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Reading comprehension performance of elementary and senior high school students

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Introduction: In Brazil, reading has been widely discussed, mainly due to the published results of national and international performance exams of Brazilian schoolchildren. Learning to read is therefore a continuous process, and the ability to make inferences while reading a text develops with age. The textual complexity involving the syntactic structuring, vocabulary and types of text progressively increases from the initial years of elementary school to high school students, also increasing the cognitive demand of the students; this occurs in parallel to their development and school advancement, which allows improvements in their teaching/learning processes. Based on the above, the following questions were raised: (1) How is the semantic process of reading established among elementary school students in elementary school (cycle II) and high school? Aim: to characterize the performance of elementary and senior high school students on semantic process tests from the Brazilian adaptation of the evaluation of reading processes (PROLEC-SE-R).

Methods: A total of 436 students of both sexes, aged between 11 and 18 years, participated. They were evaluated with Assessment of Reading Processes-PROLEC-SE-R.

Results and discussion: The results indicated that the semantic process was equally established among high school students, with a higher average performance compared with that of elementary school students. Among elementary school students, there was progression in the average correct answers with advancement in schooling. In the two levels of education, narrative texts allowed a greater number of correct answers, followed by multiple-choice and literal questions. The PROLEC-SE-R semantic process tests proved to be effective for assessing reading comprehension in elementary and high school students and reflected the Brazilian reality with regard to the gaps and weaknesses in the educational system.

KEYWORDS

reading, reading comprehension, adolescence, middle school, high school, assessment, education in Brazil

1. Introduction

In Brazil, reading has been widely discussed, mainly due to the published results of national and international performance exams of Brazilian schoolchildren. The most recent results of the International Student Evaluation Program (PISA), coordinated in Brazil by the National Institute

of Studies and Educational Research Anísio Teixeira (INEP), applied in 2018, were released in 2019 (Brasil, 2019; OECD, 2019).

From a proficiency scale of one to six, 24.5% of Brazilian schoolchildren reached level two (minimum for reading proficiency). These students can identify the main idea of moderate-sized texts, can find information based on explicit criteria and can reflect on the purpose and form of texts if explicitly instructed to do so. Thus, students begin to demonstrate the ability to use their reading skills to acquire knowledge and solve a wide variety of practical problems (Brasil, 2019; OECD, 2019).

Those who do not achieve proficiency at level two – i.e., 50% of the schoolchildren - usually have difficulty with material that is unfamiliar to them or that is of moderate length and complexity. These students can understand the literal meaning of sentences or short passages, identify simple connections between the information provided and rely on their own prior knowledge (Brasil, 2019; OECD, 2019).

Approximately 2% of students reached levels five and six; they are able to understand long texts, deal with abstract or counterintuitive concepts and make distinctions between fact and opinion based on implicit clues regarding the content or source of the information. The INEP assumes that these results hinder or even prevent these students from advancing in their studies, have better job opportunities and become active citizens (Brasil, 2019). This is because reading is the main tool for students to acquire new concepts (both in academia and in situations of daily life and participation in society) and can also influence their health and their future generations, being one of the greatest challenges of schools today (Sánchez et al., 2012; Norton et al., 2014; Azizifar et al., 2015; Denton et al., 2015; Oliveira and Capellini, 2016; Okkinga et al., 2018; ter Beek et al., 2018; Hjetland et al., 2020).

One of the models used to explain reading is the "Simple View of Reading" by Hoover and Gough (1990), which states that decoding and listening are fundamental predictors of reading comprehension. These two components are independent and may be altered separately. This means that it is possible to have a good ability to understand oral language and not to decode words efficiently but that it is not possible to have adequate reading comprehension without efficient decoding and listening (Hoover and Gough, 1990; Massonnié et al., 2019).

