



Visual fixations and characters: incidence in the understanding of expository texts

Fijaciones visuales y caracteres: incidencias en la comprensión de textos expositivos

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Abstract

Teachers generally focus on promoting criticality and try, at all costs, to develop intertextuality processes in the student body, leaving aside the other essential levels to achieve the final product. In this sense, it is vital to bear in mind that the order of the factors, in this case, would alter the result, since *velis nolis* must carry out a cycle and specific procedures to achieve the objectives set in advance. For this reason, it is necessary to show that the readings for less and above than expected according to some characters and quantity of fixations affect textual comprehension. On the other hand, a transformative sequential design with a mixed approach was applied to this research, a sample of 80 students from the secondary level of a private educational institution in the municipality of Galapa-Colombia was selected, who read three texts related to the electromagnetism on the Eye tracker T.120 screen and using Tobii.3.4.6 software. The results allow us to confront from the teaching practice different positions on the incursion of these variables in the reading processes. Finally, it is concluded that visual fixations play a main role for the understanding of a text and, therefore, the design of a didactic proposal that takes science and the image as a reference is proposed as a prospective one in order to seek adequate understanding by the student reader.

Keywords: Visual perceptions, expository texts, text comprehension, readability, basic education, electromagnetism.

Resumen

Por lo general, el profesorado se centra en promover la criticidad y trata, a toda costa, desarrollar procesos de intertextualidad en el estudiantado, dejando de lado los otros niveles indispensables para conseguir el producto final. En este sentido, es vital tener presente que el orden de los factores, en este caso, si alteraría el resultado, ya que *velis nolis* se debe llevar un ciclo y unos procedimientos específicos para lograr los objetivos trazados con antelación. Por este motivo, es necesario demostrar que las lecturas por menos y encima de lo esperado conforme a unos caracteres y cantidad de fijaciones inciden en la comprensión textual. Por otra parte, en esta investigación se aplicó un diseño transformativo secuencial con enfoque mixto, se seleccionó una muestra de 80 estudiantes de nivel secundario de una institución educativa privada del municipio de Galapa-Colombia, quienes realizaron una lectura de tres textos relacionados con el electromagnetismo en la pantalla del *Eye tracker* T.120 y con el uso del *software* *Tobii.3.4.6*. Los resultados permiten confrontar desde la práctica docente distintas posturas sobre la incursión de estas variables en los procesos lectores. Finalmente, se concluye que las fijaciones visuales cumplen un rol principal para la comprensión de un texto y por consiguiente, se plantea como prospectiva el diseño de una propuesta didáctica que tome como referente la ciencia y la imagen para buscar la comprensión adecuada por parte del lector.

Descriptores: Percepciones visuales, textos expositivos, comprensión de textos, lecturabilidad, educación básica, electromagnetismo.

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1. Introduction

Although visual fixations may have applications in various areas (Clay et al., 2019), their impact on understanding expository texts has not been explored in High School (EBS), specifically in topics about electromagnetism (hereinafter *emg*), characterized by having complex and difficult-to-access content, since the paragraphs they present are loaded with a specific discourse, monosemic, with a lexicon stratified and directed to a particular audience; moreover, it must be analyzed from semantic and pragmatic perspectives that facilitate access to textual understanding. Therefore, it is essential to address from this study those cognitive aspects related to visual fixations, the general characteristics of expository texts, their understanding and the easiness to read (Jarodzka & Brand-Gruwe, 2017).

1.1. Visual fixations

According to Reyes (2017) visual fixation is “the duration of the visualization committed to a particular objective located in the foveal range of the human eye” (p. 27). On the other hand, the ones removed are the rapid eye movements that occur between different fixations that are evident against a stimulus object. Then, as a consequence, the number of fixations produces a numerical measure that carries intrinsic information to assess, in a certain way, the ocular behavior.

Likewise, according to Gila et al. (2009), the eyes have inner muscles that regulate the diameter of the pupils and the coverage of the lens, since it has movements driven through certain cranial nerves such as the third, fourth and sixth, they achieve that the image is focused on the retina, allowing to obtain the external information necessary for understanding. There are three types of eye movements in humans: automatic movements, voluntary refixation movements, saccadic, and micro-movements related to ocular fixation, micro-saccadic and derivatives.

