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Metacognitive Reading Strategies: Analysis of Self-report Data and Oculomotor Behaviour of Russian Schoolchildren

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The paper presents the results of a study aimed to investigate the correlations between oculomotor reading behavior and self-report data of Russian high school students on their practice of using metacognitive strategies. It was found that high school students tended to use problem-solving reading strategies, while seldom using supportive reading strategies. Differences in the use of metacognitive strategies were found between schools that emphasized differently the development of reading competence in middle school. The findings suggested that there were differences in oculomotor measures across groups with varying levels of metacognitive strategy use. The paper outlines possible directions for further research on this topic.

Keywords: reading; digital reading; metacognitive reading strategies; metacognitive awareness; eye tracking; eye movements; adolescent readers.

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Метакогнитивные читательские стратегии: анализ данных самоотчета и глазодвигательного поведения российских школьников

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Приводятся результаты эксплораторного исследования, целью которого стало установление взаимосвязи между глазодвигательным поведением при чтении учебного текста с экрана монитора компьютера и данными самоотчета учащихся старших классов российских школ об их практике использования метакогнитивных стратегий. Установлено, что старшеклассники склонны использовать стратегии, направленные на решение проблем, возникающих при чтении, и в то же время редко прибегают к вспомогательным стратегиям, поддерживающим читательскую деятельность. Найдены различия по опросникам использования метакогнитивных стратегий между школами, в программе которых уделяется разное внимание формированию читательских компетенций в основной школе. Полученные результаты позволили авторам сделать предположение о различиях в глазодвигательных параметрах между группами с разными уровнями владения метакогнитивными стратегиями. Проведенный в исследовании анализ позволил авторам выделить вопросы, которые могут стать ориентиром дальнейшего направления исследований данной тематики.

Ключевые слова: чтение; цифровое чтение; метакогнитивные читательские стратегии; метакогнитивная осознанность; айтрекинг; движения глаз; читатели подросткового возраста.

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Introduction

Due to the ongoing digital transformation in education, electronic learning resources and digital texts have become an integral part of the educational process. An urgent scientific challenge is the study of cognitive and metacognitive processes that occur when reading from a computer screen, as well as the investigation of the relationship between these processes and educational outcomes.

One of the areas of research in digital reading is the analysis of reading strategies and patterns of reading behavior. In the theoretical framework of new literacy, reading multimodal hypertexts is seen as an independent process of constructing the text [11]. This involves the reader effectively and optimally building a path and method of interaction with the text. In order for such interaction to be successful, it is essential to use metacognitive reading strategies. These strategies help the reader become aware of their cognitive processing of the text and allow them to correct their work with the text. [7]. Such strategies are also known as consciously chosen actions that are aimed at achieving specific goals. These goals require conscious planning, monitoring, evaluation, and correction of the reading process [5].

Metacognitive skills and their significance for the educational process

Awareness of metacognitive reading strategies, the level of development of relevant skills, and their effective use are all related to high-level reading processes [23]. Awareness and regulation of thinking during reading are associated with effective reading comprehension. According to J. Flavella's concept, one of the first to define the nature and role of metacognition in reading, metacognition — "thinking about thinking" — includes a person's awareness of their thought processes and the active monitoring and regulation of their mental activity [15]. Using planning, monitoring, and evaluation strategies, students can become more aware of their cognitive processes and take appropriate actions to better understand the text. It has also been found to have a positive impact on reading memory. [16; 19].

In reading research, there are three main types of metacognitive strategies that are commonly used: global strategies, supportive strategies, and problem-solving strategies [26]. Global strategies include planning, regulating, and evaluating reading. This includes setting a reading goal, activating background knowledge, and checking whether the content of the text corresponds to your reading goal. Readers use problem-solving strategies when they encounter difficulties in understanding a text or when they need to optimize their reading process.These include, for example, adjusting the reading speed or focusing on reading more carefully. Auxiliary strategies, such as taking notes, highlighting text fragments, and using reference resources, are additional strategies that involve activities other than reading. A similar typology of metacognitive strategies has been used in questionnaires [28].