Decoding is the process of converting graphemes into phonemes, from which the reader is expected to achieve automaticity, i.e., speed, accuracy and efficiency in the conversion of these segments (Coltheart et al., 2001; Cunningham et al., 2002; Cuetos, 2010; Sánchez et al., 2012; Navas, 2017; Oliveira, 2017; Clemens et al., 2018, 2020). Share (1995) states that word decoding is the starting point for reading comprehension. Conversely, oral comprehension is defined as the ability to obtain semantic information at the word level and thereby assist in the understanding of both oral and written discourse (Hoover and Gough, 1990; Massonnié et al., 2019).

Upon recognizing a word, the word must be used in a sentence so that a message can be extracted and integrated into a student's knowledge. Every time a student transfers what he or she reads to what he or she already knows (his or her knowledge of the world and his or her prior knowledge), thus constructing meaning from reading a text, the student acquires new ideas, enabling cognitive development (Cuetos, 2010; Sánchez et al., 2012; Kintsch and Rawson, 2013; Nation, 2013; Perfetti et al., 2013; Capellini et al., 2014; Perfetti and Stafura, 2014; Azizifar et al., 2015; Tiffin-Richards and Schroeder, 2015; Hjetland et al., 2020).

Inference, in turn, is to go beyond what is explicit in a text or discourse to infer the intended message. Even in very clear texts, inferences are necessary (Nation, 2013). Inferences occur when two terms, apparently unrelated in a text, are related, making implicit knowledge explicit. Inference allows readers to connect the information in the text with their knowledge and to complete the information that is not present in the text but that the reader must know to understand the text (Cuetos, 2010).

Learning to read is therefore a continuous process, and the ability to make inferences while reading a text develops with age and varies depending on the nature of the inferential information requested (Spinillo and Mahon, 2007; Carvalho et al., 2009). The ability to construct inferences is determinant in the differentiation of individuals regarding reading comprehension.

Based on the above, the following questions were raised: (1) How is the semantic process of reading established among elementary school students in elementary school (cycle II) and high school?

The aim of this study was to characterize the performance of 6th to the 9th grade (elementary school cycle II) student and of 1st to 3rd grade high school students on tests of the semantic process of reading of the Brazilian adaptation of the evaluation of reading processes- PROLEC-SE-R.

2. Materials and methods

A cross-sectional quantitative study was conducted to characterize the performance of students on tests of the semantic process of reading in public and private schools in a city in Midwest São Paulo.

2.1. Participants

A total of 436 students were evaluated, among whom 221 (51%) were enrolled in state public education institutions and 215 (49%) were enrolled in private education institutions; of these, 263 (60%) were female, and 173 (40%) were male (Table 1):

The sample size was designed to ensure that the tests to be applied (Wilcoxon rank sum test, Mann–Whitney test, and Kruskal–Wallis test) obtained a minimum power of 80%, for a maximum deviation (standard deviation) of 0.2, at a significance level of 5%, for each of the three groups.

TABLE 1 Sample distribution per school year and mean age.

Group	School year	Mean age	n
G1	6th year Elementary School	11.19	61
G2	7th grade Elementary School	11.98	64
G3	8th grade Elementary School	12.83	65
G4	9th grade Elementary School	13.93	62
G5	1st grade High School	14.91	62
G6	2nd grade High School	16.09	61
G7	3rd grade High School	17.22	61
		Total	436

The criteria for the selection of students were as follows:

Inclusion criteria: (1) parents or guardians signed an informed consent form; (2) signature of the Terms of Assent; (3) regularly enrolled in elementary school cycle II or high school of the participating schools.

Exclusion criteria: (1) students who refused to participate, although the parents or guardians signed an informed consent form; (2) students with an interdisciplinary diagnosis of learning disorder, dyslexia or attention deficit hyperactivity disorder; (4) learning complaints (average score less than five); (5) alteration of language or speech; (6) refractive errors identified in school screening that were not corrected, severe reduction in visual acuity, low vision and/or visual impairment diagnosis; (7) diagnosis of hearing impairment; (8) diagnosis of genetic or neurological syndromes; (9) history of repetition; and (10) intellectual demeaning.