Finally, according to Rayner et al. (1996) the time of fixation when reading texts is defined by variables such as the frequency of words, the ambiguity of the lexicon, semantic relations, anaphors, contextual constraints and syntactic complexity. In addition, it is linked to linguistic variables that are intimately connected with the eye movements of each individual.

1.2. General characteristics of the expository text

According to Alonso and Seré (1997, p. 320): “Expository texts are very difficult to understand because of their characteristics”. This textual typology includes in its traits a lexical selection, i.e., the use of endocentric monoreferential terms that are suited to a monosemic linguistic content where the use of synonyms is avoided.

Secondly, it incorporates its own terminological field, i.e., it has a relationship between the exclusive texts and their meaning; i.e., they lead to the production of new documents with a cult lexicon that lead to conceptual coherence.

Third, expository texts have sociolectal variation, which implies the use of vocabulary and its relationship with a specific area of knowledge. This textual typology extends to a reader who must have special characteristics such as belonging to a social homogeneous sector, possessing some cultural background around sciences. Indeed, the greater understanding about the sociolect used in the text, the greater the possibility of understanding the individual.

Another condition is the syntactic organization or linguistic economy in textual content, with specific vocabulary and specific and concise descriptions. The scientific and the syntactic must be prioritized for a specific description; it tends more to explanation and description than to narrative and argumentation; it lacks of quantifiers and uses few qualifiers because of its structure. In addition, it uses precise scientific objectives with a purpose.



Finally, there are not rhetorical elements, i.e., the existence of linguistic neutrality, which implies descriptive efficiency, omission of some semantic expressive elements that reduce the length of the text, but not its scientific purpose.

1.3. Understanding Expository Texts

From a linguistic perspective, comprehension is related to communicative processes, the connection between text, reader, context and author, all seen from different angles to achieve assimilating communicative intention and facilitating the process of textual comprehension. Martínez et al. (2008), define the comprehension of texts as:

A series of cognitive processes that involve forming and connecting propositions in a sentence, making inferences for those that connect textual and knowledge-based elements, and forming macro-ideas or information integration structures. (p. 321)

According to López and De León (2017, p. 270), expository texts are “those that provide reliable information, justifications about events, phenomena, and topics, and whose purpose is to inform and/or persuade the reader”. These authors also state that understanding involves a cyclical procedure that requires integration and construction of meanings, and to achieve understanding it is essential to go through three levels of representation: first the creation of a mental model in which the text is broken down, the processing of the data and the link of the data with lexical, hierarchical and linguistic structures; subsequently, micro and macro structures would be created, consisting of a two-level propositional abstraction network of the meaning of the text, one from the local and the other from the global of the text.

Therefore, when it comes to textual comprehension, it refers to the complexity of the text and its inherent characteristics (López and De León, 2017). In this way, the expository texts require that the reader is more committed and has

prior knowledge in order to access interpretation and later understanding. Therefore, to understand it is essential to implement an author-reader correlation, so it is inescapable to relate experiences and emotions that link the new content with the previously acquired knowledge.

Another relevant aspect is the identification and interpretation of the lexicon, which facilitates semantic understanding; then a wrong interpretation of the glossary produces misunderstanding. This textual typology is impersonal, objective and accurate, which are characteristics typical of science and that are complemented with didactic resources and strategies such as graphic organizers, which could guarantee the effectiveness of understanding.

Likewise, an expository text has specific characteristics that make it more complex for its interpretation; its function is also determined and contextualized from the scientific perspective.

Similarly, Alonso and Séré (1997) say that:

An expository text has certain characteristics that make them complex as belonging to an area of knowledge, having a speech with specific syntax and the determined use of the language; they also have lexical or specific terms that make understanding more complex because they are in an academic environment detached from everyday life. (p. 321)

Finally, it can be said that the reader is the main responsible for the process, since its motivation to read and its interpretation facilitates access to content. On the other hand, the text should serve the reader as a facilitating mechanism for extracting data on functions, classification, purposes, communicative intention and characteristics of the document.

1.4. Readability

Readability is a term seen from different perspectives. In the first instance, according to Sigaud-Seals (2010) from the stylistic is the extension of phrases, periodicity of expressions, syntactic and



morphological aspects that determine the proper and assertive reading that enables the comprehension of texts. On the other hand, Campos et al. (2014) affirm that “readability is the ease/difficulty with which a text can be read and understood” (p. 16). This means that understanding depends on the optimal performance of the process. It is not just decoding, it is the domain of visual resources and its association with written documents for the purpose of allowing instant understanding (Rojas et al., 2020).