Qualitative studies on metacognitive reading strategies using verbal protocols have also supported the effectiveness of the proposed classification [3].

A representative body of research has been devoted to the role of metacognitive strategies in solving educational tasks.

It has been shown that students with a high level of metacognitive skill development are actively engaged in the reading process, utilizing effective strategies to enhance their understanding of what they read [27]. In addition, it is important to track your own current level of understanding of the text, for example, when working with scientific information to avoid problems with comprehension [29]. It has been shown that pedagogical interventions, during which metacognitive strategies are taught, change the patterns of eye movements that students use when reading text [25]. After the intervention, the students spent more time focusing on information relevant to the task and read it more often. The respondents were able to successfully locate the necessary text passages and focus on them, rather than reading the entire text superficially.

Metacognitive skills and eye-tracking reading behavior

In recent years, video oculography, or eye tracking, has been widely used in reading research as a primary method for collecting experimental data. This tool allows to collect objective data in real-time about the information processing process when working with text, such as the distribution of attention and the use of various reading strategies. Based on this data, it is possible to simulate reading processes for different categories of readers in different contexts [24; 29].

One of the areas of research in reading focuses on the strategies used to understand text materials in various formats. In this area, there is a great interest in the method and mechanism of how the pattern of eye movement is adapted to the task [13; 35]. It has previously been demonstrated in various languages that the type of text or reading task has a significant impact on oculomotor strategies, both for typical readers [1; 14; 33] and for those with reading and learning difficulties [10]. The task of reading the text thoroughly led to an increase in the amount of time spent on it, as well as an increase in the number of times people returned to previously read sections. The task requiring "familiarization" reading was performed by speed reading the entire text through longer saccades and shorter fixations and, at the same time, resulted in lower quality reading comprehension. Reading strategies, in which the reader is required to find errors, are expressed in shorter fixations and longer saccades, as well as fewer missed words. At the same time, reading comprehension was lower compared to the task for detailed reading. [33]. A study of reading patterns in scientific and educational comics has shown that increased attention to and selective rereading of key elements in text and illustrations leads to a better understanding of the material, as revealed by test results [20].

A small body of research has been conducted to analyze oculomotor behavior in relation to the use of metacognitive reading strategies. In the work of Tsai et al., it was demonstrated how the oculomotor behavior of strong and weak readers differed when using metacognitive reading strategies to resolve contradictions in a text. Students with a higher level of reading comprehension demonstrated a greater ability to navigate through the text and make connections between different parts that contained conflicting information, compared to students with less well-developed reading skills [34]. In addition, this study found small but significant correlations between self-reported use of critical reading strategies (implicit strategies) and visual behavior patterns (explicit strategies). This suggests that implicit and explicit reading strategies may work together to improve critical reading skills.

Despite the convincing evidence of the contribution of metacognitive strategies

to the results of semantic reading, there is currently a very limited number of studies examining the relationship between a reader's self-reported use of metacognitive strategies and their eye movements during reading. Most of the existing research on this topic is based on materials in foreign languages, while there is a lack of research in Russian. This study aimed to identify patterns in eye movement data when reading an educational text, and to compare these patterns with readers' self-reports on their use of metacognitive strategies. We formulated the following research questions:

1. How are the parameters of oculomotor activity during reading related to the subjective experience of using metacognitive strategies when reading educational materials?

2. Will the readers' reading strategies change depending on the task, and is it possible to track and measure these changes?

3. Are there any differences between schools that use different training programs in terms of how they assess cognitive skills or the patterns of eye movements students make when reading educational texts?

Organization and methods of research

The study consisted of two main stages: collecting data on the use of metacognitive strategies through a questionnaire and studying strategies for reading popular science texts using eye tracking to monitor oculomotor activity.

