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Scientific literacy: analysis of proficiency among students from a public school in Ceará

ARTICLE

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Abstract
Faced with the challenge of raising the quality of science teaching in Brazil, this article aims to assess the level of student proficiency in a test on skills inherent to scientific literacy, applied in a public High School in Ceará to 40 10th grade students. The research uses a qualitative-quantitative approach, using the Test of Scientific Literacy Skills (TOSLS) as a data collection instrument. The results show a low level of student achievement in the skills assessed, with an average proficiency of 37.6%, in addition to the sample group's difficulties in understanding the scientific method, evaluating scientific information, analyzing data and mastering basic mathematics. High School, however, offers an opportunity to reduce these deficiencies, if pedagogical practices are adopted that encourage critical and reflective thinking.
Keywords: Science Education. Competence Assessment. Skills Learning. High School.

Letramento científico: análise da proficiência de estudantes de uma escola pública cearense

Resumo
Diante do desafio de elevar a qualidade do ensino de ciências no Brasil, este artigo tem como objetivo avaliar o nível de proficiência dos estudantes em um teste sobre habilidades inerentes ao letramento científico, aplicado em uma escola pública de Ensino Médio do Ceará a 40 alunos da 1ª série. A pesquisa utiliza uma abordagem quali-quantitativa, por meio do Teste de Habilidades de Letramento Científico (TOSLS) como instrumento de coleta de dados. Os resultados apontam um baixo nível de aproveitamento dos estudantes nas habilidades avaliadas, com uma proficiência média de 37,6%, além das dificuldades do grupo amostral em compreender o método científico, avaliar informações científicas, analisar dados e dominar a matemática básica. O Ensino Médio, no entanto, oferece uma oportunidade para reduzir essas deficiências, desde que sejam adotadas práticas pedagógicas que estimulem o pensamento crítico e reflexivo.
Palavras-chave: Ensino de Ciências. Avaliação de Competências. Aprendizagem de Habilidades. Ensino Médio.

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1 Introduction

Science teaching is fundamental to the formation of critical and well-informed citizens, preparing them to face the challenges of the contemporary world. According to Reis (2021), science teaching should contribute to forming students with a critical and questioning attitude, enabling them, based on the scientific knowledge and skills acquired, to act “[...] actively and consciously in the socio-cultural space in which they are inserted” (Vilaça; Bertini, 2022, p. 3), so that they can solve problems responsibly.

In this way, the success of these students' teaching and learning also depends on the efficiency with which these skills are developed, allowing them to integrate scientific knowledge with their civic education. This gives them the ability to critically analyze, in the light of science, “[...] the relevant issues of society, whether of the past, present or future [...], with the aim of understanding how each code, concept, theory or law impacts on personal life and collective and democratic demands” (Medeiros *et al.,* 2024, p. 35).

This conception is the essence of scientific literacy, which seeks to promote the development of people's ability to use their skills to understand or solve real-world problem situations based on science (Santiago; Nunes; Alves, 2020). This involves, for example, using evidence and data to assess the quality of information and arguments presented, whether by authority figures, the media, social networks or even scientists.

In Brazil, the concept of scientific literacy is defined by the Base Nacional Comum Curricular (BNCC), which guides essential learning in basic education. For the area of Ciências da Natureza e suas Tecnologias, the BNCC establishes competences and skills in biology, physics and chemistry, organized into four pillars: (i) conceptual knowledge; (ii) social, cultural, environmental and historical contextualization; (iii) understanding of research processes; and (iv) knowledge of the languages of Ciências da Natureza (Brasil, 2018).

Given this context, and considering the relevant regulations, this research seeks to respond to the need for effective science teaching in a scenario marked by the worsening environmental crisis and the increase in manifestations of hatred and violence against minority social groups, as pointed out by Valladares (2021). In addition, the research considers the impact of the internet and social networks, which amplify educational challenges by exposing people to a massive volume of information and the formation of social bubbles (Barros, 2020).

Thus, the importance of effective science teaching aimed at students' scientific literacy, in favor of a sense of collectivity and social justice, is growing. In this sense, this study seeks to answer the following questions: what are the main weaknesses in the scientific literacy process of the students in the sample group and how do they impact on their capacity for critical analysis and their civic education?

Therefore, the aim of this article is to evaluate the level of proficiency of students in a test on scientific literacy skills, applied in a public High School in Ceará. This research is based on the assumption that diagnoses of skills related to scientific knowledge are essential for improving science teaching by identifying the difficulties students face in developing these competences.

In this sense, the relevance of this study lies in the fact that, through this understanding, we can seek effective solutions to overcome the gaps and strengthen the role of schools in promoting scientific literacy among the population.

2 Methodology

The methodology adopted was designed to investigate the students' level of scientific literacy, mapping the most and least developed skills. The methodological procedures used will be presented next.

2.1 Type of study and target group

This research uses a qualitative-quantitative approach, as it combines, in a complementary way, the collection and analysis of quantitative data with qualitative

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interpretation. This makes it possible to make inferences based on statistical evidence. The aim is to identify patterns and trends among the students who make up the sample group analyzed (Machado, 2023).

The field of study was a full-time public High School of the Ceará State Education System, located in the countryside of the state, with 40 students enrolled in the 10th grade of the 2024 school year.

2.2 Ethical issues

The research was approved by the Comitê de Ética em Pesquisa com Seres Humanos (CEP) of the IFRN, under protocol no. 6.770.108/2024. The inclusion criteria included students enrolled in the 10th grade of the 2024 school year at the participating school; signature of the Termo de Consentimento Livre e Esclarecido (TCLE) by the legal guardians; and signature of the Termo de Assentimento Livre e Esclarecido (TALE) by the adolescents.