These criteria, with the exception of the consent and assent forms, were assessed by consulting the school records of the participants and/or reported by the teachers and school coordinators. All information related to learning complaints and diagnoses are included in academic records with a reference to the ICD or DSM-V. The learning complaints reported by teachers when not accompanied by documentation were compared with school grades. Students with a mean of less than five in the overall calculation of subjects were excluded.

Some students were excluded from the sample after data collection because language and speech changes were detected during the application of the tests. All students who returned a signed consent form and signed an assent form were evaluated, despite the detected changes, so as to not make any student feel excluded from his or her classmates; however, such individuals were not included in the study sample.

2.2. Instruments

Assessment of Reading Processes-PROLEC-SE-R (Oliveira, 2017; Oliveira et al., 2020).

The Brazilian adaptation of the assessment of reading processes (PROLEC-SE-R) (Oliveira, 2017; Oliveira et al., 2020) aims to evaluate the lexical, syntactic and semantic processes of reading. It consists of 13 tests, the first six of which are screening versions that can be applied collectively. The materials included in the battery are two test notebooks, i.e., (1) screening versions of exams 1 to 6 (which the student has access to during the evaluation) and (2) tests 7 to 13, which are applied individually, and the answer sheet. For this study, the semantic process of the two test books was used:

- Expositional comprehension (EC): In this test, the task consists of evaluating the ability of the student to extract information from the expository text and remember it. It includes literal and multiple-choice questions, with four answer options (A, B, C, or D).
- Narrative comprehension (NC): This test includes narrative-type text, with the objective of evaluating the student's ability to form a mental representation of the narrative-type text. It contains ten multiple-choice questions, with four answer options (A, B, C, or D), with consultation;
- Pure reading comprehension (PRC): The aim of this test is to evaluate the student's ability to understand expository text without the interference of memory. The student can consult the

text to answer questions. Reading is performed aloud, and the time to complete the test is recorded;
- Mnemonic reading comprehension (MRC): This test evaluates the student's ability to understand expository texts with memory interference, with open questions; and
- Oral comprehension (OC): In this test, the examiner reads a text to the student twice, aloud. Then, one by one, ten questions are asked.

2.3. Procedures

1. The free and informed consent form was signed by the guardians of the students.
2. The terms of assent form was signed by the evaluated students.
3. The screening versions of the semantic process tests were applied collectively.
4. The remaining semantic process tests were applied individually.

Collective application: The students were collectively evaluated by the researcher in a private environment at the school. Groups were formed with ten students to minimize disruptions during the procedure. The order of application was as follows: (1) EC and (2) NC.

Individual application: The students were individually evaluated. The order of application was as follows: PRC, MRC and OC.

The application of the PROLEC-SE-R was performed in two sessions, i.e., collective and individual, performed on alternate days. Data collection was performed by seven professionals, all duly trained by the researcher to apply the PROLEC-SE-R. The information was recorded in a response sheet, which was identical for the collective and individual application sessions.

For the group session, the students were provided with a test book and a pencil with eraser to fill in the data and answers during the evaluation; average duration of the evaluation was 25 min. Groups were formed with ten students to minimize disruptions during the procedure. In the individual session, the answer sheet was kept by the evaluator, along with a stopwatch and pencil for notes; the average duration was 20 min.

The tests were applied in a classroom provided by the school or in the reading classroom during the reading period of school. Regarding the removal of students from class, permission was granted by the teacher in advance. Therefore, the removal of students was conditional on authorization by the responsible teacher and the content that was being taught at the time.

2.4. Data analysis

A database was created in a Microsoft Excel spreadsheet and transferred to STATA/SE (version 13.1) for statistical analysis.

Descriptive statistical tools were used to characterize the sample. Student's t test was performed to determine whether one average was higher than the other with respect to the variables time per education level and average age. Confidence intervals, with Student's t distributions, were calculated to determine the 95% confidence intervals for estimates of the means.

