Original articles

Lexical quality measures in the assessment of reading proficiency in Brazilian university students

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ABSTRACT

Purpose: to assess the reading ability of university students using tasks to measure Lexical Quality (LQ) and evaluate the influence of socioeconomic status (SES) on both the reading performance and the components of Lexical Quality (LQ).

Methods: 44 students from two federal universities took online linguistic tests, 19 from the Federal University of the Great ABC Region (UFABC) and 25 from the Federal University of Ceará (UFC), Brazil. Two-ranked Mann-Whitney (Wilcoxon rank-sum test) and Pearson's Correlation tests at p<0,05 were applied to analyze the data.

Results: high and medium correlations were obtained among the different components of LQ, such as vocabulary and spelling recognition. In addition, significant differences were found between the performances of the two universities' students and their distinct socioeconomic levels.

Conclusion: shorter reading times were correlated to higher accuracy in the Test of Word Reading Efficiency for Adults. The number of correct answers in the homonym test was correlated to the higher accuracy of the Test of Word Reading Efficiency for Adults, and both were correlated to the reaction time measures of these tests. The influence of socioeconomic status on reading performance and Lexical Quality components tasks was also found.

Keywords: Reading; Higher Education; Young Adult; Literacy

INTRODUCTION

Reading and writing have played an essential role in the history and development of humanity in its various fields of practice and learning, as through them, it has been possible to record, retrieve, accumulate, enjoy, and spread knowledge. As a cognitive resource, reading provides broader access to knowledge, work, and social integration. Consequently, it is a basic form of socialization for human beings, thus, when reading fails, it inflicts a heavy toll on society[1].

According to the World Literacy Foundation (2022)[2], illiteracy and low reading proficiency cost the global economy around 1.19 trillion annually, or 2% of the Gross Domestic Product (GDP) of developed countries, 1.5% of emerging countries, and 0.5% of developing countries in direct costs alone. Rastle[1] reports that the indirect costs are likely even higher since literacy gaps prevent people from clearly understanding hygiene, food, and safety information. The author also explains that low literacy is the most significant contributor to social inequality, further burdening the state with social security expenditures, health, and public safety. It is primarily responsible for keeping a large number of people dependent on welfare policies. Therefore, discussing proficiency in reading skills is more than discussing education, i.e., it is an economic program issue.

Entering the literate world is a multifaceted challenge. Research indicates that interaction with schooling institutions and the uses of writing are related to the quality of literacy[3]. In the Brazilian context, we see low performance in reading comprehension assessments in all grades, from elementary to secondary school. According to the Basic Education Assessment System (SAEB), performance in Portuguese has stagnated or evolved slowly over the last 10 years. It has fallen in all school grades over the previous two publications. The score goes from 0 to 500, and from 2019 to 2021, the score for the 5th grade dropped from 215 to 206; for the 9th grade, it fell from 260 to 258; and in high school, it lowered from 278 to 275[4].

Another indicator of reading proficiency, the Functional Illiteracy Indicator (INAF, 2018)[5], classifies proficiency in reading and comprehension into three categories and five levels. The first category includes Functional Illiteracy with the absence of reading skills (Illiterate level) and basic reading skills at the Rudimentary level. The second category has only one level, defined as Elementary, comprising the ability to read short texts and make some inferences. The third

level, called Consolidated Literacy, is subdivided into two levels: the Intermediate level, characterized by the ability to spot information expressed literally and make inferences in texts of different levels, and the Proficient level, with complete reading skills. According to the INAF data, in 2018, in the Northeast, only 68% of university students were in the Consolidated Literacy or Proficiency in the Portuguese Language categories; this percentage is 70% in the Southeast. According to the INAF 2018 evaluation, only 52% of the secondary education students in the Southeast region fell in Consolidated Literacy, dropping to 35% in the Northeast region. These indicators suggest that many high school students' reading skills are insufficient. As they are the same students who will join the university, it can be inferred that many low-skilled readers are to be admitted to the university.

