half of the text is made up of abstract words, which are more complex because they are not easy to relate to the concrete world. However, Units 2 and 4 show a text with a high presence of concrete words. Here, the difficulty for students would be to know how to relate signifiers and meaning in a foreign language, but the relationship between signifier-meaning does not tend to be complex, because texts are highly composed of words with concrete references in the real world.

Besides looking at concreteness word by word, we also notice there are metaphors present in the lessons. In Unit 4, for example, the author uses “he wrote them with his voice.” to say that her grandfather was a good storyteller. Although “voice” is a concrete noun, something we can hear, it is being used here as a metaphor, since people cannot literally write with their voices.

Another indication worth noting in our *corpus* is the lack of logical coherence in terms of complexity maintenance; it is assumed that texts should increase in complexity with the passage of units (since, in theory, students' vocabulary tends to increase with the passage of lessons). The values should be lower in the initial units and progressively increase (which does not happen). Our values show around 54 WCP in Unit 1, then 89 WCP in Unit 2, dropping again in Unit 3 to 51 WCP, and going up to 79 WCP in Unit 4.

For the lexical diversity, the Type-Token Ratio (TTR), units 1, 3 and 4 show medium complexity estimated by lexical variety, while unit 2, low complexity. The numbers indicate that units 1, 3 and 4 can be potentially complex for our audience, i.e., the texts have a considerable variety of words for our type of student (a fact that requires greater lexical knowledge). The results obtained from Coh-Metrix can be analyzed taking into consideration Silva's (2018) classification of TT values in terms of complexity, as shown in Table 8 below:

**Table 8** – Complexity classification by TT

TT	COMPLEXITY CLASSIFICATION
0.0 – 0.1	Very low
0.1 – 0.3	Low
0.3 – 0.5	Medium
0.5 – 0.7	High
0.7 – 1.0	Very high

Source: Translated from Silva (2018, p. 144)

The value of TTR for Unit 1, for instance, is 0.380, which suggests, according to Silva's (2018) classification that it is medium for a native English speaker. The TTR value for the other texts (0.251, 0.315, and 0,328 respectively) would classify them as having low complexity in terms of lexical variety. However, it is important to bear in mind that even if a text presents a highly controlled vocabulary (in terms of diversity), the words may be complex. An academic article, for instance, has the tendency of repeating several words; but it is commonly known that academic texts are usually complex. A narrative, on the other hand, usually has a greater vocabulary range (to maintain and evolve the stories), but they are usually composed with much simpler words. Thus, once mentioned before, it is always essential to consider multiple indexes for each textual feature of the texts to be analyzed (reason why, for lexicon, we have also chosen AOA and FCW).

To have a more detailed view on lexicon – which, according to our experience is the text level that potentializes the complexity of our *corpus* – we have decided to observe the Age of Acquisition (AOA) and the Familiarity of Content Words (FCW) values in contrast; especially because the indication of these indexes is complementary.

Once neither of these two indexes (AOA and FCW) are used in published literature on TC analysis with classifications of their values as indicators of complexity, our approach to analyze the values was creating a *tertio comparationis* (which means composing fragments of texts whose index values can be used to compare with the results from our *corpus*). Thus, the following table (Table 9) shows three small texts that we composed to collect the values of

AOA and FCW and check if the values of our *corpus* for these indexes are similar to the easiest text (text 1), to the text with medium complexity (text 2) or to the one with high complexity in terms of vocabulary (text 3):

**Table 9** – Tertio comparationis for AOC and FCW analysis

	<b>TEXT 1</b>	<b>TEXT 2</b>	<b>TEXT 3</b>
	I am happy. My mom is beautiful. My dad is nice. My dog is big.	I am thrilled. My mother looks stunning. My father is kind. My dog is huge.	I have been beside myself. My mother's image is ravishing. My father behaves amiably. The Border Collie I own is hefty.
AOA:	147	235	280
FCW:	614	591	589

Source: the author

As we can see from the results of the texts presented in Table 9 above, the values of AOA increase with the complexity of the vocabulary (Text 1, with the simplest vocabulary, presents a result of AOA much lower than the results of Text 2 and Text 3). For the FCW, it is the opposite: the lower the value, the higher the complexity.

Our results indicate that units 1 and 3 have an average complexity of AOA, once the values of this index for this text are closer to texts 1 and 2 from our *tertio comparationis*, and unit 4 a high complexity, once its AOA is closer to text 3.

The FCW suggests that all units have a low complexity, once all of them present values closer to text 1 from our comparative sample.

As we reach the final considerations portion of this study, we will evaluate the process with which we conducted the study, as well as the hardships faced during the process. We will reflect on what these results mean for the teachers and students of the second grade at ISPA. Finally, we will consider what can be done as a result of this study.