It should also be noted that the lexical diversity of texts requires the reader to take a motivational attitude to understand, since he/she must associate the greatest number of words. Therefore, if the reader does not know the vocabulary, their understanding will be inconclusive or null. On the other hand, syntactic complexity can affect an individual’s reading performance, because he/she must understand the structure of sentences and pragmatic content; in other words, short, simple, and simple propositions will be easier to interpret than compound sentences.

In short, the more complex the text is, the more difficult it will be to understand it, since it is up to the reader to associate lexical terminologies, grammatical and syntactic aspects that relate pragmatically in the same content. As a result, they have an impact on reader performance and on the behavior of readers over the text.

2. Methodology

A sequential transformational design was applied, which means having as its purpose a transformative conceptual frame of reference, or defense of a specific ideology, as well as implementing from the quantitative phase or the qualitative phase a series of resources on equal scale to achieve certain research goals (Cresswell et al., 2008). Based on a quasi-experimental design (Ramón, 2000) and under the guidance of a mixed approach, a sample of 80 schoolchildren from 7 and 8 grade levels of secondary education were selected, who belong to Centro Educativo Mixto de

Galapa-Colombia, a private school located in Barranquilla, to be able to analyze whether the readings of *emg* related topics performed above or below the expected level according to a few characters and number of paragraph fixations affect the understanding of expository texts.

This sample was selected from a population of 112 students, and control variables were included, such as being from 12 to 13 years old, not having visual or cognitive deficits and not having prior knowledge regarding the subjects of the texts. It was also necessary to apply an operational memory test (Wechsler Subgroup), bearing in mind that participants had to exceed the lower limit (16).

Regarding the quasi-experimental, what was done at random was to assign an experimental group to the sample members by simple and systematic random sampling units in four groups of 20 participants A, B, C and D.

Initially, children read individually on the Eye tracker T.120 screen three readings related to battery, alternator, and electric chimes after having observed images on different scales of iconicity, then each student was tested for understanding expository texts (hereinafter TPC) (Martinez et al., 2008), in which the texts appeared again with a series of items that allowed to verify if the readings on the screen could affect the results of the test conducted.

The *emg* topics selected for this research were not part of the program for the sample participants. The texts about the battery, the alternator and the chime were submitted to experts in the areas of cognition, language and physics teaching. Criteria such as macrostructure, superstructure, model, functionality, clarity, coherence and relevance were a reference point based on the reconstruction of texts. For this purpose, an example of evidence related to the text “The Penguins” taken from Martinez et al. (2008) allowed to make adaptations from the semantic-conceptual aspects, the structure of the items to be evaluated according to the educational level of the schoolchildren and the characteristics of an expository text, as shown in table 1.



Table 1. Items of the TPC

Capture of ideas in a sentence	Anaphoric inference	Inference-based on knowledge	Formation of macro-ideas
The Reader must			
Break down the sentence into propositions; analyze the semantic and syntactic relationships that propositions have with each other.	Connect two ideas that appear in the text.	Activate previous knowledge schemes.	Select what is common with the topic read, omitting non-essential information.

Source: Padilla (2020, p. 316).

It is necessary to emphasize that the TPC was validated, so a pilot test was previously conducted on 80 schoolchildren of Institución educativa María Auxiliadora de Galapa-Colombia. It was necessary to guarantee that vocabulary, grammatical structure, language, and format of items were appropriate for the student, and time duration was determined by cognitive processes or complex skills involving this type of testing (Medina-Díaz & Verdejo-Carrión, 2020).

Regarding the validation of the test, the results showed that children presented difficulties in three questions, and these were subjected to a restructuring process. Each assertive answer was scored with 0/1 points, with the highest score being 18 points, as there were six questions per topic. From this pilot, it was established that one hour and 30 minutes must be taken into account to apply TPC with this type of texts, an overall time used by the group of participants.

Using the Tobii 3.4.6 software, CF (number of fixations) was evaluated in school children using the Eye Tracking technique, which is intended to “record information about what the participants found interesting, i.e., this caught their attention during the various observations of the images presented in the software” (Duchowski, 2007, p. 5).