At the beginning of the study, the participants completed a questionnaire about their use of metacognitive reading strategies when reading digital texts. It was developed based on the Metacognitive Skills Assessment Methodology — Metacognitive Awareness of Reading Strategies Inventory (MARSI). [26]. Its content included a description of the actions and strategies that the respondent employs when reading educational or scientific materials. The questions are divided into three categories. The first category includes Global Strategies (GS), which generally characterize reading behaviour. For example, it includes planning reading actions and monitoring reading comprehension. Problem-solving strategies (PS) are used when difficulties or failures arise during reading. Supportive strategies (SS) differ from other reading strategies in that they involve additional activities that take place alongside reading, such as highlighting text fragments with different colours, accessing a dictionary to look up words, and taking notes. The questionnaire consists of 30 questions about the frequency of using certain strategies, with answer options ranging from "almost never" (1 point) to "almost always" (5 point). MARSI has been translated into Russian, and the wording of some questions has been adjusted. Five new questions have also been added, including questions about digital reading strategies, which were identified in a previous qualitative study [3]. herefore, the final questionnaire consisted of 35 questions. Each question was related to one of the different types of strategies. In addition, the questionnaire included questions about the type of study, gender, and age.

At the second stage of the experiment, participants were asked to read text from a computer screen and then answer questions about it. Before starting this part of the experiment, each participant was given a short training text to read that did not require answering any questions. This was done in order to allow the participant to become familiar with the structure of the text and the principles of the experiment. In the main part of the experiment, the participant was first presented with one of two tasks: analyzing the text or searching for information. No instructions were pro-

vided regarding the pace or strategy for reading and the sequence of actions. For the search reading task, participants were required to locate specific information within the text. Analytical reading requires an understanding of the general content and logic of the patterns presented. After completing the reading task, the participant was asked to read the text aloud and answer the questions by himself. The students had no time limits for reading and completing their assignments. After reading the text, the participants were presented with a series of questions with answer options that appeared in a pop-up window. These questions were displayed on the same page as the text. The student could easily return to the text and answer the questions as many times as needed. randomly assigned to one of two groups.

The popular science text "Kolchuga" has been chosen as an incentive material, referencing texts of a humanitarian nature and dedicated to the history of armaments in Russia. It was designed as an article for an online publication. That is, it included illustrations, was supplemented with hyperlinks, and was checked in accordance with the usual standards for an Internet page, such as font, indentation, breaking into short paragraphs, and pop-up hyperlink hints for target words.

The text consisted of ten paragraphs, each containing between two and four sentences. To maintain the ecological validity of the material, the text was designed to be long enough that the reader would need to scroll down the page to read it fully. The Flash Readability Index (FRE), adjusted for the Russian language by I.V. Oborneva, was 42 for the text, which is equivalent to the category of fairly difficult texts, similar to those found in high school textbooks [4]. The level of lexical complexity, calculated using the Textometer service, based on the percentage of words in the text that are included in the 5,000 most frequently used words in children's literature, is 7 out of 10. The level of structural complexity, based on the readability index of the Flash text with additional parameters, is also 8 out of 10 [2]. These scores indicate a high level of complexity in the text, which would likely correspond to an age group of 13—15 in terms of readability.

Each participant had a normal or adjusted vision. The parents of the participants and the participants themselves gave their informed consent to take part in the study. Oculomotor activity was recorded using the SR Research Eyelink 1000+ eye-tracker, with a sampling frequency of 500 Hz. Before the experiment, a 13-point calibration was performed. The stimulus materials were presented on a 23-inch monitor with a resolution of 1920 by 1080 pixels. All the study participants were approximately 760 millimeters from the screen. The width of the text is 949 pixels and the height of each letter is 26 pixels. During the recording, the respondent's head position was fixed using a forehead rest. The SR Research Web Link software was used to design and present the experimental task.

The study involved students from grades 9 to 11 from two schools in Moscow and the surrounding area. The data on the distribution of students by class and gender is presented in Table 1. Both schools are gymnasia, but School 1 is a private school that uses its own curriculum with a focus on the development of student's skills in the humanities. According to the testimonies of school management and teachers who were interviewed, special attention is given to the development of skills related to working with textual information and semantic reading in school education. School 2 is a public school that operates under a standard federal curriculum. During the conversation with the school administration and teachers, we found out that there is not a specific focus on the development of reading comprehension skills.