The Wilcoxon rank sum test (Mann–Whitney test) was used to compare the performance of students (correct answers) on the PROLEC-SE-R by level of education (elementary and secondary).

Kruskal–Wallis analysis of variance was used to compare the performance of schoolchildren per year of primary and secondary school, adopting a significance level of $\alpha = 0.05$. When it was necessary to identify which school years differed significantly from each other, contrast analysis was used.

2.5. Statement of ethics

This study is registered in the Brazil Platform (CAAE: 45464915.4.0000.5406) and was approved by the educational institution (opinion no. 1,125,746).

3. Results

Student's t test and the confidence interval (95% CI) were used to compare the mean age per school year and public and private schools. Student's t test was used to analyze whether one mean was greater than the other, and the 95% CI indicated how much variability in the estimates was concentrated around the estimated value.

The Student's t test results indicated that for the 1st grade of high school, one average was higher than the other. When analyzing the mean value obtained, private school students had a mean age higher than that of public school students. Despite this indication, when analyzing the 95% CI, the confidence intervals overlap, indicating equality between the means if the test were two-tailed ($p = 0.038$, 95% CI 1st public education: 14.51–15.05/95% CI 1st private education: 14.89–15.23).

When comparing the students by level of education (elementary and secondary), regarding the variable time and the collective version and individual version, by Student's t test, there was no evidence that one average was lower than the other, in relation to the time in minutes, for the execution of the tests (collective version $p = 0.999$, 95% CI: 40.04; 41.43/95% CI: 38.37; 39.50) and (individual version $p = 0.999$, 95% CI EF: 33.83; 35.37/95% CI ME: 31.95; 33.39).

To characterize the performance of elementary school students (PE) and high school students (ME) on the PROLEC-SE-R tests, the semantic processes of reading were assessed using Kruskal–Wallis analysis of variance, and when necessary, contrast analysis was performed to verify which groups differed from each other.

For the PE students, the Kruskal–Wallis test did not indicate evidence of a difference in EC ($p = 0.202$) and PRC-A (correct variable: $p = 0.136$), which are the tests that evaluate the comprehension of expository texts, one with memory interference (CE) and the other without (PRC-A). When analyzing the mean score and the median of the PRC test, all students of all years obtained a median value of 4 to 5, i.e., half of the correct answers.

In the narrative comprehension (NC) test, the Kruskal–Wallis test revealed differences ($p < 0.001$). The performance of multiple comparisons (contrasts) suggested that the differences occurred between students in the 6th and 8th grades, 6th and 9th grades and 7th and 9th grades (Table 2).

Evidence of a difference between the means was indicated in the timed reading comprehension test (PRC-T) ($p < 0.001$), MRC

($p = 0.002$) and OC (CO) ($p = 0.005$). The performance of multiple comparisons (contrast) suggested differences between students in the 6th and 7th grades, 6th and 8th grades, and 6th and 9th grades for the PRC-T, indicating longer reading times for 6th graders than for students in other grades. In the MRC test, the differences between the 6th and 8th graders, the 6th and 9th graders and, finally, the 6th and 8th graders in OC indicated inferior performance by the 6th graders in such tests.

In the timed PRC test (PRC-T), the median values corresponding to the time in seconds reading the expository text decreased with the advancement of education, as did the dispersion of the answers and the discrepant values.

For ME students, Kruskal–Wallis analysis of variance revealed differences between school years in the MRC test ($p = 0.041$). Despite the evidence of differences, differences were not identified in the contrasts (multiple comparisons: 1st grade and 2nd grade, 1st grade and 3rd grade, and 2nd grade and 3rd grade) (Table 3).

In the PROLEC-SE-R semantic process tests, there was no indication of evidence of differences for ME students (CE: $p = 0.262$; CN: $p = 0.221$; PRC-A: $p = 0.527$, PRC-T: $p = 0.065$ and CO: $p = 0.078$) (Table 2).