## 6 FINAL CONSIDERATIONS

Overall, the purpose of this paper is to celebrate language learning in all its stages, and to provide educators with information that will help them guide their language learning students to success.

What sparked our interest in this topic was the difficulties the teachers and students were facing during the instructional portion of the lessons from Heinemann's Units of Study. The mini lessons tend to take longer than the proposed fifteen minutes due to the repeated pauses the teachers need to make to explain vocabulary and the metaphors used in the lessons. We noticed the only student who could understand what was being said enough to explain it to someone else was a native speaker of English and an avid reader, a highly skilled student. After hearing that other teachers were facing the same problem, we started researching to verify if the content in the Units of Study were designed for native English speakers.

Since Heinemann offers a separate book that provides some insight to scaffolding in a classroom with ELL, we can assume the mainstream materials are created for native speakers, although none of them actually state that. It is important to observe that textbooks meant for language teaching should take into consideration the students' first languages; once their first language highly influences their learning process of a second one (PAJAK *et al.*, 2016). Without this observation, both the educators and the students using this material may encounter barriers. Our guiding questions were formulated based on this.

Revisiting our first question, which is "Are the Units of Study potentially complex to our target reader?," we were able to identify levels of complexity as great as High School levels. Being that our target reader is a language learner in second grade of Elementary School, it is possible to conclude that the Units of Study are, in fact, potentially complex for our target reader. An example of a metric that indicated our *corpus* from Units of Study as appropriate for tenth and eleventh grade is the Gunning Fog, which estimates the school level necessary to comprehend a text.

As for our second question, "Which textual features indicate potential complexity?," we found that all of the textual features analyzed were potentially complex for our readers, some of them being considered too complex even for native English speakers of the second grade level. For example, the SMOG metrics, which measure how much formal education someone needs to comprehend a text, all appear to be appropriate for native English speakers in sixth grade.

We were also able to answer our third question, which is “Among the selected metrics, are the ones related to lexicon the main disruptors of comprehension?.” The study showed that they are, indeed, since the syntax analysis of narrativity percentile proved to be less problematic than the lexical type-token ratio, for example. Other lexical metrics, such as the analysis of word concreteness and the Coleman Liau formula, have also given us evidence of the incoherence among units.

We were guided by the following aims: to understand what Text Complexity is; to evaluate how Text Simplification can be helpful to English Language Learners; to analyze the difficulty in the text used in the Heinemann Program for second grade; and to present ideas for how the Heinemann Program lessons can be simplified. With a basis on theoretical papers, in Chapter 2 we highlighted that TC considers how a text can be perceived by a particular reader. Also in Chapter 2, we understood that TS can help situate the ELL with what is being taught in the classroom. Chapter 4 presented the metrics we used to analyze the complexity in the text, while Chapter 5 displayed evidence that the texts are potentially complex for our audience.

As far as presenting ideas to how TS strategies can be applied to the Units of Study, we believe that this theme would be a suitable one for a research paper for a master’s dissertation. Our metrics encourage educators to believe that there is room for the application of TS strategies. One feasible strategy is to raise the concreteness level of the texts, both in a lexical and a semantic sense, by decreasing the number of the metaphors. As we pointed out in the Dale Chall results analysis, extra words could be removed to shorten sentences while still communicating the same message to the students.

Although we were able to thoroughly examine the guiding questions and most of the aims of this paper, this study was not without limitations. The first challenge we faced was the fact that the metrics, regardless of how researchers apply them (for instance, TC analysis, automatic translation, etc.) are all destined for native English speakers. Therefore, once our audience is mainly composed of non-native speakers, the estimation would be more efficient if we tested their indication with real readers - which we intend to do in the future. Due to time constraints related to how long it takes to get approval from the Ethics Committee, the applied part was not a possibility for this study. As a future investigation, scholars could visit the question “How can we make Heinemann’s Units of Study accessible to ELL?” and test applied simplification strategies on real readers.

Thirdly, we faced a lack of theoretical papers on the subjects of TC, TS, and TA, especially applied ones and studies that take into account ELL. This is a Linguistics field that

is still developing, so there are not many published research papers yet. On a more positive note, there is room for more research to be conducted in the field, which inspires us to keep studying these subjects. Interest in bilingualism is also growing. Recent statistics show exponential growth in the number of bilingual schools in Brazil (“Mercado de escolas bilíngues cresce exponencialmente no Brasil”, 2022). With a lack of experienced bilingual professionals in the area, there is growth opportunity in the job market. This study has the potential to help bilingual educators in Brazil and in other countries where Units of Study is being used.

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