Table 1

The distribution of study participants by class and gender between schools, according to the survey data

	School 1	School 2
Grade		
9 grade	35	41
10 grade	28	28
11 grade	11	34
Sex		
boys	37	54
girls	37	49

Data analysis

Statistical data analysis was performed in the R [30] environment and the Statistica 10 software. To analyze the survey data, we used variance analysis, paired t-tests, and correlation analysis. The analysis of eye movements covered the period from the start of the text presentation on the screen until the first transition to a question. Subsequent returns to the text after reviewing the questions were not considered.

The lme4 package was used to create models for analyzing fixation data [8]. Unlike the analysis of variance, mixed linear models allow us to take into account not only fixed factors but also random ones, such as individual variability, which can influence the outcome of the variable [6]. In the context of studies on reading using the eye-tracking method, the data on fixation or reading of successive blocks of text from one individual are not completely independent. This limits the use of different variants of variance analysis. However, the use of mixed linear models can help explain a significant portion of the variability in the data [32].

The following variables were selected as fixed effects in this analysis: school (group), text assignment (task), class (grade), and their interactions. We also took into account the repeated measurements that were found in our data. The study participants (ID) and individual paragraphs of the text (IA_LABEL) were selected as random effects. The dependent variables were the number of fixations for a paragraph (fixation count), the average time of fixations for a paragraph (fixation duration), the time of reading a paragraph (dwell time), the number of transitions of the gaze to and from the paragraph (run count), the number of regression transitions of the gaze back to the paragraph (regression in count). Contrast matrices for fixed factors were used in all models (for more information about contrasts in linear models, see [31]). The logic of linear models involves comparing the effect of each independent variable with the conditional mean (intercept). This logic involves the assignment of rules, hereinafter referred to as the contrast matrix, according to which each independent variable will be introduced into the model. A rule is also defined that indicates what exactly will be considered the neutral mean value (intercept). For the variable “group”, the contrast matrix was compiled in such a way that the value of the school 1 falls into the intercept. A matrix of sum contrasts was applied for the variables “grade” and “task”. This was done in order to ensure that the intercept included the total average value for all levels of each independent variable, rather than some specific value. The P-values for the models were calculated using the lmerTest package [8], which employs the Satterthwaite approximation to estimate degrees of freedom.

Results

177 students completed the metacognitive skills questionnaire, with 74 students from School 1 and 103 students from School 2. The answers to the individual questions were grouped into three categories of strategies: global strategies (GS), problem-solving strategies (PS), and supportive strategies (SS). The Cronbach’s alpha coefficient was used to assess the reliability of the questionnaire. The result was 0.81, indicating a high level of reliability. The obtained coefficient indicates that the questionnaire has a high level of reliability.

Table 2

The average values for all subscales of the strategies tested in the questionnaire were calculated for two schools: global strategies (GS), problem-solving strategies (PS), and supportive strategies (SS). The values that differ significantly between schools are highlighted in bold

Strategies	School 1			School 2		
	The average value of the school (SD)	The average value of the grade (SD)		The average value of the school (SD)	The average value of the grade (SD)	
GS	**3,78 (0,45)**	9	3,75 (0,44)	**3,63 (0,48)**	9	3,57 (0,52)
		10	3,80 (0,43)		10	3,68 (0,45)
		11	3,90 (0,55)		11	3,65 (0,46)
PS	4,02 (0,56)	9	3,89 (0,41)	3,95 (0,54)	9	3,98 (0,56)
		10	4,01 (0,66)		10	4,05 (0,44)
		11	**4,47 (0,49)**		11	**3,86 (0,58)**
SS	3,00 (0,75)	9	2,75 (0,60)	2,98 (0,63)	9	3,02 (0,61)
		10	3,17 (0,74)		10	2,97 (0,67)
		11	3,38 (0,97)		11	2,92 (0,62)
All strategies	3,57 (0,47)	9	3,43 (0,39)	3,48 (0,42)	9	3,48 (0,45)
		10	3,63 (0,49)		10	3,52 (0,45)
		11	**3,85 (0,56)**		11	**3,44 (0,38)**

The level of application of reading strategies in solving problems was higher than that of global reading strategies and reading support strategies, as shown in Table 2. The correlation analysis revealed that the indicators from all the subscales were positively correlated with one another (GS-PS: r=0,52; GS-SS: r=0,38; PS-SS: r=0,47, p<0,001 for all correlations).