The Wilcoxon test was used to compare the test performance of PE students with ME students. There was evidence of differences between the groups, and the ME students had a mean score higher than that of PE students. Regarding the time variable (PRC-T), the PE students had times that were longer than those for ME students (Table 4).

4. Discussion

By characterizing the semantic reading process levels of elementary school (ES) and high school (HS) students, it was possible to observe that the mean performance of HS students was higher than that of ES students. As mentioned in the National Curriculum Common Base (BNCC, acronym in Portuguese) (2018), the textual complexity involving the syntactic structuring, vocabulary and types of text progressively increases from the initial years of PE to ME, also increasing the cognitive demand of the students; this occurs in parallel to their development and school advancement, which allows improvements in their teaching/learning processes (ter Beek et al., 2018, 2019; Brasil, 2019).

By characterizing the level of education, year by year, in PE, 6th and 7th graders are adapting to the new curricular structure. This finding is in agreement with what was proposed in the Common National Curriculum Base (BNCC) and in the National Curriculum Guidelines for Nine-Year Elementary Education (Resolution CNE/ CEB no. 7/2010). PE is the longest stage of basic education, covering children between 6 and 14 years old, and for this reason, it is divided into two phases, initial years and final years. The transition between the initial and final years involves, in many cases, a change in school and is marked by changes in educational, curricular and faculty structures, in which there is a change from generalist teachers to specialists in different areas of education (Brasil, 2018).

Regarding the semantic process tests, pairwise comparisons indicated that HS students did not differ from each other, a finding that may lead to the inference that the semantic process is consolidated among these students; however, for these tests, the mean performance

TABLE 2 Description and comparison of the performance of elementary school students on the PROLEC-SE-R semantic tests.

	Mean (SD)	Median	Minimum	Maximum	p value	Difference between groups
Collective version						
EC						
6th year	6.36 (1.97)	7.00	2.00	10.00	0.202	
7th year	6.53 (1.99)	6.00	2.00	10.00		
8th grade	7.06 (1.84)	7.00	3.00	10.00		
9th year	6.79 (1.92)	7.00	3.00	10.00		
NC						
6th year	4.70 (2.00)	5.00	0.00	6.00	<0.001*	6°<8°
7th year	4.90 (1.87)	5.00	0.00	6.00		6°<9°
8th grade	5.86 (1.86)	6.00	2.00	7.00		7°<9°
9th year	5.98 (1.63)	6.00	2.00	7.00		
Individual version						
PRC-A						
6th year	3.60 (2.11)	4.00	0.00	8.00	0.136	
7th year	4.29 (2.01)	4.00	0.00	9.00		
8th grade	4.41 (1.95)	5.00	0.00	9.00		
9th year	4.32 (2.05)	4.00	1.00	8.00		
PRC-T						
6th year	263.39 (92.03)	240.00	150.00	540.00	<0.001*	6°>7°
7th year	217.45 (66.64)	200.50	109.00	428.00		6°>8°
8th grade	199.06 (51.01)	191.00	130.00	380.00		6°>9°
9th year	196.83 (39.18)	194.50	132.00	300.00		
MRC						
6th year	3.65 (2.50)	3.00	0.00	9.00	0.002*	6°<8°
7th year	4.64 (2.41)	4.00	0.00	10.00		6°<9°
8th grade	5.21 (2.29)	5.00	0.00	10.00		
9th year	5.33 (2.96)	5.50	0.00	10.00		
OC						
6th year	3.55 (2.42)	3.00	0.00	9.00	0.005*	6°<8°
7th year	4.51 (2.59)	4.00	0.00	9.00		
8th grade	5.23 (2.71)	6.00	0.00	10.00		
9th year	4.77 (2.63)	5.00	0.00	10.00		

Kruskal–Wallis test. *Evidence of statistical association ($p < 0.05$). SD, standard deviation; EC, expository comprehension; NC, narrative comprehension; PRC-A, pure reading comprehension-correct answers; PRC-T, pure reading comprehension-time in seconds; MRC, mnemonic reading comprehension; OC, oral comprehension.

score was below the ceiling range. This result is consistent with the Spanish PROLEC-SE-R results (Cuetos et al., 2016); however, the average number of correct answers by these students was higher than that by Brazilian students, and the heterogeneity of the answers was lower. This result can be justified by the classification of Brazilian schoolchildren in the 2015 PISA, in which 51% were at level one, compared with 17% of Spanish schoolchildren (OECD, 2016).

