

Reading speed in Elementary School and Junior High

Evolução da velocidade de leitura no Ensino Fundamental I e II

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ABSTRACT

Purpose: To verify the influence of schooling on reading speed measures in Elementary School and Junior High, also aims to explore the levels of accuracy of the variables of reading speed in the epidemiological investigation stages of cases. **Methods:** 535 students from the 2nd to the 9th grade from a private school and a state school system participated in the study. The oral reading of a simple text was evaluated in the following parameters: words read per minute and correctly words read per minute. Descriptive statistics and T-test measures with the significance of 5% were conducted, besides the z-score, standardized and individual. **Results:** The results corroborate the literature review which shows an increase in reading speed with the progression of schooling. The reading fluency was presented in the construction process between the 2nd and 7th grades, with stabilization from the 7th year. A more fluent and homogeneous reading was sedimented between the 7th and 9th grades. The study proposes the interpretation of the findings with scales suggestive of the deficit using the z-score. The data are stratified from values suggestive of significant deficit to non-suggestive, with a total of five strata. The stratification allows a clearer reference on which point the scholar found in the expected ranges for their schooling. **Conclusion:** The measures of the expected values according to schooling are essential for better-quality knowledge of reading development, to provide reference standards for adequate monitoring in the clinical and educational sphere and prediction of reading skills and difficulties.

RESUMO

Objetivo: Verificar a influência da escolaridade em medidas de velocidade de leitura no ensino fundamental e explorar os níveis de precisão das variáveis da velocidade de leitura nos estágios de investigação epidemiológica de casos. **Método:** Participaram 535 escolares do 2º ao 9º ano de escola particular e pública. A leitura oral de um texto simples foi avaliada nos parâmetros palavras lidas por minuto e palavras lidas corretamente por minuto. Foram conduzidas medidas de estatística descritiva e teste T de student com significância de 5%, além do escore Z, padronizado e individual. **Resultados:** Os resultados corroboram a literatura que evidencia aumento da velocidade de leitura com a progressão da escolaridade. A fluência leitora se mostrou em processo de construção entre o 2º e o 7º ano do Ensino Fundamental, com estabilização a partir do 7º ano. Uma leitura mais fluente e homogênea se mostrou sedimentada entre o 7º e o 9º ano. O estudo propõe a interpretação dos achados com escalas sugestivas para déficit por meio do z-escore. Os dados são estratificados desde valores sugestivos de déficit importante até o não sugestivo, com um total de cinco estratos. A estratificação permite uma referência mais clara sobre qual ponto se encontra o escolar nas faixas esperadas para sua escolaridade. **Conclusão:** As medidas dos valores esperados segundo a escolaridade são essenciais para melhor conhecimento do desenvolvimento da leitura, de forma a prover padrões de referência para um adequado monitoramento no âmbito clínico e educacional e predição das habilidades e dificuldades leitoras.

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INTRODUCTION

The ability to understand what is read has been strongly related to development of word recognition accuracy and reading fluency⁽¹⁻⁶⁾. During the school years, the speed at which students read increases, as shown by some other studies^(3,5,6). However, there are still some important questions that need to be answered in relation to Brazilian school children. What are the expected values of reading speed in each school grade and when should suspicions be raised of problems with reading fluency? With the progression of school years, at what point will the increase in reading speed stabilize, approaching the standards of a fluent adult?

When students start to read, most of their concentration is focused on the task of decoding and consequently their reading will initially be slower and require much more effort. As familiarity with written words grows so do their reading rates and fluency⁽¹⁻⁵⁾.

Reading fluency is the ability to read accurately with natural speed and expressiveness⁽⁷⁾ and combine accuracy, automation (fluency) and expressiveness⁽⁸⁾.

Accuracy refers to the correct decoding of words with a good understanding of the alphabetic principle, the ability to put together different sounds and to know a large number of words. From this point automation in reading can be established, which consists of four elements: speed, absence of effort, autonomy and absence of conscious attention^(9,10).

As soon as word decoding is achieved and becomes quick and effortless, a text can be read efficiently and expressed with appropriate prosody and only then does reading start to have appropriate expression, rhythm and intonation, allowing the reader to accompany the meaning of the text^(8,11).