Significant differences between schools were observed only in the subscale for global strategies (GS) (t-тест, p<0,05). Two-factor analysis of variance also showed that the school factor had an influence on the GS scale, but there was no significant influence from the grade factor. For schools of PS and SS, an interaction of factors was identified: in school 1, there was an increase in scores from ninth to eleventh grade, while in school 2, there were no significant differences between grades (for PS F(171,2)=5,333 p=0,006; for SS F(171,2)=4,035, p=0,02). At the same time, the scores for SS and PS in the ninth grade were similar for both schools. In the subsequent pairwise comparisons of schools, for each class separately, only the results from the SS (t-test, p<0.01) and the average scores for all assessment strategies (t-test, p<0.01) were significant (see Table 2).

Despite the differences in the average scores for strategies, when it comes to individual questions, the average responses from both schools correlated with a coefficient of r=0.95 (p<0.001). The highest and lowest points in the questionnaire for each school were also very similar. The most rarely used (less than 3 points in both schools) were four SS and one PS, and the most frequently used (more than 4.1 points in both schools) were three GS and two SS.

Of the participants who completed the questionnaire, 141 individuals passed the second stage involving the recording of eye movements. Data filtering was performed for the analysis. Low-quality records were excluded, as were records of experiments in which the student answered questions

without reading the entire text. This resulted in 122 records being included in the analysis, with 52 from School 1 and 70 from School 2. Paragraphs of the text have been identified as areas of interest.

The intercept of the model for the "fixation duration" parameter was β=232.0419, SE=3.0203. The duration of fixations for school 2 was significantly shorter compared to the intercept of the model (β=–8.04, SE=3.02, 95% CI [–15.39, –0.70], t-value=—2.15, p=0.032). The intercept of the model for the "number of fixations" was β=49.32, SE=3.73. It was found that the number of fixations was significantly higher for school 2 compared with intercept (β=8.3, SE=2.79, 95% CI [2.83, 13.79], t-value=2.97, p<0.01).

For the parameters "paragraph reading time" and "regression movements from the paragraph", no significant influences of the factors "school" (p>0.05), "grade" (p>0.05) and "task" (p>0.05) were recorded in the model. The intercept of the model for the parameter "number of regressions per paragraph" was β=0.44, SE=0.08. A statistically significantly higher number of returns to the previously viewed zone were made in school 2 (β=0.19, SE=0.05, 95% CI [0.10, 0.29], t-value=4.005, p<0.0001), and the difference was ensured by more frequent returns to the first half of the text (see figure 1). The intercept of the model for the parameter "number of occurrences of a glance to a paragraph" was β=2.31, SE=0.13. A significantly higher number of transitions were also made in school 2 in comparison with the intercept (β=0.63, SE=0.14, 95% CI [0.36, 0.91], t-value=4.52, p<0.0001), the difference was stable for all paragraphs. For all the above parameters in the model used, the factors "grade" (p>0.05) and "task" (p>0.05) did not have significant effects.

For the parameters "paragraph reading time" and "regression movements from the paragraph", no significant effects of the factors "school", "grade", and "task" were recorded in the models (p>0.05).

A pairwise comparison of the basic reading indicators averaged for all paragraphs was carried out, first at the school level as a whole, then between grades 9, 10 and 11 of the two schools separately. The average data for all oculomotor parameters in groups with deviations were given in Table 3.

