



Reading comprehension of mathematical problems and narrative and expository texts: an eye-tracking study

Compreensão leitora de problemas matemáticos e de textos narrativo e expositivo: um estudo com rastreamento ocular

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ABSTRACT: This research investigated the reading comprehension of mathematical problems of students with better and worse performance in reading, called as effective and ineffective, being this performance measured by reading and comprehension tests of narrative and expository texts and by the average school performance in the subject Portuguese Language. 30 students read and mentally calculated six math problems, while their eye movements were recorded. Analyzes have shown that effective readers read in less time, made fewer fixations and saccades compared to ineffective readers. The results indicate that the worst performance in solving mathematical problems is attributed to the inability in reading and comprehension, and it was concluded that the good performance in reading and comprehension enables the acquisition of knowledge in all areas.

KEYWORDS: Reading comprehension; eye movement; reading in mathematics; textual genres.

RESUMO: Esta pesquisa investigou a compreensão leitora de problemas matemáticos de estudantes com melhor e pior desempenho em leitura, denominados eficazes e ineficazes, sendo este desempenho em leitura medido por testes de leitura e compreensão de textos narrativo e expositivo e pela média do rendimento escolar na disciplina de Língua Portuguesa. Os 30 estudantes fizeram a leitura e o cálculo mental de seis problemas matemáticos, enquanto seus movimentos oculares foram gravados. As análises demonstraram que leitores eficazes leram em

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menor tempo, fizeram menos fixações e sacadas em comparação aos leitores ineficazes. Os resultados indicam que o pior desempenho na resolução dos problemas matemáticos se atribui à inabilidade em leitura e compreensão e concluiu-se que o bom desempenho em leitura e compreensão propicia a obtenção dos saberes em todas as áreas.

PALAVRAS-CHAVE: Compreensão leitora; movimentos oculares; leitura na matemática; gêneros textuais.

1 Introduction

Teaching how to read is one of the most crucial tasks of the school since it is believed that, by achieving this goal, other educational objectives will also be reached. Reading comprehension is considered an essential tool for learning in many areas of knowledge. Proficient readers have the ability to monitor their comprehension while reading different textual genres, and therefore, they are able to regulate cognitively their own learning. This, as a result, leads to a more effective school performance (PEREIRA, 2022).

Reading is an active, dynamic, interactive process of representation, construction, and reconstruction (GOODMAN, 1987; SOLÉ, 1998; KATO, 1990; LEFFA, 1996). To read, the reader needs to have mastery of reading and to dialogue with the text through an active posture according to what he or she intends for reading.

Thus, reading comprehension is the purpose of reading. If comprehension is the essence of reading, the readers must not only master the decoding of the code, but also activate their prior knowledge in constant interaction with the information contained in the text to transform the information into knowledge.

Given the importance of understanding what one reads, the Brazilian reality observed by teachers at all levels of education and verified in the results of large-scale evaluations applied to students in elementary school is that there are real difficulties in reading and comprehension as well. Based on the National Institute of Educational Studies and Research (INEP, 2017), the results of the 2017 SAEB general evaluations in Portuguese Language (Reading) were level 4, as an average on the proficiency scale from 0 to 9 in 5th grade and, in

9th grade of School, the average proficiency achieved was level 3 on the same scale (INEP, 2017).

In this context, Fini and Calsa (2006) state that school failure, especially in Elementary School, has grown significantly, which is due to the difficulties in learning the different contents of the subjects taught. This failure is closely related to unsatisfactory performance in the learning of subjects, which has as its main cause the mastery of reading.

In this direction, Freitas and Rocha (2003) state that low school performance is verified by difficulties in reading, because reading comprehension is a tool for all forms of knowledge acquisition, therefore for learning. In this way, students who do not show comprehension when reading will surely present difficulties in learning the contents of the subjects. Albuquerque and Morais (2005) point out that students with difficulties in reading and comprehension have disadvantages in learning all areas of knowledge, which results in barriers that are sometimes insurmountable.

The capacity of effective reading and comprehension permeates all areas of knowledge. For example, in the area of mathematics, during the reading of mathematical problems that contain graphs and tables, it is necessary to understand them and later solve them; the teacher needs to work with language in order to allow the students to read and understand the statements and plan their actions through the mother tongue, oral or written (PEREIRA *et al.*, 2019).

About narrative and expository texts, a relevant topic in this research as well as mathematical problems, Eason *et al.* (2012) state that narrative texts contain structural and compositional elements different from expository texts, therefore, in reading these texts, different cognitive processing occurs, requiring different skills, which only effective readers can put into practice.

Thus, the present research investigated the reading comprehension of mathematical problems of students with better and worse reading performance, as measured by reading comprehension tests of narrative and expository texts and by the average school performance in the Portuguese Language.

2 Reading Comprehension

Reading comprehension is understood by the authors of this study as the result of the correlation between different cognitive processes. It does not materialize only in decoding, word recognition and construction of meaning, but requires memory, the use of reading strategies, metacognitive skills, and previous knowledge of both the subject as well as the textual genre (KINTSCH; DIJK, 1978).