It is a recognized fact that fluency is a critical component of skillful reading, and its development can be monitored by following reading accuracy. Reading accuracy is measured by counting the number of correctly read words, excluding those read incorrectly with substitutions, omissions or insertions. It can also be monitored by reading speed, the number of words that can be read in a given time, in addition to the prosodic variations during reading aloud^(1,12-14).

Diagnostic tools to monitor basic national education, such as IDEB (Índice de Desenvolvimento da Educação Básica), which is the Brazilian index for basic educational development, showed in 2017 that Brazil did not achieve significant results in the areas of education. Only the early years of elementary school managed to meet the 5.8-target. The final years of elementary school achieved a national average of 4.7, the established target was 5 points. In high school, the country reached 3.8, falling far short of expectations⁽¹⁵⁾. The data presented in this index show that students finishing basic education have low averages. That said, systematic monitoring of reading in the classroom can be an important strategy for early identification of schoolchildren at risk. Early identification can allow the adoption of more assertive educational methodologies and remedial interventions, before academic progress might be compromised.

Another important point worth noting is a lack of national studies that investigate expected performance and establish parameters to assess reading and writing skills for each school

grade^(16,17). Therefore it is a necessity to understand the process of evolution of reading fluency of Brazilian students, to create parameters for monitoring the development of reading throughout the school cycle. Studies have shown that the reading fluency of students increases as schooling progresses⁽¹⁶⁻¹⁹⁾.

Reading is extremely important and it is a known fact that it allows participation and autonomy in society, and impacts both academic and personal life. This study seeks to investigate the influence of school education and reading speed in elementary school and to explore levels of accuracy of reading speed variables in the stages of epidemiological investigations of the cases.

METHODS

This study is an observational and cross-sectional analytical study approved by the Research Ethics Committee, protocol number CAAE 38861914.4.0000.5096 and ruling No. 885546. All the parents and guardians of the participants in the study signed a consent form, as well as the participants themselves.

To analyze reading speed, audio recordings were made of students reading aloud in a natural manner of an easy text containing 210 words⁽²⁰⁾. For a sample calculation, an error rate of 5% was considered, and a confidence rate of 95%. Information was used from a 2018 IBGE⁽²¹⁾ analysis in Belo Horizonte, with the results of 174 elementary school students. The choice of schools was not random, the two schools that accepted and that we extrapolated the number suggested in both public and private sector, totaling 535 students from the 2nd to the 9th grade of elementary school in both schools in the metropolitan area of Belo Horizonte, Minas Gerais. Of these 535 students 180 were from the private school and 355 from the public school, totaling 259 from primary elementary schools, and 276 from secondary elementary schools.

The choice of schools was based on the similarity of the education indexes shown by the institutions researched and by the diversity of teaching, to ensure that the results obtained in the research had a greater external validity for the sample. Making comparisons between education systems was not one of the objectives of this research. The two schools had IDEB (Basic Education Development Index) of around 7 (6.9 and 7.2) and SAEB (Basic Education Assessment System) of 7.55 and 7.53 (The data are available on the website of the INEP The National Institute of Educational Studies and Research)⁽¹⁵⁾. They are schools located in more central regions of the city, with similar sociodemographic profiles. These are not considered areas where the populations is socially or economically vulnerable.

To participate in the research, the students had to be enrolled from the 2nd to the 9th grade of elementary school in one of the schools mentioned, without being behind in grades or any diagnosis of changes in learning, language, sensory or cognitive problems. Students with such problems were excluded from the research to avoid any possible excess of outliers in the statistical analysis. Information for inclusion in the research was collected by means of a questionnaire attached to the consent form and answered by the parents, pedagogical coordinators and teachers. The participating students and their legal guardians were informed about the objectives, risks and benefits of the research. Those who did not meet the described criteria or did

not agree to participate or whose parents did not sign the ICF were excluded, this resulted in 74 participants being excluded from the research.