3. Results and analysis

The number of characters versus the number of fixations in reading comprehension processes

were taken into account, which were criteria that enabled, with the help of the Tobii 3.4.6 software, to identify whether children read less than expected (i.e. below the number of fixations set out in Table 2); read more (above the number of fixations set out in Table 2); made incomplete readings; did not read the texts related to the battery, the alternator and the chime; and how they became a reference for checking the results obtained in the TPC.

Less fixations are related to regressions and more fixations are directly related to refixing. According to Fernández (2011), “Refixations, reflect the difficulty of lexical processing of the word and regressions may also be an indicator of an oculomotor difficulty, where there is an adjustment of the fixation position in the word, without taking into account the lexical state of the fixed word” (p. 52-53). However, other explanations about regressions are related to those presented by Tremps-Garín (2014), who claims that regressions present in the reading processes are characterized by giving importance to the observation of the most distinguished aspects of the text; in addition, it includes aspects of textual reading such as retaking words, misread phrases, check meanings and make corrections in oculomotor failures.



Table 2. Number of characters and fixations for each paragraph

Topics	Number of characters	Number of Fixations or CF (Number of Fixations)
Battery		
Paragraph 1	277	39.6
Paragraph 2	332	47.4
Paragraph 3	501	71.6
Alternator		
Paragraph 1	188	26.9
Paragraph 2	305	43.6
Paragraph 3	414	59.1
Chime		
Paragraph 1	199	28.4
Paragraph 2	254	36.3
Paragraph 3	367	52.4

Source: Padilla (2020, p. 208)

Based on the above table, the following results were obtained per group from the data provided by the software:

Group A

Group A identified three incomplete readings in paragraph 1 related with the battery, and 1 in paragraph 3 of the same text. Three incomplete readings were also found in paragraph 1, 3 in paragraph 2 and 1 in paragraph 3 of the alternator. Only 1 fixation above the expected level was identified in paragraph 1 of the alternator (26.9 fixations). Only incomplete reading in paragraph 1 was seen by a student on the chime reading. More than expected fixations were observed in the reading of the text related to chime in paragraph 1 (28.4 fixations) and 1 in paragraph 3 (52.4); 2 in the text of the battery in paragraph 1 (39.6), 2 in paragraph 2 (47.4) and 2 in paragraph 3 (71.6), unlike the alternator on which 1 fixation was obtained in paragraph 1 (26.9 fixations). In the TPC result, the hits on the battery paragraph were higher, and the least hits were

on the chime. From 20 school members of the group, 12 passed above 50% the 18 test questions.

Group B

Incomplete readings were present in group B; this is seen in the reading in paragraph 1 related to the battery in which two children did not do the reading as expected; thus, it happened once in paragraph 2 and two in paragraph 3. Five children in paragraph 1, two in paragraph 2 and two in paragraph 3 did not fully read the alternator text. The text about the chime was read in its entirety by all members of the group. Regarding the above-expected fixations, it can be said that they focused more on chime, 1 in paragraph 1 (28.4 fixations), 1 in paragraph 2 (36.3 fixations) and 4 in paragraph 3 (52.4 fixations). In the TPC result, the hits on the battery-related items were higher and the hits on the chime were lower. From 20 children, 13 passed over 50% the 18 test questions.



Group C

Regarding group C results, six readings were incomplete in paragraph 1 of the alternator, three in paragraph 3 and one in paragraph 2. Regarding fixations, two above those expected were equally present in paragraph 1 (39.6 fixations), paragraph 2 (47.4 fixations) and paragraph 3 (71.6 fixations) of the text related to the battery. Two fixations more than expected were identified in paragraph 2 (43.6 fixations) of the text related to the alternator. When reading the text about the chime, some children exceeded the above-expected fixations, one in paragraph 1 (28.4), one in paragraph 2 (36.3) and three in paragraph 3 (52.4).

Despite the existence of incomplete readings, it can be stated that these occurred generally and to a lesser extent in texts about the alternator. For that reason, the items evaluated in the TPC results showed the greatest number of hits in the alternator text compared to the other texts. The items related to the chime test were the least successful. From 20 children, 13 presented 50% of the 18 questions in the test.