Da Silva and Novais[6] measured the reading fluency of university adults in the Psychology course at the Pontifical Catholic University of São Paulo (PUC-SP) in 2022. The study showed that a significant number of students had a reading automaticity rate below the expectation for their level of education. In 2016, Aniceto et al.[7] conducted studies on the reading comprehension ability of college students from various universities in Paraíba, Brazil, and concluded that reading proficiency was low in the group studied. Therefore, it is crucial to assess the reading skills of university students to address this issue better. That can be achieved by evaluating adults' essential reading skills to perform proficient reading from the Lexical Quality Hypothesis (LQH) perspective.

Within the scope of the LQH of reading, Lexical Quality (LQ) is postulated as the quality of the representation of the word in the mental lexicon[8,9]. A high LQ precisely delineates the linguistic features of the word being read: orthographic, phonological, morphosyntactic, and semantic. The highly skilled reader understands that the word has an identity based on the components that define it: the linguistic form, which includes phonology and morphosyntax; the orthographic form, which involves the structure of the word; and the conceptual form, applying semantics and the context of use[8-11]. That's how the word's identity in the mental lexicon is established, as an interaction between the precise components, but with redundant interaction to account for orthographic and phonological overlaps (homographs and homophones, for example). Furthermore, according to Perfetti, any failure in the representation or interaction of the word's components

represents a threat to the lexical quality and retrieval of the word[8-11].

Perfetti[11], through LQH, refers to the causal role of lexical knowledge in reading, implying individual differences in the speed and efficiency of word retrieval. Low LQ, in contrast to high quality, results from a non-synchronous relationship between the three components (linguistic, orthographic, and conceptual). A failure in the readiness and/or recovery of one of them impacts the process of recovering the identity of the word in a reader's memory. This event leads to less fluency in reading at the word level, requiring more processing time and the commitment of additional cognitive resources. Thus, low LQ might lead to less availability of resources for sentence-level processing in word integration and contextual comprehension.

The LQ has also been assessed using different cognitive skills, such as word recognition, vocabulary assessment, reading and comprehension, and pseudo-words reading aloud[12]. In addition to evaluating the components of the LQ, more subjective proficiency measures can be applied. The author Recognition Test presents students with a 100-name list, from which they should discriminate authors' names. Scores are computed by subtracting the number of incorrect answers from correct ones. The task aims to gauge the individual's exposure to the written word[13].

Andrews and colleagues[12-17] assessed individual differences in language processing using various proficiency measures. Throughout their published work, Andrews et al. sought a way to assess the core characteristics of Lexical Quality. The construct is vital because fast and precise word identification through visual word recognition requires the reader to extract the word's most relevant features by employing perceptual input and vision. These features allow the reader to retrieve the read word among the existing lexical representation in the reader's mental lexicon.

Andrews et al.[18] point out that tests combining spelling dictation and orthographic recognition, applied together with tests that assess lexical proficiency, such as vocabulary reading comprehension, among other tasks, show that the readiness in spelling recognition can predict this unique variation[12-20]. The authors emphasize that there is accumulated evidence that measures of lexical proficiency predict systematic variation in adult reading performance due to individual differences acquired in literacy and consolidated through reading experience.

The motivation for the present study was the need to produce an efficient assessment that captures the essential reading abilities of Brazilian adults. The instruments available in Portuguese for this population are scarce, and they are often not sensitive to differentiating reading performance among adult readers or are aimed at distinguishing clinical groups, such as dyslexia. Among the tests published in Brazil for the adult population are RAN (rapid automatized naming)[21], which evaluates lexical access, and Test of Word Reading Efficiency for Adults (TCLP-2)[22], which assesses word recognition.

Therefore, the present study aimed to assess the reading ability of university students using tasks to measure Lexical Quality (LQ) and evaluate the influence of socioeconomic status (SES) on both the reading performance and the components of Lexical Quality (LQ).

METHODS

The Federal University of the Great ABC Ethics Committee, Brazil, issued a favorable opinion letter numbered 5.073.251 and a certified statement (CAAE) under number 44406721.6.1001.5594 in compliance with the National Health Board's administrative resolution 466/2012. All participants signed an informed consent form that was recommended for research with human beings.