Reading involves processes of word recognition and comprehension. They occur through direct visual processing or phonological mediation, according to dual-route models (DEHAENE, 2012b; CAPOVILLA; CAPOVILLA, 2000). The visual system captures and decomposes the word into graphemes, syllables, and roots. This recognition of the internal and constituent parts of the word as a visual object occurs in the brain (COSENZA; GUERRA, 2011).

Decoding is performed by phonological and lexical routes, the first one performs a combination between graphemes (letters) and phonemes (sounds) and the second one gives access to the semantic content of the words (meaning). The combination of the two paths characterizes fluent reading (DEHAENE, 2012b; CAPOVILLA; CAPOVILLA, 2000).

These reading pathways, according to Dehaene (2012a), are complementary and related pathways. The reading process is composed of comprehension and decoding, understanding of the text goes through the recognition of the word and mastering the functioning of the alphabetic code (MORAIS, 1996; DEHAENE, 2012b). The visual system of word recognition communicates with the subsystems of access to the lexicon until it reaches the recognition of pronunciation. According to Dehaene (2012a), word recognition results from a process of combining several brain systems by entering the visual input.

The visual input is fragmented and reconstructed to be recognized. When there is recognition, the lexical route operates; when there is no visual recognition, the phonological route operates so that the reader performs the correspondence of graphemes and phonemes to access the meaning (DEHAENE, 2012b). The visual recognition process interacts and changes

constantly, thus reading involves a set of internal and environmental actions and interactions that provide constant organization and reorganization in multiple linguistic and cognitive processes (DEHAENE, 2012a).

For Sesma *et al.* (2009), cognitive processes in reading competence show that working memory skills, as well as attentional alternation, organization, and planning, store, organize, and integrate information so that the individual assigns meaning to what he or she has read, in order to collaborate to reading comprehension.

According to Kintsch and Van Dijk (1978), high-performance cognitive processes, such as memory skills, inferences, and previous knowledge, help the reader to understand the macrostructure of the text being read. Hence, reading comprehension is the result of a combination of different cognitive processes, since the recognition of words and their meaning is not sufficient for the successful comprehension of texts from different areas of knowledge.

3 Reading in Mathematics

In the area of mathematics, working memory contributes to the adequate performance of cognitive skills. There is a relationship between working memory and mathematical activities when it comes to solving mathematical problems and assimilating information to solve calculations. During the information assimilation, the phonological loop is activated and visuospatial sketching is fundamental for solving problems with a lot of data, in which mental representation is necessary (ASHCRAFT *et al.*, 1992).

The central executive acts in task resolution, because it is responsible for starting and ending processing, as well as manipulating the information that is being processed (ASHCRAFT *et al.*, 1992).

Working memory is a structure with distinct components which develops during childhood and adolescence. It allows the individual to solve cognitive activities of everyday life. It works as an area of interaction between short-term processing and storage of information from the external environment and attentional procedures linked to long-term memory. Disturbances in working

memory function generate specific learning problems, such as in solving mathematical calculations (ASHCRAFT *et al.*, 1992).

Reading traverses all areas of knowledge and, for Smole and Diniz (2001), "[a]mong the various skills involved in learning mathematics, the first of them concerns the ability to use languages to learn meanings, transform them and combine them to build new learning."⁵ (SMOLE; DINIZ, 2001, p.11, translated by the authors).

When faced with problem solving, the difficulties encountered may be related to the wording of these problems, not to algorithms or formulas. The difficulties may be in the linguistics, in the semantics of the texts, which prevents students from solving mathematical problems correctly, because they have difficulties in reading and understanding the text (AZEVEDO; ROWELL, 2007).

For Cury (2004), the difficulties in understanding mathematics are related to the insufficient use of the written language in a cause-and-effect relationship. Therefore, the low mastery of the language leads to the failure of learning abstract mathematical concepts, because it prevents the development of mathematical thinking in its different levels.

The development of mathematical thinking, since Elementary School I⁶, starts from an intercession with the first language, through the comprehension of the statements for the construction of concepts in mathematical language, that is, when faced with a mathematical problem, the reader needs to translate the written code into a new language, extract information and apply mathematical concepts to give meaning to this information (MACHADO, 1998; POZO, 1998).

In this sense, Cagliari (2005) states:

The student often does not solve math problems, [...] because they do not know how to read the statement of the problem. They know how to add, divide, etc., but when reading a problem, they do not know what to do with the numbers and the relationship of this, with the realities

⁵ “Dentre as diversas competências envolvidas no aprendizado da matemática, a primeira delas diz respeito à capacidade de utilização de linguagens para aprender significados, transformá-los e combiná-los para construir novas aprendizagens.”