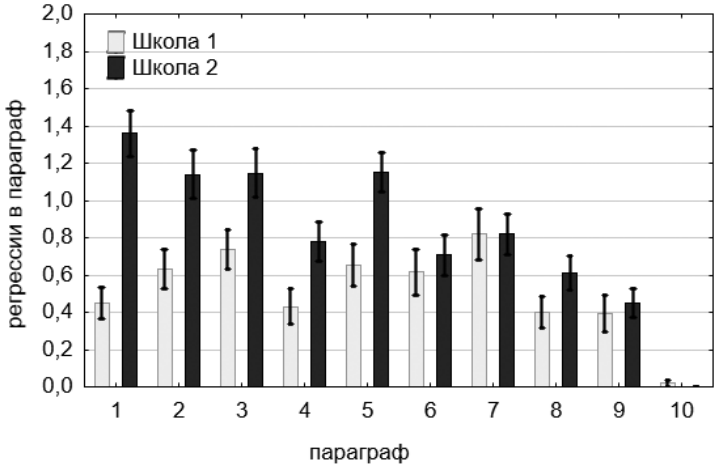

Fig. 1. The number of times participants' eyes returned to each paragraph of the text, averaged across the two groups of participants, is given below. The standard error of this average value is also provided

Table 3

The average values with a standard deviation for the parameters of oculomotor activity in individual paragraphs. Values significantly different between schools are highlighted in bold when compared in pairs (t-test, * — p<0.005; * — p<0.001)**

	School 1			School 2		
	The average value of the school (SD)	The average value of the grade (SD)		The average value of the school (SD)	The average value of the grade (SD)	
The time of reading the paragraph, sec.	12,7 (3,98)	9	13,47 (4,22)	13,78 (4,22)	9	13,71 (5,08)
		10	12,57 (3,8)		10	13,61 (4,59)
		11	11,41 (4,12)		11	13,96 (2,99)
The number of regressions to the paragraph from the subsequent text (Regressions in)	**0,63 (0,6) *** **	9	**0,59 (0,27) *** **	**0,96 (0,49)*** **	9	**1,01 (0,48) *** **
		10	0,54 (0,38)		10	0,79 (0,45)
		11	0,99 (1,34)		11	1,03 (0,51)
The number of occurrences of the view to the paragraph (Run count)	**2,5 (0,92) *** **	9	**2,48 (0,66) *** **	**3,32 (1,05) *** **	9	**3,43 (1,05) *** **
		10	2,39 (0,78)		10	2,94 (0,9)
		11	2,89 (1,63)		11	3,47 (1,11)
The number of fixations per paragraph (Fixation count)	**52,03 (14,98) ***	9	54 (15,28)	**59,22 (15,92) ***	9	58,32 (18,98)
		10	**51,67 (14,59*)**		10	**60,25 (16,74) ***
		11	48,79 (16,88)		11	59,42 (12,12)
Duration of fixation, ms (Fixation duration)	233,42 (15,29)	9	236,94 (16,75)	223,98 (22,29)	9	224,22 (19,16)
		10	233,52 (15,37)		10	215,9 (21,2)
		11	225,2 (8,28)		11	229,34 (24,93)

An analysis of the relationship between eye movement patterns during reading and self-reported metacognitive strategies was conducted. The correlation analysis did not reveal significant relationships between the average scores on the three main metacognitive reading strategies and parameters such as the number of fixations, average fixation duration, average time to read paragraphs, or the ratio of time to read the last sentence in a paragraph to the first sentence (finishing time). However, correlations between oculomotor activity metrics and performance on individual tasks were found. The most significant correlations were between the evaluation of a strategy ("I read more carefully those parts of the text that are underlined, in italics, or in bold") and the average number of returns to the previous paragraph in the text (r=0.28, p=0.002). There were also correlations between the number of returns from the previous paragraph to the top of the page (r=0.19, p=0.037) and the number of times the user looked at the paragraph (r=0.27, p=0.003). The value of the average duration of fixations was correlated with the scores for several questions, most significantly with the statement "When reading online, I read slowly and carefully to make sure I understand everything correctly" (r=–0.23; p=0.008). It was also correlated with the statements: "When I read new information, I often relate it to what I already know about the topic" (r=0.20; p=0.031), "I can distinguish facts from opinions during reading" (r=0.21; p=0.022), "To remember information, I print out texts and underline or highlight important information" (r=–0.20; p=0.027), and "To mark key information, I highlight text fragments or leave comments" (r=–0.21; p=0.020). There was also a positive correlation between the scores for the

strategy “reading more carefully those parts of the text that are framed or colored” and the average number of times a person glanced at a paragraph (r=0.19, p=0.032).