For English, Andrews used form H of the Nelson Denny Test (NDT) to assess reading comprehension and vocabulary for the lexical quality construct[12]. The NDT consists of 80 vocabulary questions, where the participant is to choose from 5 alternatives, which can be synonyms/antonyms or the definition of the word that best matches a word presented. It also has a reading comprehension section, where 38 comprehension questions are asked based on 7 short texts on various subjects. This test also assessed the participants' reading speed in 1 minute. They also used the Spelling Recognition Test, which comprised 88 words, half of which were misspelled. The participants had to identify the incorrect spellings.

Based on these validated instruments for the English language, similar tests were created for the Portuguese Language. These tests are not a validation of a new instrument or a translation of the English tests but rather an attempt to approach the LQ construct from the perspective of Brazilian Portuguese. The premises are the same, and validation is a future step.

Participants

The data were collected for 44 students at two federal universities (UF), 19 from the Federal University of the Great ABC Region (UFABC) and 25 from the Federal University of Ceará (UFC), Brazil. The UFABC sample encompassed mainly neuroscience undergraduates and was heterogeneous regarding the course terms. The UFC sample comprised sixth-term undergraduates from the English Language and Literature course. The mean age of the participants was 23.51 years (SD = 4.07), with 52.83% of the sample female. All participants reported Portuguese as their mother tongue.

LQH assessment instruments

Spelling Recognition Test (SRT) (devised by the research group): 4 words were shown in one attempt: 3 were misspelled, and 1 was correct. The participant had to choose the word with the correct spelling from the alternatives. There were 7 questions, and performance was assessed based on the correct answers and response time measures.

Homonym Test (HT) (devised by the research group): Gapped sentences were presented, and after reading, the participant had to indicate which, between two alternatives of homonymous words with different meanings, was the correct word, semantically and orthographically. There were 25 questions in total. Performance was assessed based on correct answers and response time measures.

Reading Comprehension Test (RCT) (passages collected by the research group from existing texts): The students were asked to read a few short texts from the genres studied in primary and secondary schools. These texts were presented to the reader for comprehension, followed by 1 comprehension question. There were 7 texts in total. Performance was assessed by scoring the correct answers and the average reading times for all the texts.

Test of Word Reading Efficiency for Adults (TWRE) (devised by the research group): A list of low-frequency words was presented, and they were instructed to read them aloud as quickly and correctly as possible. The 126-word- list was divided into 5 pages, each containing two columns. The task was recorded. Later, it was transcribed, and performance was assessed by scoring correct pronunciation and reading speed rate.

Brazil Criterion (BARC): This socioeconomic questionnaire was devised by the Brazilian Association of Research Companies. It ranks participants into social classes by yielding different scores. It comprises education, occupation of the Family Head, as well as income and living conditions.

Procedure

Due to the incidence of the COVID-19 pandemic during the data gathering period, contacts and data gathering were made remotely. Participants were contacted and recruited in two ways. Students made appointments with the researcher via WhatsApp or email. The participants went through the procedure following a controlled sequence of tasks: half of the participants started with the multiple-choice questions on the JsPsych platform and then continued with the word reading task via Google Meet, and the other half of the participants followed the reverse order. Although the tasks were easy to understand, throughout the assessment, an examiner remained available on WhatsApp to answer any questions that might have arisen during the task administering. All the participants completed all the lexical quality tasks and the socioeconomic questionnaire.

Inferential statistical tests were conducted on the data using the two-way Mann-Whitney (Wilcoxon rank-sum test) and Pearson's correlation tests. An open-source statistical analysis program (JASP) analyzed the data. The significance value used was 0,05.

Both score and reaction time data resulting from the LQ components' assessment were examined for normality, which showed a non-parametric distribution (Shapiro-Wilk; $p<0,001$); therefore, non-parametric comparisons were adopted.