The EC and MRC tests are mnemonic tests, with expository texts that require the use of memory. In the EC test, the questions are multiple choice, whereas MRC open questions require a greater linguistic demand by the student. In the EC test, the student reads the text silently; in the MRC test, the student reads aloud. For both ES and

HS students, the average performance on the multiple-choice version (EC) was higher. This finding can be justified by the fact that tests with open questions require a greater linguistic demand than do tests with multiple-choice answers (Guimarães and Mousinho, 2019; Gentilini et al., 2020). However, in a recent study of a theoretical and empirical survey of international studies of reading comprehension tests, the authors found that many of the differences between tests with multiple-choice and open-ended questions may be related to the length of the text and the development of the reader (Guimarães and Mousinho, 2019).

Another important aspect is decoding. In the collective version of the EC test, reading was performed silently; in contrast, in the

TABLE 3 Description and comparison of the performance of high school students on the PROLEC-SE-R semantic tests.

	Mean (SD)	Median	Minimum	Maximum	*p* value
Collective version					
EC					
1st grade	7.25 (1.92)	8.00	3.00	10.00	0.262
2nd grade	7.81 (1.73)	8.00	2.00	10.00	
3rd grade	7.68 (1.84)	8.00	3.00	10.00	
NC					
1st grade	5.93 (1.99)	6.00	1.00	10.00	0.221
2nd grade	6.45 (1.63)	7.00	0.00	9.00	
3rd grade	6.55 (1.91)	7.00	2.00	10.00	
PRC-A					
1st grade	4.66 (2.20)	4.00	0.00	10.00	0.527
2nd grade	5.04 (1.87)	5.00	1.00	9.00	
3rd grade	4.91 (1.87)	5.00	0.00	9.00	
PRC-T					
1st grade	184.61 (36.31)	179.50	120.00	291.00	0.064
2nd grade	172.00 (31.31)	167.00	90.00	265.00	
3rd grade	179.34 (27.64)	176.00	120.00	305.00	
MRC					
1st grade	5.41 (2.73)	6.00	0.00	10.00	0.041*
2nd grade	6.31 (2.55)	7.00	0.00	10.00	
3rd grade	6.54 (2.58)	7.00	0.00	10.00	
OC					
1st grade	5.01 (2.53)	5.00	0.00	10.00	0.077
2nd grade	5.73 (2.70)	6.00	0.00	10.00	
3rd grade	6.01 (2.14)	6.00	1.00	10.00	

Kruskal–Wallis test. *Evidence of statistical association ($p < 0.05$). However, the contrasts did not indicate which groups differed individually from the others. SD, standard deviation; EC, expository comprehension; NC, narrative comprehension; PRC-A, pure reading comprehension-correct answers; PRC-T, pure reading comprehension-time in seconds; MRC, mnemonic reading comprehension; OC, oral comprehension.

MRC test, the text is read orally by the student. Reading aloud demands the activation of the phonological codes of words, while in silent reading, the orthographic forms of words directly activate meaning. Studies indicate that the identification of misspelled words is identified more frequently in oral reading than in silent reading, indicating that orthographic and phonological characteristics at the word level may affect oral reading more than silent reading (van den Boer et al., 2014).