Data collection took place at the end of the second term, between the months of May and July. A laptop computer running Praat software⁽²²⁾ connected to a unidirectional microphone was used to make the recordings. The recordings were made of students reading aloud. Each recording was made individually, in an isolated room in each of the schools, so there was no noise pollution from outside or from within the schools themselves and after school hours so that there would not be any impact on lesson times.

Before reading began any queries the students had about the activity were clarified. After reading, the participants answered a multiple choice questionnaire with ten questions about the text that they had read⁽²⁰⁾. Please note that the objective of the research was not to test the students understanding. The objective of the research was only to ascertain if the text was read attentively and the ability to evoke literal and inferential facts about the text, and not an automatic decoding, without access to the meaning of the text.

The following parameters were evaluated from the recorded readings. Words read per minute (WPM) - fluency rate - and words read correctly per minute (WCPM) - accuracy. To analyze the WPM, all the recordings made were reviewed and the total number of words counted that were read in the full text, of these only the words read correctly were included to calculate the WCPM. Different people carried out the analysis, the objective of which was to achieve greater reliability, in other words accurate verification of the statistics counted.

The variables of gender and age were not considered in the analysis of this study. To make comparisons between genders was not an objective of this research and a study conducted of the Brazilian school population did not show a significant difference in performance in these skills between boys and girls⁽¹⁷⁾, additionally age was not an objective for analysis, but rather to understand the relation between the measurements recorded throughout the school years. There is no age-grade distortion in the statistics, and in Brazil there is strict criteria regarding a child's age and grade, therefore schooling reflects the performance of each age.

To achieve the objective of this research, which was to evaluate the development of reading speed of students from the 2nd to 9th grades of elementary school, it was important to ensure that the text provided a good possibility to decode and automatically recognize words, as a way of providing cognitive resources and as a way to access fluency standards for both primary and secondary elementary school students. For this reason a well-known literary text was chosen⁽²⁰⁾, with a suitable degree of complexity so that students were able focus on fluency and not have to concentrate on the cognitive effort of decoding. This methodology was based on a study carried out in Brazil with students from a secondary elementary school⁽¹⁷⁾.

The fluency and accuracy rates for each reader were calculated using the methodology explained below⁽¹²⁾.

The formula used to calculate the words read per minute (WPM) was as follows:

$$WPM = \frac{\text{Number of words read} \times 60 \text{ seconds}}{\text{Total reading time (in seconds)}} \quad (1)$$

To calculate the correct number of words per minute (WCPM), the number of words read correctly was estimated, including only the words that were read correctly and fluently. Reading errors were deemed a failure of decoding, omissions and hesitations, errors of tonicity and disregard for graphic accentuation signs.

The calculation for this item was made using the following formula.

$$WCPM = \frac{\text{Number of words read correctly} \times 60 \text{ seconds}}{\text{total reading time (in seconds)}} \quad (2)$$

The data were analyzed using descriptive statistics (mean, median and standard deviation) and the Anderson-Darling normality test with normal data distribution. To compare the reading speed variables between school years, Student's t tests were used for unpaired samples for each school year. The level of significance adopted was 5%.

In order to delimit the ranges for each school year studied, the standardized and individual Z score was used, with the following formula.

$$Z = \frac{X - \bar{X}}{dp} \quad (3)$$

In which,

X = gross score

\bar{X} = group average in the test.

dp = standard deviation of the normative group in the test.

For the epidemiological analysis of suggestive deficits, the following score was used⁽²³⁾

$Z \geq -1.0$ standard deviation - not suggestive of deficit

Z between -1.0 and -1.5 standard deviation - alert of deficit

Z between -1.6 standard deviation and -2.0 standard deviation - suggestive of moderate to severe deficit.

$Z < -2.0$ standard deviations - suggestive of a serious deficit.

RESULTS

Table 1 shows the values of the mean, standard deviation and coefficient of variation obtained for each school year for WPM, WCPM and total reading time, in which it can be found that the measures of fluency (WPM) and accuracy (WCPM) increased from the second to the ninth year of elementary school. In Figure 1, it is easier to ascertain the variation coefficient for each student, observing a decrease with an increase in school years. This is an indicator that in the initial grades the variability in performance and in reading fluency among children is very large while at the end of elementary school there is a homogeneity in performance.