RESULTS

The student sample was initially ranked according to their socioeconomic classes for each university (UFABC and UFC), whose outcome is displayed in Figure 1. The students in the sample were from socioeconomic grades A to C2; however, most students from both universities were placed in grade B2.
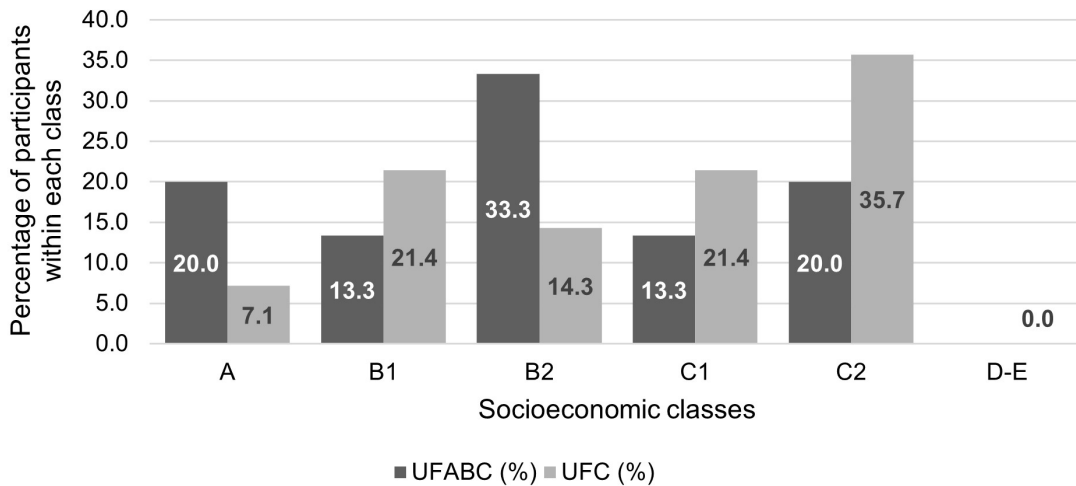
Captions: UFABC = Federal University of ABC; UFC = Federal University of Ceará

Figure 1. Relative frequency graph of economic class in relation to the participants' university. The socioeconomic classification was based on the 2019 Brazil criterion of the Brazilian Association of Research Companies (BARC).

The performance of students from both samples (UFC vs. UFABC) was compared for total scores (Correct) and reaction time measures (RT) in each of the tasks. The student groups showed statistically significant differences in some tests, especially concerning execution time measures. Federal University of Ceará students performed spelling and homonym recognition tasks in less time without impacting their level of accuracy. The score was statistically different only in the Reading and Comprehension task, with greater accuracy for the UFC group. All the means, medians, and standard deviations for each test are shown in Table 1.

Table 1. Descriptive Tests

Test	Group	Mean	Median	Standard Deviation	Mann-Whitney U	P	d*
SRT	UFC	5.52	6.00	1.81	235.50	0.97	-0.01
	UFABC	5.58	6.00	1.64			
SRT(rt)	UFC	10.63	8.89	8.51	326.50	**0.04**	0.38
	UFABC	7.08	6.36	3.52			
HT	UFC	20.36	21.00	2.84	256.50	0.66	0.08
	UFABC	20.26	20.00	2.28			
HT(rt)	UFC	7.50	7.24	2.87	319.50	**0.05**	0.35
	UFABC	5.83	6.29	1.57			
RCT	UFC	5.48	6.00	1.12	339.50	**0.01**	0.43
	UFABC	5.00	5.00	0.67			
RCT(rt)	UFC	62.95	63.11	18.5	204.50	0.44	-0.14
	UFABC	66.58	70.73	20.88			
TWREA	UFC	120.64	121.00	3.84	304.00	0.12	-0.02
	UFABC	118.00	120.00	5.52			
TWREA (rt)	UFC	146.96	145.00	27.29	231.50	0.90	0.28
	UFABC	149.37	152.00	35.23			

Captions: SRT = spelling recognition test; HT = homonym test; RCT = reading comprehension test; TWREA = reading words aloud test; rt = reaction time; UFABC = Federal University of ABC; UFC = Federal University of Ceará. The table shows the scores and reaction times for the evaluation of the components of Lexical Quality (QL), using descriptive and variance measures along with the test for comparing the performance of the UFABC and UFC groups.
*The Mann-Whitney effect size is calculated by the rank-biserial correlation.

Given the difference in performance, the groups were combined, and correlation analyses were carried out between the tasks to assess the relationship between the LQ component task. The results showed a negative correlation between reading rate and accuracy on the TWREA (r = -0.40; p < 0.01), which indicates that students whose reading rates were slower (longer time) also read less correctly (fewer correct answers).