Group D

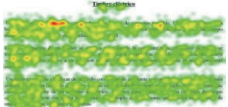
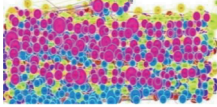
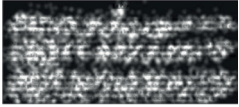
Group D obtained the highest number of fixations for less than expected according to the

number of characters and fixations for reading text on the Stimulus screen. 2 fixations were identified in paragraph 1 of the battery (39.6 fixations) two in paragraph 2 (47.4 fixations) and paragraph 3 (71.6 fixations). A more than expected fixation was obtained in paragraph 1 of the text related to the battery. Less readings were also identified in the texts about the alternator in paragraph 1 (26.9 fixations) by three children, whereas in paragraph 2 (43.6 fixations) three fixations were more than expected and three in paragraph 3 (59.1 fixations).

The text related to the chime had a fixation above the expected in paragraph 3 (52.4 fixations) by a student. The items evaluated in the Expository Text Understanding (TPC) test yielded results in the text related to the alternator, the items with less success in the answers are those related with the chime. In the test, 14 children obtained correct answers above 50% of the 18 questions in the test. No incomplete readings were performed.

It was possible to know after the observations of the students on the screen stimuli different eye movements and certain phenomena related to the processing of the information, as indicated in Table 3.

Table 3. Phenomena related to the processing of information

Mapas de calor	Mapas de rutas	Mapas de opacidad
		
Fig. Heatmaps. Through these maps “areas with a higher density of fixations are observed, marking with red the areas with more fixations, and it gradually varies to yellow and green as the number of fixations decreases” (Martinez et al., 2015, p. 7).	Fig. Gazeplot. “It serves to provide detailed information about the user’s behavior, such as first fixations, display duration, and locations” (Reyes, 2017, p. 27).	Fig. Opacity maps. They allow to see more clearly the area that has been most observed. They provide the same information as heat maps, but in a different way (Martinez et al., 2015, p.7).

Source: Own elaboration.



4. Discussion

Something that is not taken into account by language teachers or people linked to other disciplines is the fact that visual fixations play a major role in the understanding of a text, because it is through sight that the information enters, which will be then stored in the brain (Dharmawansa et al., 2015). Then all is part of the foveal range of the human eye, the number of fixations, the areas of interest and, therefore, the motivation of the individual to achieve the comprehension of texts. It is important to mention that if there is no motivation there will be no fixations either; without either of them there will be no proper reading process, much less understanding. In this regard, it is consistent to see how the results of the heat maps show that the visual fixations focus on the areas of interest of the student (Cuesta-Cambra et al., 2017).

Questions arise from the above, such as what is more important in an individual's comprehensive reading process, the levels of reading performance or the number of visual fixations that occur during the reading? Why was group D the one who read the most and had less readings than expected? Why was there no overreading in group D?

It is worth noting that teen reading processes are intimately related to different social, cultural and emotional variables. Therefore, to ask whether a text addresses the same issue in terms of coherence and global cohesion, what makes paragraph 3 to be more understandable and have more readings than expected, while at the same time it has more incomplete readings or null readings?

In this part, it is worth citing Pozo (1996) from the Piaget view of psychology, who examines some considerations that may answer these questions. Thus, in the cognitive perspective, there are mutations in terms of formal thoughts and operations. In other words, teenagers stop thinking and acting as a child, begin to think and conceive reality in a different way, their objec-

tives change, they tend to see contents not from the level of the concept or definition but from the practical aspect.

The understanding of a scientific text is very complex since the terms used are generally monosemic, circumvent the use of synonyms and tend to be specific in an area of knowledge. This could be a reason why refixations and regressions are relevant in readings (Fernández, 2011; Tremps-Garín, 2014), because reading less or more regarding a certain number of character fixations in the paragraphs of this type of text would be more linked to a language that is not so common in the school group; as well as because it has very complex characteristics that prevent reaching higher levels of understanding. However, it is not always true to say that one cause of regressions is oculomotor failures. It is therefore necessary to build on previous knowledge to enable the acquisition of new material on the subject (Olivo-Franco, 2021).