The results of the comparison between school years, shown in Table 2, shows that the progression has statistically significant differences between the 2nd and 7th grades, the 7th and 8th and between the 8th and 9th years there were no significant differences. The difference is only statistically relevant when comparing the 7th and 9th grades.

The results related to the z-score for defining suggestive values of deficits for the sample studied are shown in Table 3.

Table 1. Average, standard deviation and variation coefficient of reading fluency measured in each school year

School years	n	Descriptive	WPM	WCPM	TRT
2 nd	56	Average	70.62	66.89	3.67
		sd	25.09	24.90	1.56
		CV	35.53	37.23	42.51
3 rd	52	Average	105.64	100.96	2.44
		sd	32.19	31.20	0.82
		CV	30.47	30.90	33.61
4 th	69	Average	116.59	111.83	2.18
		sd	31.29	31.18	0.62
		CV	26.84	27.88	28.44
5 th	82	Average	137.01	132.68	1.85
		sd	27.02	26.48	0.42
		CV	19.72	19.96	22.70
6 th	87	Average	150.43	147.70	1.65
		sd	22.68	23.46	0.27
		CV	15.08	15.88	16.36
7 th	92	Average	160.54	156.33	1.53
		sd	22.24	24.39	0.30
		CV	13.85	15.60	19.61
8 th	54	Average	162.74	160.64	1.52
		sd	26.38	26.83	0.37
		CV	16.21	16.70	24.34
9 th	43	Average	168.74	167.18	1.42
		sd	13.02	13.51	0.17
		CV	7.72	8.08	11.97

Caption: n = number of students; WPM = words per minute; WCPM = words correct per minute; TRT = total reading time sd = standard deviation; CV = coefficient of variation

Table 2. Comparison of reading speed variations between school years using the two-tailed Student t test for unpaired samples

Comparison	WPM	WCPM
2 nd x3 rd	0.000	0.000
3 rd x4 th	0.063	0.060
4 th x5 th	0.000	0.000
5 th x6 th	0.001	0.000
6 th x7 th	0.003	0.016
7 th x8 th	0.608	0.336
8 th x9 th	0.147	0.122
7 th x9 th	0.008	0.001

Caption: Student's t-test with 5% significance

Table 3. Results of the z-score to delimit values suggestive of deficit for each school year of the present sample.

	2 nd	3 rd	4 th	5 th	6 th	7 th	8 th	9 th
Suggestion of a major deficit important	below from 20	below from 47	below from 55	below from 78	below from 93	below from 92	below from 99	below from 108
Suggestion of deficit moderate to severe	from 20 to 29	from 47 to 57	from 55 to 65	from 78 to 86	from 93 to 101	from 92 to 103	from 99 to 107	from 108 to 116
Suggestion of deficit	from 30 to 31	from 57 to 59	from 65 to 67	from 86 to 88	from 101 to 103	from 103 to 105	from 107 to 109	from 116 to 118
Warning of potential deficit	from 32 to 43	from 59 to 71	from 67 to 79	from 88 to 98	from 103 to 113	from 105 to 119	from 109 to 120	from 118 to 128
No suggestion of deficit	above from 43	above from 71	above from 79	above from 98	above from 113	above 119	above from 120	above from 128

Caption: WPM: word per minute; WCPM: words correct per minute; TRT: total reading time

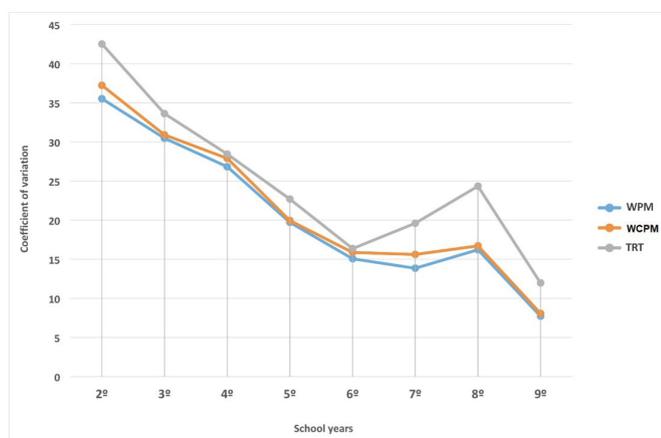


Figure 1. Evolution of the variation coefficient over the school years for each variable of reading fluency studied

DISCUSSION

In this study, it was decided to evaluate the development of reading by calculating the number of words read per minute (WPM) and words read correctly per minute (WCPM), which are pointed out as good measures to monitor the development of reading fluency in students^(7,19).