A high correlation was found between valid scores on the HT and SRT tasks (r = 0.484; p < 0.001) and the response time measures for these tasks (r = 0.739; p < 0.001), indicating that effective and rapid recognition of spelling correlates with correct and rapid vocabulary evaluation. In addition, a correlation between HT and TWREA (r = 0.46; p < 0.01) suggests a relationship between correct vocabulary and spelling recognition.
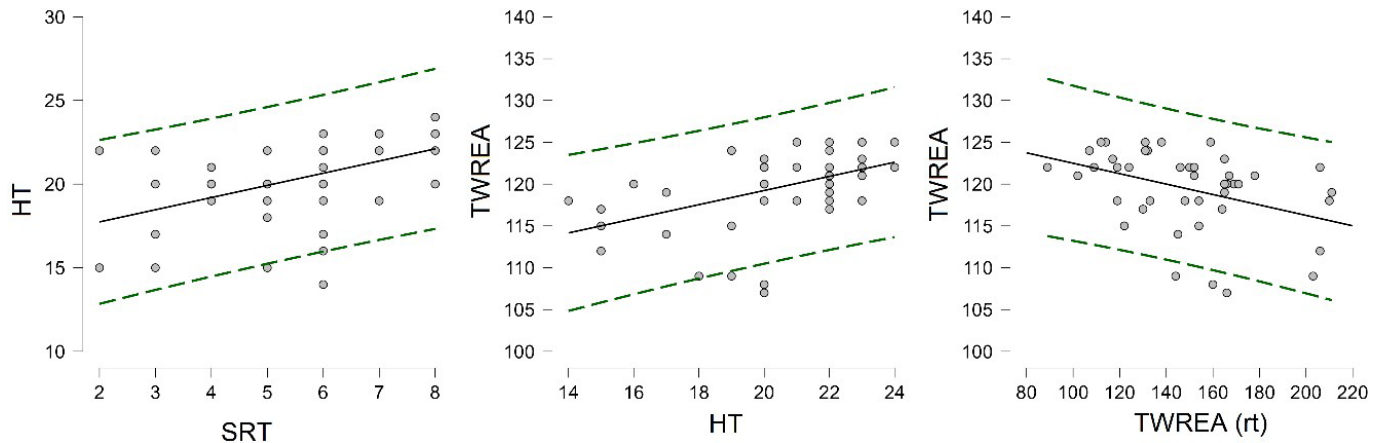

Captions: SRT= Spelling Recognition Test; HT = Homonym Test; TWREA = Test of Word Reading Efficiency for Adults; rt = reaction time measures.

Figure 2. Scatterplots of significant correlations, with prediction interval at the green dotted line. The figure on the left shows SRT and HT correlation; the figure in the middle shows HT x TWREA correlation; the figure on the right shows TWREA x TWREA (rt).

Furthermore, correct HT scores showed a moderate correlation (r = 0.415; p < 0.05) with socioeconomic status, indicating that readers with sound vocabulary knowledge belong to the upper classes. The same trend

was observed for the correlation of socioeconomic level and reaction time measures for RCT rt (r = 0.352), i.e., students with higher socioeconomic status tend to read a set of texts faster. The data are shown in Figure 3.
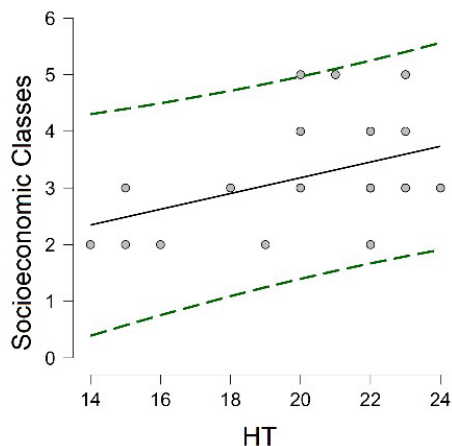
Caption: HT = Homonym Test

Figure 3. Scatterplot of homonym test and socioeconomic status significative correlations. 95% prediction intervals at the green dotted line. Only 29 students were counted in that correlation due to problems with filling out forms.