⁶ Elementary Education in Brazil is divided into two groups: initial years or elementary school I, and final years or Elementary School II. According to the Ministry of Education - MEC, Elementary School 1 corresponds to the 1st to 5th year, for children aged 6 to 10.

to which they refer. (CAGLIARI, 2005, p. 130, translated by the authors).⁷

Thus, the student, when reading and solving the mathematical problem, needs "[...] to reconstruct the logic of this text in a mathematical approach. To do this, knowledge of linguistic and mathematical codes are required. Absence in understanding the problem or lack of knowledge will lead to error⁸" (PEREIRA et al., 2019, p. 154, translated by the authors).

Reading is an interactive process between author - text - reader, which allows acquisition of information through predictions and inferences and elaboration of concepts in all areas of knowledge (CAGLIARI, 2005). In Mathematics, in Elementary School, the student is able to elaborate mathematical concepts from a text written in a first language, when the student masters the linguistic and mathematical codes and uses these codes interactively in order to understand the text and elaborate his/her mathematical thinking (CAGLIARI, 2005).

Given the fact that reading and comprehension permeate all areas of knowledge and that students need to use strategies to read and understand mathematical texts, it is necessary to understand the processing of reading, which in this research is focused on the analysis of eye movements.

4 Eye Movements

Eye movements vary between regressive or progressive fixations and saccades. The fixations occur on some words of the text and may or may not be fixed more than once. Short words, on the other hand, are usually omitted. In some way, all words receive some kind of visual processing, although not all words are fixed (RAYNER, 1998). The location of the first fixation is determined by the length of the word, as is the number of fixations within the word. The

⁷ "O aluno muitas vezes não resolve problemas de matemática, [...] porque não sabe ler o enunciado do problema. Ele sabe somar, dividir, etc., mas ao ler um problema não sabe o que fazer com os números e a relação deste com as realidades a que se referem."

⁸ "[...] reconstruir a lógica desse texto em uma abordagem matemática. Para fazer isso, requer conhecimentos sobre códigos linguísticos e matemáticos. A ausência na compreensão do problema ou a falta de conhecimentos acarretará em erro."

most familiar words to readers, those with high frequency in their vocabulary, are the ones with the lowest number and duration of fixations due to their greater contextual predictability (RAYNER, 1998).

Progressive saccades are the leaps that the eye makes from one fixation to the next one, with information processing taking place in the intervals of these fixations. During reading, the progressive saccades occur in a space of seven to nine letters, and the fixations last an average of 200 to 250 milliseconds.

Meanwhile, regressive saccades are movements made in the opposite direction of the reading. They occur 10% to 15% of the time during reading; in less effective readers the incidence of regressive saccades is higher and this group has difficulty in adjusting the saccade to the size of the word with more than five letters; in effective readers, this ocular behavior differs, because they enlarge and adjust the saccade to the size of the word with an increase in reading speed (MURRAY; KENNEY, 1988).

The reading processing in proficient readers begins in the first half of the word, so if the word is processed successfully, the eye moves on to the next word, if there is failure, a second and greater fixation occurs performed near the end of the word (RAYNER, 1998). Proficient readers tend to increase reading speed as the amplitude of the saccade increases, the greater the familiarity with the word, the greater the contextual predictability, which results in a decrease in the number of fixations and their duration, whereas in non-proficient readers, this ability is limited in words with more than five letters (RAYNER, 1998). About children who are finishing Elementary School I, 5th grade:

By age 10, or after 4 years of schooling, the student who is a good reader already presents all the characteristics of the observable behavior of a proficient reader, with only quantitative differences: the distance between saccades is shorter, the fixation pause is a little longer, there are more regressive movements, the distance between the eye and the voice is a little smaller. But the flexibility, or ability to adapt these mechanisms to the difficulty of the material being read, is already developed in the young reader. In other words, he or she is prepared to face the ever-increasing demands of the school, which is

the foundation of the entire educational process of reading (KLEIMAN, 2004, p. 14, translated by the authors).⁹

Therefore, it can be seen that there is a correlation between effectiveness in the eye movement pattern and increased reading ability, which is a determining factor for the present research.

5 Participants

The sample of this research was made up of 60 children, who attended the 5th grade of public schools in the city of Ponta Grossa, Paraná, Brazil. The readers were categorized into three groups: effective readers (E), less effective readers (ME) and ineffective readers (I), based on the results of three instruments:

1) School performance in the subject Portuguese Language, considering the average of the participants' two-quarter grades in Portuguese Language.

2) Reading comprehension of narrative text (Cloze technique)¹⁰. The narrative chosen was Esopo's fable: "John and Mary". The fable contained 37 spaces to be completed with a single word in each space. The choice was made for rigid lacunation "by strictly erasing every fifth word of the text"¹¹ (LEFFA, 1996, p. 71, translated by the authors). The lacunated words belong to the following classes: noun, adjective, article, numeral, pronoun, verb, adverb, preposition and conjunction.