According to the results presented in Table 1, we can see the development of reading performance by students from the second to the ninth year, marked by an increase in the number of WPM and WCPM, as well as a decrease in the average of the total reading times of the students as they advance in school years (Figure 1). Such results allow us to infer that the increase in accuracy enables faster reading, in agreement with the findings found in other studies, which show an increase in the development of reading accuracy and a decrease in oral reading times as students progress through the school years^(5,12,14,17). Interestingly this progression through the years and in addition to the increase in the average reading speed and accuracy, there is a decrease in the coefficient of variation (Figure 1). Qualitatively, these results point out that there is a tendency to homogenize the studied sample, in the initial years the results of reading speed vary more than in the final years of elementary school.

These qualitative and quantitative observations are also seen quantitatively: Table 2 indicates a statistically relevant progression (p value <0.05) from the 2nd to the 7th year of elementary school, when WPM and WCPM of the school year is compared with that of the previous year. Later from the 7th year onward, progression is still evident but slower. The difference is only statistically relevant when comparing the 7th and 9th grades. In other words, between the 2nd and the 7th year of elementary school, the reading fluency of the students appeared to be in the construction process, with a greater stabilization from the seventh year onward and establishment of a more fluent and homogeneous reading style between the 7th and 9th grades.

Studies^(3,16) have shown that at the beginning of literacy, the reading process is slow and laborious because the student uses

the phonological route, establishing the sound of each letter read, a process required for the grapheme-phoneme convention. As the student starts to become more literate and familiar with the growing number of words written in their language, they begin to read using the lexical route, enabling reading with automation and increased speed.

An important aspect when analyzing the development of reading speed is associated with the number of errors made during the activity. Students at the beginning of elementary school had a lower number of WCPM than students in the final years, which indicates a greater number of words read incorrectly. With an advance in the level of education there is a reduction in errors, indicating a command of the rules of orthographic decoding in reading, which allows for more fluid reading^(24,25). An American survey⁽¹⁹⁾ found that accuracy (words read correctly) is higher, for higher levels of education, from 70.3% of words correctly read for the first year with an increase to 92.6% and 90.5% for the fifth and sixth years, respectively.

To assess the importance of reading fluency and the development of reading comprehension in Portuguese in the early years of literacy, a Brazilian survey⁽³⁾ pointed out that the ability to read words accurately and quickly at the end of the first year was significantly correlated with the ability to understand what was read at the end of the second year of elementary school. The study suggests that fluency significantly contributes to reading comprehension from the beginning of reading acquisition⁽³⁾.

A study that we consulted⁽²⁶⁾ considered that, during reading development automaticity is achieved when readers reach around 80 correct words per minute (WCPM) reading an age appropriate text, which indicates that the student has passed the first stage of reading to an independent reading stage. Although there are no similar parameters for Brazilian Portuguese readers, we found in this research that students in the third year of elementary school reached this average, indicating automaticity in reading. Between the third and seventh year, growth continues to be progressive and from the seventh year such patterns stabilize, there is no significant increase in the comparison of gains in the fluency of each year.

According to this perspective, the word averages read per minute from the seventh to the ninth year of elementary school can be considered independent, stable and corroborate the values found in scientific literature⁽²⁵⁾.

As automaticity develops, student performance not only becomes accurate, it also becomes faster. However, this increase in speed is not unlimited. Instead, the learning curve for these tasks follows what is known as power law: reaction time decreases with practice until an irreducible limit is reached. Speed increases with practice, but the gains are greater at the beginning and decrease with additional practice⁽¹⁰⁾.