Discussion

In this study, we evaluated the use of metacognitive reading strategies using the results from a survey, as well as the impact of pre-text tasks on oculomotor patterns when reading texts.

The obtained Cronbach’s alpha coefficient of 0.81 indicates a high level of reliability for the questionnaire used in this study. This confirms the clarity of the questions and their uniformity, which is essential for the accuracy and reliability of the research.

In general, the average results from both schools show similar patterns of strategy usage. According to self-reported data, high school students most often use strategies to solve problems. This is natural, as a reading difficulty, associated with, for example, a misunderstanding of the text, is a significant event that should be addressed by using one or more strategies. The least used strategies are those related to modifying digital text or supplementing reading with additional activities: reading aloud, taking notes, and printing text.It is possible that this is due to a lack of understanding among schoolchildren of the significance of these strategies for effective reading. Another possible reason could be the lack of training in schoolchildren in reading techniques such as taking notes and reading with notes. Finally, the implementation of supportive strategies requires additional resources and organizational conditions (such as the ability to print text), which may not always be available.

The results of the study indicated that the use of global strategies was not common among the respondents who were surveyed. Global strategies include targeted actions such as planning the reader’s route, determining the reading speed, and deciding on the type of reading material.It has been established that the active implementation of global strategies is essential for successful education at high school, and students who achieve high academic results report on their active involvement [3]. In this study, the most popular global strategy was found to be the one that relies on context to understand the text. At the same time, it has been revealed that schoolchildren do not tend to preview the text before reading (i.e., use an introductory reading strategy) or focus on individual fragments of the text that are relevant to completing reading tasks (i.e., employ search or selective reading strategies). This indicates the prevalence of linear sequential reading among high school students, which the school has been preparing for since the first grades. Meanwhile, effective reading to solve a specific task often requires a non-linear approach to the text, including browsing, selective reading, and search reading.

In grade 9, the average performance of students in all groups using different strategies does not differ significantly between schools. In school 1, there is an increase in self-esteem in the use of all strategies from grades 9 to 10 and 11. In contrast, there has not been any significant change in school 2. The reason for these differences may be due to the differences in the educational programs offered by the schools. According to teachers and the school administration, school 1 places a special emphasis on the development of reading literacy and reading independence during high school.

An analysis of eye movement activity revealed a significant difference between the two schools. The average reading time for the paragraphs was not significantly different, but the students from the two schools had slightly different reading patterns. The students of school 2 had

shorter but more frequent fixations when reading, while this group made more regression movements through the text and had a lower total number of paragraphs read compared to students from school 1. Such specific reading patterns, especially returning to read paragraphs, may be due to the use of a re-reading strategy for better comprehension [9; 28]. The study participants were aware that they could revisit any part of the text at any time and took advantage of this feature, which correlates with one of the metacognitive strategies described in the literature. However, according to the survey results, this strategy was not mentioned as a frequent one by the respondents. On the other hand, previous studies have shown that when working memory is heavily loaded, readers prefer to rely on repetitive searching in the text [12]. Therefore, students from school 2 may have revisited previously read paragraphs before moving on to questions, in order to refresh previously read information in their working memory.

Previous studies have shown that students who use critical reading strategies more often make more connections between paragraphs [34]. We expected to see a similar trend among school 1 students who score high on one of the criteria for the global strategy, which involves using context to better understand a text. However, our results showed a different pattern: the students from school 1 made fewer paragraph transitions compared to the students from school 2. Perhaps the material was easy for students from school 1 to understand and did not require a specific strategy for critically assessing the context or better understanding. The reading pattern, as indicated by longer fixations on words and fewer returns, in students at school 1 may suggest that they initially read the text with more care. This may be due to the school's emphasis on in-depth work with written material. It should be noted that reading in school 2 was not selective. Students rather used a strategy of rapid and relatively superficial reading, rereading all or most of the text. This is indicated by the relatively more frequent returns to the first half of the text and the consistently higher number of readings of all paragraphs. Based on the results of studies on attention and the influence of prior knowledge and individual reading strategies on eye movement patterns [17; 18; 21; 22], we can allow students in school 1 to better memorize and assimilate the material during their first reading without the need to return to previously read parts of the text before moving on to questions. However, in this study, an estimate of the amount of working memory among readers was not made, which limits our ability to fully rely on this interpretation. Further research should include measurements of the working memory capacity of readers in order to better understand the findings.