3) Reading comprehension of an expository text. The scores were obtained by means of a reading comprehension test validated in Brazil

⁹ Por volta dos 10 anos, ou após 4 anos de escolarização, o aluno que é bom leitor já apresenta todas as características do comportamento observável do leitor proficiente, com apenas diferenças quantitativas: a distância entre as sacadas é menor, a pausa da fixação é um pouco mais longa, há mais movimentos regressivos, a distância entre o olho e a voz é um pouco menor. Mas a flexibilidade, ou capacidade de adaptar esses mecanismos à dificuldade do material lido já se acha desenvolvida no pequeno leitor. Em outras palavras, ele está preparado para enfrentar as demandas cada vez maiores da escola, que fundamenta todo o processo educacional da leitura.

¹⁰ Cloze is a technique that measures the reading proficiency. It consists of leaving out some words in the text to fill in an established time and it is possible to check the skills of inferences, prediction, vocabulary and structure of the textual genre.

¹¹ "apagando rigorosamente cada quinta palavra do texto".

(SARAIVA; MOOJEN; MUNARSKI, 2005). A 172-word expository text entitled "The giraffe" was selected, which deals with the animal's habitat, characteristics, food, natural enemies and defense (SARAIVA; MOOJEN; MUNARSKI, 2005).

After this process, 14 effective readers, 30 less effective readers and 16 ineffective readers were obtained.¹² In this text, the scores of the effective and ineffective readers who read mathematical problems in front of the eye-tracking will be considered, that is, of the 60 initial participants, 30 were considered for analysis regarding eye movements.

The study was conducted in accordance with the Declaration of Helsinki and approved by the Ethics Committee of the State University of Ponta Grossa - Brazil (3,652,707, 21th October 2019).

6 Eye tracker technical specifications

The system utilized in the experimental study, which tracked the children's eye movements, is RED 500 from the German manufacturer SMI (Senso Motoric Instruments), which has hardware with infrared sensors and is used with a DELL Precision M4800 notebook. It has a spatial resolution of 0.03°. This equipment is monocular and records the position, movement, and duration of fixation of one eye or both eyes; in this research, the equipment was configured for both eyes. An infrared light source measures pupil size, pupil position, corneal reflection, and a sample is generated every 2ms (500Hz), which characterizes it as a fast eye tracker.

¹² In the Cloze technique the comparison parameter was the number of correct answers. The correct answers were more frequent in the word classes: articles, conjunctions, pronouns, prepositions and numerals and the errors were more frequent in adverbs, adjectives, nouns and verbs. In the expository were text reading comprehension test, comprehension questions asked before reading, during silent reading, during oral reading and after reading. Question data was organized as reading skills and compared across readers. In the academic performance test in Portuguese, the averages of two quarters in the subject were observed and the averages of the readers were compared. The three research steps served to categorize readers into effective, less effective and ineffective in order to guide the analysis after data collection with the eye tracker and answer the guiding research question: What impact can effective reading comprehension have in reading both narrative and expository texts and mathematical problems by 5th year students?

The tracker has the iView software that captures eye movements, BeGaze that manages and tabulates data reports, and Experiment Center, where the stimuli were created. For greater reliability of the data, the participants sat at a distance of 50 cm from the monitor (where the stimuli were projected) with 9 calibration points. The calibrations and validations were done at the beginning of each stimulus, with a 0.5° limit in the x and y axes.

7 Procedure

The instrument consists of 6 stimulus-questions which were adapted from the Prova Brasil or taken from pedagogical books. For the selection, the Mathematics reference matrix of the 5th year of elementary school was considered regarding the theme: "Treatment of information" and the "Descriptors D27 - read information and data presented in tables and D28 - read information and data presented in graphs (particularly in column graphs).¹³" (INEP, 2017, translated by the authors).

The stimuli are composed of a statement, a direct or indirect question, a chart or table, and four multiple-choice alternatives (A, B, C, D). Figure 01 shows an example¹⁴.

¹³ "Tratamento da informação" e aos "Descritores D27 – ler informações e dados apresentados em tabelas e D28 – ler informações e dados apresentados em gráficos (particularmente em gráficos de colunas)."

¹⁴ All stimulus questions used are annexed.

Figure 01 - Screen of the Experiment Center with stimulus-question I

Leia a tabela de venda de sorvetes da Sorveteria Chiquinho e responda: Quais as duas estações que venderam mais e menos sorvete, nesta ordem?