In addition, motivation determines understanding and can therefore be considered an internal and positive attitude that facilitates learning (Carrillo et al., 2009; Herrera y Fraga, 2009). The reader must have a reading purpose, goals that allow him/her to be motivated. The reader must perceive the text from a pragmatic perspective, in which he/she relates it with the context. Then, it is necessary to recognize the communicative context of the text, to relate it to the immediate and cultural context to have clear interests and to understand the senses of the document under study. In this way, pragmatics involves critical analysis by the reader, creating understanding.

Teachers normally do not take into account the time students spend reading texts, which limits them in the process. In the image, for example, there is a limited time of 18 seconds of observation and this was observed when piloting observations of images related to electromagnetism with three students, since there were some distractions on the screen of the Eye tracker T.120 after this time (Padilla, 2020); however, the length of the



paragraphs at various times generates discouragement and fatigue for reading. Thus, the three texts used on this research only had three paragraphs, in which the student had to select the topic read and omit the non-essential information, all this using previous knowledge.

Other important assessments refer to examining whether the length of paragraphs and texts generally influenced the fact that some students did not read or overread, such as demotivation, fatigue and eye fatigue.

5. Conclusions

Most readers have difficulties in understanding expository texts because they normally lack of a rich and suitable vocabulary that allows them to access a coherent discourse to describe what is observed. Grammar structures, visual perceptions, and student interests are the main influencing factors of reading comprehension processes, because lack of reading, overreading or the comprehensive reading depend on these processes. It is necessary to emphasize that the time devoted to these activities is scarce, since generally, the teaching-learning of reading is presented as a finished product that does not keep a sequential and continuous process, which must be in constant evaluation.

Another aspect to keep in mind is the incidence of perceptive stimuli of the eye fovea in texts, the areas of interest and the understanding of semantic resources inherent in the document faced by the reader, who must be motivated and must understand the terms found in the document to facilitate the understanding of the document.

It should not be ruled out that although there is a high degree of visual capture and fixation, such processes in which information is extracted and organized would also be influenced by the fixation levels of the established parameters by the quantity of visual fixations, overreading, the different regressions formed during the reading process, the emotional states, the interests of the reader, among other aspects.

On the other hand, humans have unique capabilities to use sight quickly, effectively and automatically, without requiring additional effort (Trempe-Garín, 2014; Reyes, 2017). These skills are the result of the number of fixations that were captured during the specific observation of an area of interest; these areas significantly influence the semantic understanding of expository texts.

However, the processes of accommodation, convergence, divergence and binocular vision do not lose their sequential disposition. This situation occurs in the reading of expository texts by saccadic movements, which are fast and irregular, and orient the look toward visual stimuli whose variations in number, speed, length of the text and the motivation of the reader acquire importance in the cognitive processes.

The process of reading comprehension requires a variety of elements other than those commonly worked in schools, as cognitive, metacognitive, biological, emotional and psychological aspects are envisioned. It is important to mention that expository texts can generate minor fixation guidelines because of their intrinsic characteristics. In contrast, this research determined through the Eye tracker test that a minimum group of observers did not fix their eyes on all areas of interest present in the images and ignored the title of each of the texts in the TPC test; likewise, some only read sentences present in one paragraph, others read in one, two, or three paragraphs; and many others read absolutely nothing.

On the other hand, the pedagogical and didactic strategies presented in the text would be useful to facilitate the understanding, as well as the interest presented by the reader. For this reason, expository texts are aimed at an objective group with specific characteristics that restrict the actions of the reader.

As described above, it is confirmed that expository texts have certain limitations for an audience not prepared for their understanding. All of these are limiting aspects to achieve tex-



tual understanding, but it is the task of teachers to find the tools to guide children to find the appropriate process to understand what they read. It is not a unique task of language teachers, but a commitment of teachers from different disciplines and the same student in their self-learning.

Consequently, the more knowledge the reader has about the lexicon used in the text, the greater the understanding. However, this is not due to the lack of knowledge of the sociolects and technolects employed and the little scientific background on the topics used. Another difficulty that often arises is the existence of linguistic neutrality or omission of certain expressive semantic elements that possess scientific value despite a short extension. Indeed, there are multiple factors that would facilitate the understanding processes. The work is not easy at all, but it is a task in which all the actors involved must contribute to facilitate the process. It is intended that with the implementation of these instruments in school groups of two or more educational institutions, results can be contrasted to continue testing hypotheses regarding the incidence of visual fixations and characters in the understanding of expository texts.

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