The choice of studying reading fluency by using the z-score and scheduling proposal⁽²³⁾ was based on three main areas. First, to study a case, it is important to have levels of precision in the stages of epidemiological investigation⁽²⁷⁾. The use of the z-score as being suggestive of alertness, suggestive of a moderate to severe deficit or suggestive of an important severity deficit is used in instruments by speech pathologists as reference points^(28,29). Second, the proposal allows the visualization of signs⁽²⁷⁾, despite

being sufficient in themselves for the conclusion of cases. Finally, the scheduling sought to identify similar cases, that is it shows an attempt to present a more sensitive and nonspecific proposal⁽²⁷⁾. Thus, table 3 allows the user to place an individual case, inside a classroom or within a group or even an office.

It is also important to highlight the proposed analysis of these scales suggestive of deficits of using the z-score presented in this research. These data whose results are shown in Table 3, show a stratification from the important deficit to the non-suggestive one, with a total of five strata. Here we have two points to highlight. The first concerns the methodological use of this type of analysis. When stratifying, we allow teachers and professionals who deal with the child to have a clearer reference on what point they are at, in the expected ranges for their schooling. In other words, it is a spreadsheet whose main objective is to make individual analysis easier. For example, if a student in 2nd grade reads at a rate of 23 words per minute, he or she should receive special attention from the school immediately because this reading speed would indicate a moderate to severe deficit. This shows the particular value of the table based on the data of a group, it is easy to visualize the degree of risk of the above example within the parameters of reading fluency.

The second important point to highlight is about the suggestive scale for deficits using the z-score is relative to the baseline data. Depending on the entry (which students participated in the data collection analysis), the table can vary. These results do not represent Brazil, they represent the sample collected for this research. Different contexts can lead to different values. We had a research limit and the data source was limited to the city of Belo Horizonte. Regarding the strategies for schools, we have two possibilities. The first would be software capable of carrying out this detection automatically and able to stratify considering local particularities. The second more expensive strategy would be to conduct this research nationally, collecting data from all states and the Federal District.

The results of the research showed the development of reading fluency with the progression of students through the school cycle, from primary elementary to secondary elementary school, in line with other studies that establish a relationship between reading fluency and progression in school levels^(6, 7,17,19,20,30).

The reason for this research was motivated by the requirement to establish parameters to evaluate the rate, accuracy and reading fluency of Brazilian students. For this reason, research that investigates students from different educational systems and regions of Brazil is indispensable, in addition to extending to other cycles of Brazilian education, such as High and Higher Education in order to gain an overview of development and other information about consolidation of the skill in the national education system. Longitudinal research is also needed to provide information on the development of fluency and how it changes over time, the contributions of specific instructional practices, the relationship with school grades and how the reading experience impacts the development of skill and efficiency. Like any study conducted in a specific location in a country as large and extensive as Brazil, the results should be treated with caution before using in other locations.

Another limitation of this research is in the parameters chosen for analysis. The choice of temporal parameters exclusively, disregarding the fundamental frequency variations make it impossible to analyze the reading in tonal groups. We suggest that future research also contemplates the melodic variation together with the duration parameters for the analysis reading development.

CONCLUSION

The study showed the development in reading speed between the 2nd and 7th year of elementary school, and from the 7th to 9th year, despite the increase found in the averages the statistical analysis did not show any significance. Such measures of the expected values for each school year are essential to better understand the reading development of students, to provide reference standards for adequate monitoring in the clinical and educational scope and to predict schooling skills and difficulties.

The results showed an association between progression in school grades and reading skills. Reading assessments provide critical and timely information to identify students who require immediate attention, and reading speed is a potential measure to make a brief measurement of students' educational performance and development as they progress through school. It must be emphasized that there is a need for further studies of the development of reading, as well as a proposal of the expected parameters for each educational level.

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Author contributions

LMA - responsible for the research, data collection, analysis of results, review of the study and approval of the final version to be published. VOMR, LCC and ICCM - responsible for supervising the research execution, data analysis, study review, approval of the final version to be published. LFS - responsible for data analysis and writing of the article. IMC, GLR and LSCF - responsible for data analysis and checking and supporting the final text construction.