Estações do ano	Quantidade de sorvetes
Verão	3.658
Outono	632
Inverno	447
Primavera	2.836

A) Outono e Verão
B) Primavera e Inverno
C) Verão e Inverno
D) Verão e Outono

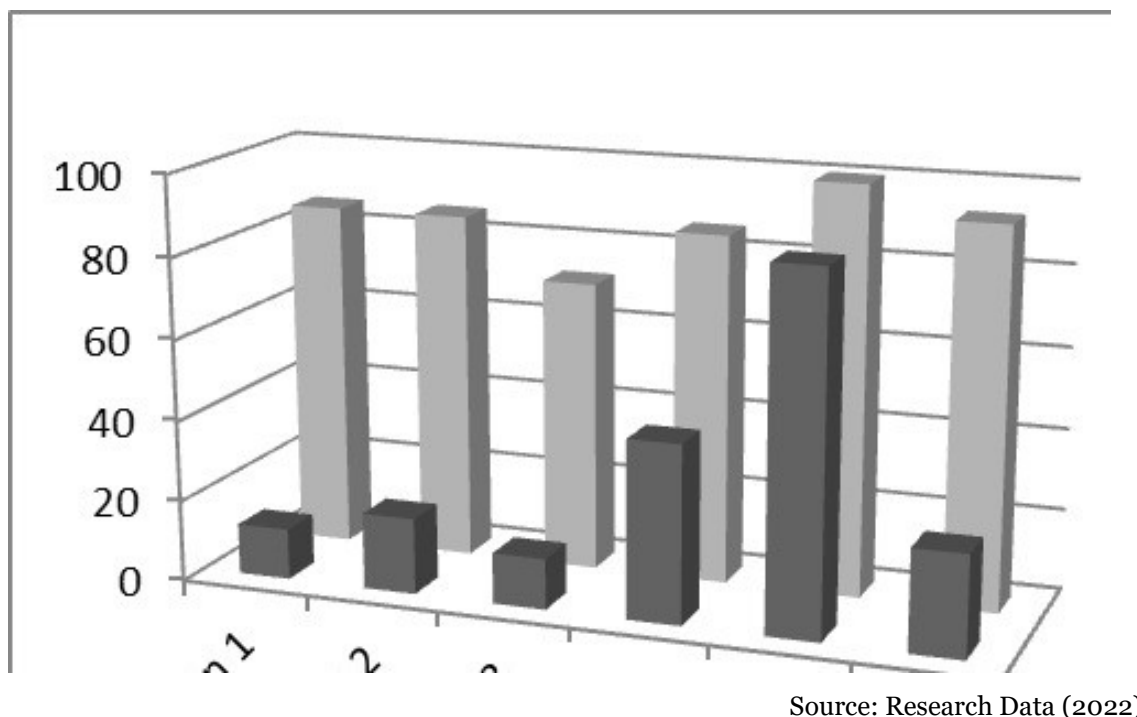
Source: *BeGaze* (2019)

8 Data Analyses: hits and misses of the questions

As for the successes and errors of the effective and ineffective readers on the six questions, we chose to make a general survey, with graphical representations to summarize the results.

The performance of the effective readers was highly satisfactory, with a success rate ranging from 71% to 100%.

GRAPH 1- Correct answers from effective and ineffective readers



Regarding the performance of readers categorized as ineffective, the number of mistakes was much higher than the number of correct answers. Only in question 5, the number of correct answers was expressive. The ineffective readers reached a percentage of correct answers that varied between 12.5% and 43.7% in questions 1,2,3,4 and 6. Only in question 5, the percentage of correct answers was 87.5%.

9 Data Analyses: eye movement data

To analyze the ocular variables reading time, number of fixations and saccades it was necessary to:

- Export the quantitative data from the BeGaze software;
- Select the participants belonging to the groups of effective and ineffective readers in each stimulus-question;
- Organize the data in spreadsheets;
- Process and select the data in the spreadsheets;

e) Export the qualitative data from the BeGaze software (the modules used were: AOI Statistics - Single for reading time; AOI Statistics - Trial Summary for the number of fixations; Event Statistics - Trial Summary for the number of saccades).

9.1 Reading Time

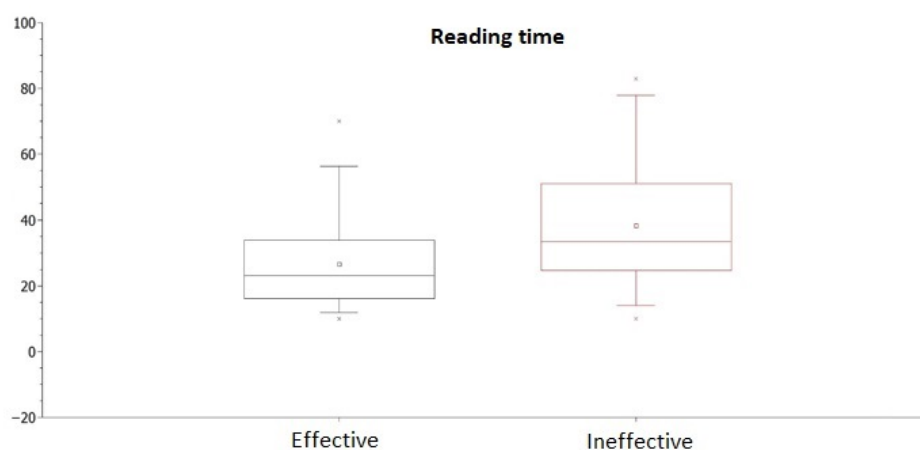
To obtain the reading time, the data were exported in milliseconds of the variable visible time in each of the six questions of effective and ineffective group participants.