The NC and PRC tests are structured in the same way as the EC and MRC tests; however, the evaluation is based on the inferential processing of a narrative (NC) and expository (PRC) text. The superior performance of both PE and ME students on the NC test may have been influenced by the linguistic decrease that multiple-choice tests offer. However, in addition to the multiple-choice answers and open questions factor, there are also types of narrative and expository texts. Narrative texts are more common in the early years of PE, potentially hindering the adaptation of students when entering PE II to expository texts. In addition, with school progression, expository texts increase in syntactic complexity, and the content becomes denser, with unknown vocabulary and no previous reference to the subject, requiring the student to monitor his or her reading and knowledge of strategies for understanding (Ahmed et al., 2016; Okkinga et al., 2018;

Cockerill et al., 2019; Guimarães and Mousinho, 2019; ter Beek et al., 2019; Gentilini et al., 2020).

When comparing the EC and MRC tests (mnemonic) with the CN and PRC tests (without interference of memory with inferential questions), at all levels of education, the inferential questions generated more difficulties for the students to answer than did the literal questions. The students showed superior performance on the tests with literal questions, both in the collective and individual versions.

The best performance in literal-type questions indicates that the students acquired only general textual representations and details directly related to the topic; that is, the students built the macrostructure of the text, which is nothing more than the relationship of the ideas of the text, known as global understanding (Azizifar et al., 2015; Cunha and Capellini, 2016; Hjetland et al., 2020). The findings of this study agree with the latest PISA evaluations conducted in 2015 and 2018. Brazilian students have greater ease answering questions that involve the skills of locating and retrieving information (textual macrostructure). These skills are involved in the basic and elementary levels of reading development (Brasil, 2016, 2019; OECD, 2016, 2019).

As occurred in this study, in the PISA evaluation, the questions involving integration and interpretation skills were the most difficult.

TABLE 4 Description and comparison of the performance of elementary and high school students on the PROLEC-SE-R semantic tests.

	Mean (SD)	Median	Minimum	Maximum	P-value	Difference between groups
Collective version						
EC						
PEII	6.69 (1.94)	7.00	2.00	10.00	<0.001*	PEII < HS
HS	7.58 (1.84)	8.00	2.00	10.00		
Total	7.06 (1.94)	7.00	2.00	10.00		
NC						
PEII	5.36 (1.92)	5.00	0.00	10.00	<0.001*	PEII < HS
HS	6.31 (1.86)	7.00	0.00	10.00		
Total	5.76 (1.95)	6.00	0.00	10.00		
Individual version						
PRC-A						
PEII	4.16 (2.04)	4.00	0.00	9.00	<0.001*	PEII < HS
HS	4.87 (1.98)	5.00	0.00	10.00		
TOTAL	4.46 (2.05)	4.00	0.00	10.00		
PRC-T						
PEII	218.39 (69.85)	200.00	109.00	540.00	0.000*	PEII > HS
HS	178.68 (32.22)	175.00	90.00	305.00		
Total	201.84 (60.37)	186.50	90.00	540.00		
MRC* **						
PEII	4.72 (2.62)	5.00	0.00	10.00	0.000*	PEII < HS
HS	6.08 (2.65)	7.00	0.00	10.00		
Total	5.29 (2.71)	6.00	0.00	10.00		
OC						
PEII	4.53 (2.65)	4.00	0.00	10.00	0.000*	PEII < HS
HS	5.58 (2.49)	6.00	0.00	10.00		
Total	4.97 (2.63)	5.00	0.00	10.00		

Wilcoxon test. *Evidence of statistical association ($p < 0.05$). EC, expository comprehension; NC, narrative comprehension; PRC-A, pure reading comprehension-correct answers; PRC-T, pure reading comprehension-time in seconds; MRC, mnemonic reading comprehension; OC, oral comprehension; PEII, elementary school II; HS, high school.

These skills involve the formulation of inferences, an understanding of gender, linguistic style, knowledge of the world and prior knowledge, the ability to think about the structure of a text and how it is organized and the relationships of grammatical structures (Brasil, 2016; OECD, 2016). Inferential questions can only be answered with a full understanding of the text, with the integration of information in the memory and with the completion of corresponding inferences. As stated in the PISA report (Brasil, 2019; OECD, 2019), Brazilian students are able to easily identify the function of specific textual sequences for the objectives and purposes of different texts and to understand their global meaning; however, they have difficulty inferring information on the same subject.