As can be seen from Table 3, there were differences between classes in both schools, but these differences were not systematic or unidirectional. As can be seen in Table 3, there were some differences between classes in both schools, but these differences were not systematic or unidirectional. The absence of a significant grade effect on the "fixation duration" parameter in School 1 is likely due to the wide range of individual variation in this parameter within the studied group. It can be noted that there were significant differences between schools in terms of the number of times students regressed and re-read text, with the most pronounced differences in grade 9. However, older classes also made use of re-reading.

Within the scope of this study, there was no significant effect of the task factor on reading performance, according to the average data presented in Table 3. Previously, it has been shown in studies that different tasks alter the reading pattern, as evidenced by

oculomotor characteristics [33]. The lack of significant impact on our data may be due to the lack of proficiency in the use of metacognitive strategies among school students and their limited application in the eyetracking experiment. This may prevent them from fully adapting their reading patterns to the task at hand. The habit of reading more thoroughly at school 1 and reading quickly with frequent re-reads at school 2 may explain the lack of significant differences in reading performance when completing different tasks. Additionally, another factor could be the absence of time pressure: students had no motivation to use a riskier strategy of rapid skimming in the case of information retrieval.

The lack of clear and unambiguous connections between the data on self-assessment of metacognitive strategy use and eye movement patterns among strategy groups is expected, as each group is quite diverse and should not display clear patterns in oculomotor activity. Many strategies relate to processes such as preparing for or working with text, which may not be reflected in an eye-tracking experiment. Of interest are the significant correlations found between the parameters of rereading the text andan assessment by one of the schools related to working with the paragraph "I read more carefully those fragments of text that are underlined, written in italics or bold". The text selection was not used in the experiment, but both the question and the metric for re-reading the text reflect the elaboration of information. At the same time, the estimates on the question about re-reading, which were included in the questionnaire, did not show any connection with the real re-reading metrics. An inverse correlation was found between the average duration of fixations and the score for the item "I read online slowly and thoughtfully to ensure I understand everything correctly". Although slower and more thoughtful reading is expected to increase cognitive load, this should also be accompanied by a longer fixation duration [28]. In general, a lack of a clear and consistent relationship between self-reported use of metacognitive strategies and actual metrics of eye movement behaviour during reading may indicate a gap between a person's perception of their metacognitive abilities and their actual use of these strategies.

Conclusion

The aim of our study was to investigate the metacognitive strategies used by high school students while reading from a computer screen, the variability in their reading patterns based on the task, and the possible relationship between eye movement patterns and self-reported strategies, as well as to analyze the consistency of these patterns across grades 9 to 11 in two schools.

Differences were found in the use of metacognitive strategies among schools that focus on different aspects of reading competence. The main differences were related to the use of global reading strategies. At the same time, students in both schools often use strategies to solve problems.

The data collected on oculomotor activity suggests that there are more shorter fixations on individual paragraphs in school 2, and a higher number of transitions between paragraphs. used by some students, where they quickly and superficially read a text the first time, with the opportunity to revisit previously read parts an unlimited number of times. No significant effect of the class level on oculomotor activity has been found, however, there seems to be a tendency for oculomotor characteristics to change from 9th to 11th grade at school 1. The study also found no significant impact of the task on eye movement parameters. The lack of task effect may be due to students' insufficient use of metacognitive strategies, which prevents them from adapting their reading pattern to the task. Additionally, students may use the most familiar reading strategy, regardless of the task, in the

absence of any incentives to change their approach.

It was not possible to establish a clear connection between the data from the questionnaire about the use of metacognitive strategies and the patterns of eye movements while reading. This may indicate a difference between how people perceive their own use of metacognitive strategies and how they actually use them.

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