These data were subjected to the Shapiro-Wilk normality test, which signaled that the distribution is not normal in both the effective readers group (p-value= 0.000002) and the ineffective readers group (p-value= 0.0002) with $p < 0.05$.

Given the non-normality of the sample, the Mann-Whitney test was applied and showed that there is a significant difference in the reading time of effective and ineffective readers ($p < 0.0001$). Overall, the group of effective readers showed shorter reading time compared to the group of ineffective readers at an observable 95% confidence level.

In Graph 2, when considering the median reading time of effective readers, we have the value of 23 seconds and of ineffective readers we have the value of 33.5 seconds. The data in Table 1 reveal that the average, the median, and the standard deviation of the ineffective readers were higher compared to the effective readers. Noteworthy is the average reading time in the questions of ineffective readers of 38 seconds and of effective readers 27 seconds.

GRAPH 2 - Boxplot of the reading time (question 1 to 6)



Source: Research Data (*Qtiplot*)

Table 1 - Statistical data of the reading time

Reader Groups	Average	Median	Standard Deviation
Effective	26,61s	23s	13,86s
Ineffective	38,29s	33,5s	18,74s

Source: Research Data (*Qtiplot*)

The data in Table 1 together with Graphs 1 and 2 suggest that effective readers read faster and tend to have greater understanding (evidenced by the higher number of correct answers) than ineffective readers.

9.2 Fixations

In this item, it was decided to consider for analysis the variable fixation count, establishing the sum of the fixations and the white space^{15 16}, in order to obtain the total number of fixations per questions in the groups of effective and ineffective readers.

The Shapiro-Wilk normality test showed that both the distribution of effective readers (p-value = 0.0003) and the distribution of ineffective readers (p-value = 0.00005) is not normal with p-values <0.05.

Upon finding the non-normality of the sample, the data was subjected to the Mann-Whitney test which showed that there is significant difference in the total number of fixations in the groups of effective and ineffective readers (p <0.05). In general, the group of effective readers made fewer fixations on the questions compared to the group of ineffective readers observed at a 95% confidence level.

In Graph 3, when considering the median, the total number of fixations of effective readers is 84 fixations and of ineffective readers is 122 fixations. The data exposed in Table 2 show that the average of the total number of fixations of effective readers is 94 and of ineffective readers is 139. The median and standard deviation values of the effective readers group are also lower compared to the ineffective readers group.

¹⁵ “Dentre as diversas competências envolvidas no aprendizado da matemática, a primeira delas diz respeito à capacidade de utilização de linguagens para aprender significados, transformá-los e combiná-los para construir novas aprendizagens.”

¹⁶ The BeGaze software automatically creates an AOI called a "blank space" that covers all areas left outside the user-defined AOI. A "blank space" AOI is only generated on static stimuli.(SMI, 2017).

GRAPH 3 - Boxplot of the total number of fixations (question 1 to 6)

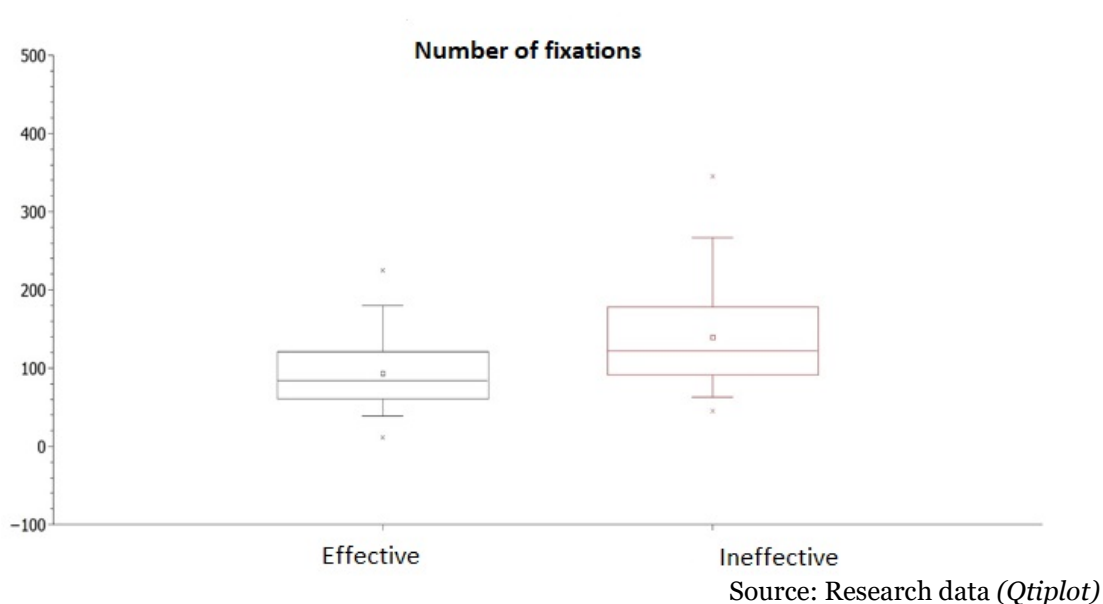


Table 2 - Statistical data on the total number of fixations

Reader Groups	Average	Median	Standard Deviation
Effective	93,85	84	47,01
Ineffective	139,27	122	66,16

Source: Research Data (*Qtiplot*)

Based on the data in Table 2, it is stated that ineffective readers perform more fixations on the questions, while effective readers perform fewer fixations. This fact must be one of the reasons why ineffective readers tend to perform slower readings than effective readers, as found in Table 1.