DISCUSSION

The present study used the assumptions of LQH and evaluated instruments to measure the components of Lexical Quality (LQ) in adult readers. Veldre and Andrews[17] stated the reliability of spelling recognition tests (orthographic, phonological, and morphological) in assessing LQH measures, and they reported a correlation between reading comprehension and reading time measures. This evidence was partially reproduced in the present research, showing important relations between the Test of Word Reading Efficiency for Adults, homonym tests (comprising vocabulary and spelling), and spelling recognition. Distinctively from what was expected regarding the results for the English language, positive correlations between accuracy and execution time measures were not found in the Brazilian sample of undergraduate readers. In other words, those who score higher in a task do so faster. A possible explanation might be that Portuguese is more transparent than English, implying that transparent language readers make fewer mistakes than opaque languages. Other potential causes might be investigated in further studies.

Overall, the tasks applied in this study showed evidence of assessing LQ components as essential skills that differentiate the level of reading proficiency in adults. There are currently no similar tests in Brazil for this population.

Another important finding is the relationship between socioeconomic class and scores in some LQ component tasks, specifically the homonym test and text reading rate tasks. Participants from higher socioeconomic classes showed better performance in these tasks. Since good performance in the homonym task and speed reading requires spelling and vocabulary knowledge, it can be hypothesized that those skills are deficient among low-income undergraduate students. Another study[22] has shown that previous deficits can be burdened since the initial literacy years. Students with poor reading experience, i.e., students who join the workforce to make their family's ends meet and/or because their families are experiencing food insecurity, have less free time for reading practice than those who are not compelled to work[23].

This revelation is critical; however, its interpretation is limited by class D and E sub-representation in the present study; nonetheless, it is consistent with recent research on the profile of undergraduates in Brazil. According to the 10th Map of the tertiary degree issued by the São Paulo state supporting college education authority group (Semesp)[24], only 19% of the Brazilian population from D class, aged 18-24, attended college education in 2018. Just 5,4% of that total was enrolled in public institutions. Among class E members, only 10,5% attended higher education. The percentage of those attending a public university plunges to 4,2%. When comparing underprivileged classes to classes A, B, and C, 61,9%, 54,7%, and 30,1% were enrolled in the tertiary level, while 15,5%, 16,7%, and 6,8% of those classes attended public institutions. These data show that socioeconomic status strongly impacts youngsters joining a public university, and the present article complements this information, stating that students from underprivileged classes still strive against the adverse effects of their socioeconomic background, which are still apparent in their reading component measures. The effect of deficient academic performance on dropout rates still deserves a comprehensive examination.

The results of the present study are consistent with the LQH theory, which states that individuals with extensive lexical knowledge perform better in spelling recognition tests and word decoding tasks[10]. In addition, the better performance of UFC students in the reading comprehension task may be explained by the more homogeneous same-term sample of language students compared to the heterogeneous sample of students from different UFABC course terms. It can also be hypothesized that the reading load of the language graduation courses is more consistent compared to neuroscience courses. According to Da Silva and Novais[7], many language and literature students do not maintain a frequent reading habit, yet this habit may be higher than that of neuroscience students.

This study has only provided initial evidence concerning the quality of reading in university students, a relevant topic lacking a detailed inquiry in Brazil. Some of the limitations of this study should be improved in future research, namely, the small sample size of participants and the lack of validated measures. Despite the small sample size, it was representative of two Brazilian states with different sociodemographic realities. The LQ instruments still lack sensitivity analyses to better portray Brazilian students' reading proficiency levels. The absence of other tests in the Brazilian market has prevented measures validation. Another unintentional bias encountered in this study was comparing two groups of students with different majors. However, the UFC group concentrates mainly on students majoring in Letters, while the UFABC group comprises students

from distinct Neuroscience courses. Homogeneity should be sought in further investigations.

CONCLUSION

Shorter reading rates were correlated to higher accuracy in the Test of Word Reading Efficiency for Adults, the accuracy of the homonym tests was related to the accuracy in the Test of Word Reading Efficiency for Adults, and both were correlated to their reaction time measures. Evidence also revealed that socioeconomic status influenced reading performance and the outcome of the LQ components tasks.

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KL, MCMF: Conceptualization; Data curation; Investigation; Methodology; Project administration; Resources; Supervision; Writing – Original Draft; Writing – Review & editing;