When analyzing the reading time of the expository text in the PRC test, there is evidence of a difference between the means, indicating that with the advancement of schooling, there is a decrease in the time in seconds of reading from ES to HS. By decreasing the reading time, there is a consequent increase in words read per minute. This finding is contrary to the studies by Hasbrouck and Tindal (2017) and Washburn (2022); according to the data presented by those authors, the number of words read correctly per minute increases with

the progression of schooling but only until the sixth school year, when the number of words read per minute remains the same, even with advancement of schooling.

In a Brazilian study conducted by Gentilini et al. (2020), the average silent reading time for a narrative text was recorded for 6th and 7th graders grouped in a single group and 8th and 9th graders in another group. No statistically significant difference was found, indicating a possible stabilization of textual fluency in adolescence.

One of the differentials of the PROLEC-SE-R is the evaluation of the OC of texts. The main reason for the evaluation of OC is that difficulties in reading comprehension may originate in oral language, in decoding and/or in the lack of automatic identification of written words.

The progression in the performance of students, with the advancement of education, supports results reported in the literature, i.e., OC increases throughout development and has a reciprocal relationship with the development of reading comprehension. Lexical knowledge, knowledge of the world, syntactic processing and the making of inferences develop as these skills advance (Perfetti et al., 2013).

The poor reading performance of Brazilian schoolchildren may be due to difficulty in the development of oral language as well as a lack

of knowledge of the subject and vocabulary, which develop with age and reading practice and experience, fundamental factors for a thorough understanding of texts (Cuetos, 2010; Sánchez et al., 2012; Nation, 2013; Perfetti et al., 2013). The authors state that reading comprehension and OC originate from the same neural circuit. The general ability to understand text increases with reading experience and experience with spoken language (Cuetos, 2010; Perfetti et al., 2013).

The results from this study provide speech-language pathologists and other health and education professionals with elements for understanding the reading profile of students in PE II and Brazilian high schools. The PROLEC-SE-R semantic process tests proved to be efficient for the evaluation of reading comprehension in elementary and high school students and reflected the Brazilian reality with regard to the gaps and weaknesses in the educational system. With this knowledge, professionals can both evaluate reading with adequate parameters and contribute to the planning of both clinical and educational interventions.

4.1. Study limitations

The sample size was calculated on the basis of the statistics used. Inferences from the sample can be made for students from schools and municipalities similar to the study population because there is no evidence that the phenomena studied are different in other schools and cities. However, when generalizing the population data, different types of teaching materials used in the country, teaching methods, socioeconomic-cultural conditions and regionalism should be taken into account.

5. Conclusion

Reading processes are established equally among HS students, and in ES, there is a progression in the average performance (correct answers) as schooling advances, especially in those from the 6th year to other years of ESII.

There is evidence that compared with that of ES students, the average performance of HS students on the PROLEC-SE-R semantic process tests is superior.

For both primary and secondary education, narrative texts allow a greater number of correct answers, as do texts that offer questions with multiple-choice answers. Inferential questions generate more difficulties for students to answer than do literal questions. The OC of expository texts by students is low, which may reflect difficulty in language development, low vocabulary, a lack of knowledge of the subject, among other factors that can affect OC.

The PROLEC-SE-R semantic process tests proved to be effective for assessing reading comprehension in elementary and high school students and reflected the Brazilian reality with regard to the gaps and weaknesses in the educational system.

Data availability statement

The original contributions presented in the study are included in the article/supplementary material, further inquiries can be directed to the corresponding author.

Ethics statement

The studies involving human participants were reviewed and approved by Research Ethics Committee of the School of Philosophy and Sciences of the São Paulo State University "Júlio de Mesquita Filho" (UNESP), Marilia, São Paulo, Brazil (opinion no. 1.125.746). Written informed consent to participate in this study was provided by the participants' legal guardian/next of kin.

Author contributions

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Publisher's note

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