9.3 Saccades

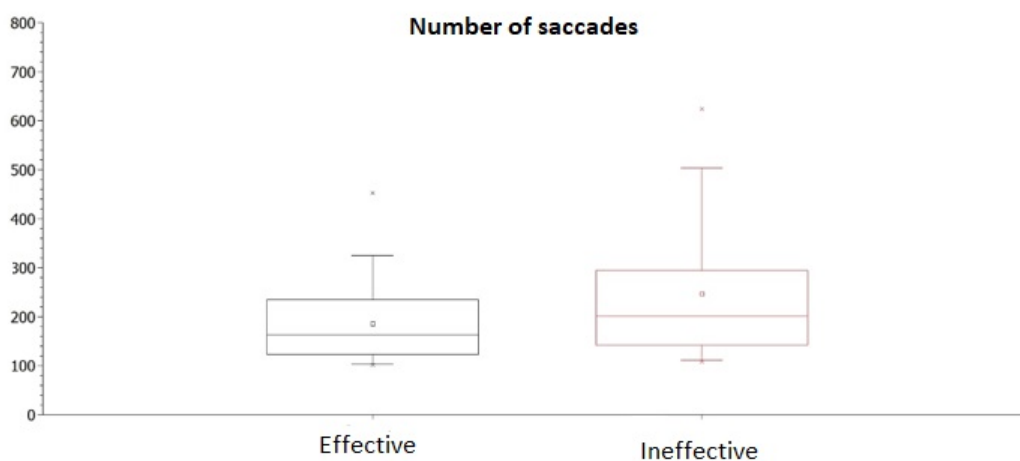
The number of saccades was analyzed based on the saccade count variable, establishing the sum of the saccades in the question and in the white space, in order to obtain the total number of saccades made by the groups of effective and ineffective readers.

The Shapiro-Wilk normality test showed that both the distribution of effective readers ($p\text{-value} = 0.0001$) and the distribution of ineffective readers ($p\text{-value} = 0.0000003$) is not normal ($p < 0.05$).

The data were subjected to the Mann-Whitney test which showed that there is significant difference in the total number of saccades in the groups of effective and ineffective readers ($p < 0.05$). In general, the group of effective readers performed fewer saccades on the questions compared to the group of ineffective readers, observed at a 95% confidence level.

In Graph 4, when considering the median, the total number of saccades of the effective readers is 164 saccades and of the ineffective readers is 201 saccades.

GRAPH 4 - Boxplot of the total number of saccades (question 1 to 6)



Source: Research Data (*Qtiplot*)

Table 3 - Statistical data of the total number of saccades

Readers Group	Average	Median	Standard Deviation
Effective	186,31	164	78,90
Ineffective	247,17	201	134,36

Source: Research Data (*Qtiplot*)

From the data in Table 3, it is asserted that ineffective readers perform more saccades on the questions, while effective readers perform fewer saccades.

10 Discussion of the results

The analyses revealed that the group of effective readers read the text faster and made fewer fixations and fewer saccades on the question. That is to say, the effective readers read more fluently and probably located the most relevant areas of the question, on which they had more visual attention. This behavior revealed that the effective readers knew how to read the proposed text, which strategies to use, and how to reach the understanding of the math problem, the intention of the reading. This group achieved the percentage of correct answers ranging from 71% to 100%.

The group of ineffective readers assumed a different ocular behavior compared to the effective readers, with longer reading time, more fixations and saccades on the questions. It is interpreted that despite allocating more visual attention time on the questions, which could lead to good comprehension, this did not materialize. This ocular behavior revealed that these readers did not know how to read the text, which reading strategies to use, which ideas were the

most relevant, which had repercussions on comprehension failure and incorrect alternative choices. Hence, the percentage of correct answers ranged from 12.5% to 43.7% in questions 1,2,3,4 and 6. Only in question 5, this group got 87.5% of correct answers. It is believed that this better performance in the question 5 is due to the presentation of the bar graph, which, by presenting bars of different sizes, facilitated the reading and understanding of the participants and pointing out of the correct answer.

11 Final Considerations

The analyses performed on the reading time of questions showed that there was a correlation between reading fluency and the performance of the readers. Reading speed is closely linked to effective readers: this group read in less time. In the opposite direction, ineffective readers took longer reading time, which comparatively was considered poor performance. It was concluded that there is correlation between shorter reading time and good performance and there is correlation between longer reading time and poor performance. This conclusion agrees with Rayner (1998), who states that the reading speed of proficient readers tends to increase due to familiarity with the word, which results in a decrease in the number and duration of fixations on the stimulus, leading to a shorter reading time. The reading speed of less proficient readers would be slowed down due to low contextual predictability and familiarity with the words, resulting in a longer reading time.

It is in the learning process that reading comprehension of expository and narrative texts and mathematical problems can have a great impact. The object of this research was reading comprehension, as it is considered a tool for learning. The results of this study showed the difference in the performances of effective and ineffective readers. It is interpreted that these performances are directly linked to learning. Therefore, it is defended that effective reading provides better quality in the acquisition of knowledge and this impacts not only the relationship with the object, but also the cognitive development of the individual. It is through language that individuals develop cognitively, in the

case of written language; the reader builds new mental schemes, he/she is stimulated by the information acquired from the text and this interaction is mediated by reading skills, which results in cognitive development. In short: reading, comprehension and thinking are inseparable.

Reading comprehension impacts not only on the quality of acquisition knowledge, but also in the cognitive development of the individual. The reader learns while reading and continues to learn while establishing new schemas from new readings. Reading, comprehension and thinking are inseparable, because reading and comprehension are cognitive actions. The reader who remains at the decoding level, and does not participate actively and interactively in the reading action, does not understand what he/she reads and, consequently, does not acquire knowledge.

Good performance in reading and comprehension enables the acquisition of knowledge in other areas of knowledge. Consequently, reading is a practice that requires autonomy, in which the challenge is to read to learn, and one can only learn if there is understanding, which is an ability of the literate reader.

As reading is a tool for knowledge construction, good reading performance in the different areas of knowledge guarantees full participation in society. So, schools need to guarantee students the right to read and understand different texts in order to advance in their school careers. This consolidated learning of reading will reach its fullness if teachers base their practices on scientific evidence. (BRASIL, 2019).

Learning to read is not innate, the teaching of reading must happen systematically in the early school years. After the literacy years, students need to have frequent contact with distinct and increasingly complex textual genres to develop skills in reading and comprehension. This development process is autonomous, independent and individual. Therefore, reading is centered on the reader and the text, and results in effective reading comprehension if the reader takes an active and interactive stance, developing cognitive processes of

decoding, memory, fluency, predictions, inferences, and prior knowledge that propitiate learning, that is, the construction of his or her own knowledge.¹⁷

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¹⁷ We suggest reading the thesis that generated this article: <http://tede2.uepg.br/jspui/handle/prefix/3707>

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Annex

Stimulus-question I

Leia a tabela de venda de sorvetes da Sorveteria Chiquinho e responda: Quais as duas estações que venderam mais e menos sorvete, nesta ordem?

Estações do ano	Quantidade de sorvetes
Verão	3.658
Outono	632
Inverno	447
Primavera	2.836

- A) Outono e Verão
- B) Primavera e Inverno
- C) Verão e Inverno
- D) Verão e Outono

Stimulus-question II

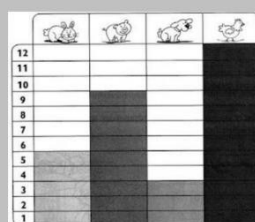
A Escola Pequeno Príncipe fez uma gincana para arrecadar caixas de bombons para doações. Qual ano conseguiu o 2º lugar nesta gincana?

Ano	Caixas de bombons
1º ano	30
2º ano	20
3º ano	40
4º ano	50

- A) 2º ano
- B) 1º ano
- C) 4º ano
- D) 3º ano

Stimulus-question III

Na chácara do senhor Bernardo há muitos animais. Quantos coelhos e galinhas há respectivamente?



- A) 12 e 5
- B) 5 e 12
- C) 9 e 3
- D) 5 e 9

Stimulus-question IV

Na tabela a seguir, está representado o ano das primeiras publicações de algumas revistas.

REVISTAS	ANO DAS PRIMEIRAS PUBLICAÇÕES
Mickey	1928
Zé Carioca	1945
Pato Donald	1950
Garfield	1978
Senninha	1994

A revista que foi publicada na década de 50 foi:

- A) Zé Carioca
- B) Mickey
- C) Garfield
- D) Pato Donald

Stimulus-question V

O gráfico a seguir representa o número de aniversariantes da turma em cada mês. Qual mês teve mais aniversários?



- A) maio
- B) outubro
- C) fevereiro
- D) janeiro

Stimulus-question VI

Quatro candidatos disputaram as eleições para direção de uma escola. A tabela a seguir mostra o número de votos obtidos. Qual candidato ganhou a eleição?

Candidato	Número de votos
Antonio	235
João	108
Marina	320
Alberto	70

- A) Alberto
- B) João
- C) Marina
- D) Antonio

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