2.3 Research design

The study was carried out in three stages: administering an evaluation questionnaire, processing the data and giving the students feedback on their individual performance in the evaluation.

2.4 Evaluation questionnaire

This study was based on research by Gormally, Brickman and Lutz (2012), who proposed the use of the Test of Scientific Literacy Skills (TOSLS) as a tool for biology teachers to assess their students' proficiency in the competences and skills that are essential to scientific literacy.

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The TOSLS consists of 28 multiple-choice questions, with alternatives from **A** to **D**, and an average completion time of 2h40min, covering two competences. They are: I – Understanding of research methods that lead to scientific knowledge; II – Organization, analysis and interpretation of quantitative data and scientific information. Competence I is made up of four skills (table 1).

Table 1 – Skills related to understanding scientific communications for the general public

Competence I – Understand the research methods that lead to scientific knowledge			
Skills	**Questions**	**Explanation of the skill**	**Examples of common challenges and misconceptions that students have in these skills**
H1. Identify a valid scientific argument.	1, 8, 11	Recognize what is considered scientific evidence and identify when this evidence supports a hypothesis.	Inability to correctly link assertions with evidence and lack of meticulous analysis of that evidence. Sometimes “facts” or even evidence unrelated to the topic are considered to support scientific arguments.
H2. Assess the validity of the sources.	10, 12, 17, 22, 26	Distinguish between different types of sources and recognize the elements of prejudice, authority and reliability.	Inability to identify problems of accuracy and credibility.
H3. Evaluate the use and misuse of scientific information.	5, 9, 27	Recognize a valid and ethical scientific course of action and discern the appropriate use of science by government, industry and the media, ensuring that it is free from prejudice and economic and political influences when making social decisions.	Prevailing political beliefs can influence how scientific discoveries are applied. It is important to give equal consideration to all sides of a controversy, regardless of their validity.
H4. Understand the elements of research design and their impact on scientific findings or conclusions.	4, 13, 14	Identify the positives and negatives in research design, including issues of bias, sample size, randomization and experimental control.	Lack of understanding about the meaning of randomization in a specific study context. There is also a general lack of understanding of the essential elements of good research design.

Source: Gormally; Brickman; Lutz, 2012, p. 367.

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Competence II is made up of five skills (table 2).

Table 2 – Skills related to issues of scientific uncertainty and the collection, evaluation and interpretation of data

Competence II – Organization, analysis and interpretation of quantitative data and scientific information			
Skills	**Questions**	**Explanation of the skill**	**Examples of common challenges and misconceptions that students have in these skills**
H5. Create graphical representations of data.	15	Identify the correct format for graphically representing data of a given type.	Scatter plots highlight the differences between groups. They are more effective at representing averages, as they show the entire range of data.
H6. Reading and interpreting graphical representations of data.	2, 6, 7, 18	Interpret the data presented graphically to draw a conclusion about the results of the study.	Difficulty interpreting graphs: Inability to correlate growth patterns (e.g. linear or exponential) with the shape of the graph.
H7. Solve problems using quantitative skills, including probability and statistics.	16, 20, 23	Calculate probabilities, percentages and frequencies to draw a conclusion.	Guessing the correct answer without being able to explain basic mathematical calculations. Statements indicative of low self-efficacy: "I'm not good at math".
H8. Understanding and interpreting basic statistics.	3, 19, 24	Understand the need for statistics to quantify uncertainty in data.	Lack of familiarity with how statistics work and with scientific uncertainty. Statistics prove that data is correct or true.
H9. Justify inferences, predictions and conclusions based on quantitative data.	21, 25, 28	Interpret data and critique experimental projects to evaluate hypotheses and recognize flaws in arguments.	Tendency to misinterpret or ignore graphic data when developing a hypothesis or evaluating an argument.

Source: Gormally; Brickman; Lutz, 2012, p. 367.

2.5 Data processing

Initially, the students' answers were organized into individual tables, distinguishing between correct and incorrect questions. The questions were grouped according to skills and competences, as shown in tables 1 and 2.

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After this procedure, all the answers, taking into account errors and correct answers, were organized in Microsoft Excel, version 2013, to make it easier to count the data. With the help of this tool, the percentage of correct answers and errors per question was calculated.

Next, the students' proficiency by skill was determined. To do this, a formula was used in which the numerator represents the total number of correct answers to all the questions in the skill, while the denominator represents the total number of answers to all the questions in the same skill. To calculate the error rate per skill, the errors of all the questions in the skill were added up and the result divided by the total number of answers to those questions.

In this way, we understand that the sample group is close to what we consider to be scientific literacy when they reach 60% proficiency in the skills analyzed and in the overall average of the TOSLS. This approach is supported by the studies of Laugksch and Spargo (1996), who investigated scientific literacy in High School graduates. The graphics used in this research were created using the Overleaf portal, with the help of the LateX2e typesetting system.

2.6 Dialogue with students about their performance on the TOSLS

After all the tests had been corrected, each student received an individual and confidential detailed report highlighting both their correct and incorrect answers for each skill. In addition, examples of common challenges and misconceptions related to the results were provided, as discussed in the study by Gormally, Brickman and Lutz (2012) (tables 1 and 2). This was followed by an individual conversation with each student to discuss the meaning of these results.

In the next section, the results of this data will be presented, followed by a detailed discussion of the resulting inferences and implications, with an emphasis on improving science teaching and the search for scientific literacy among students.

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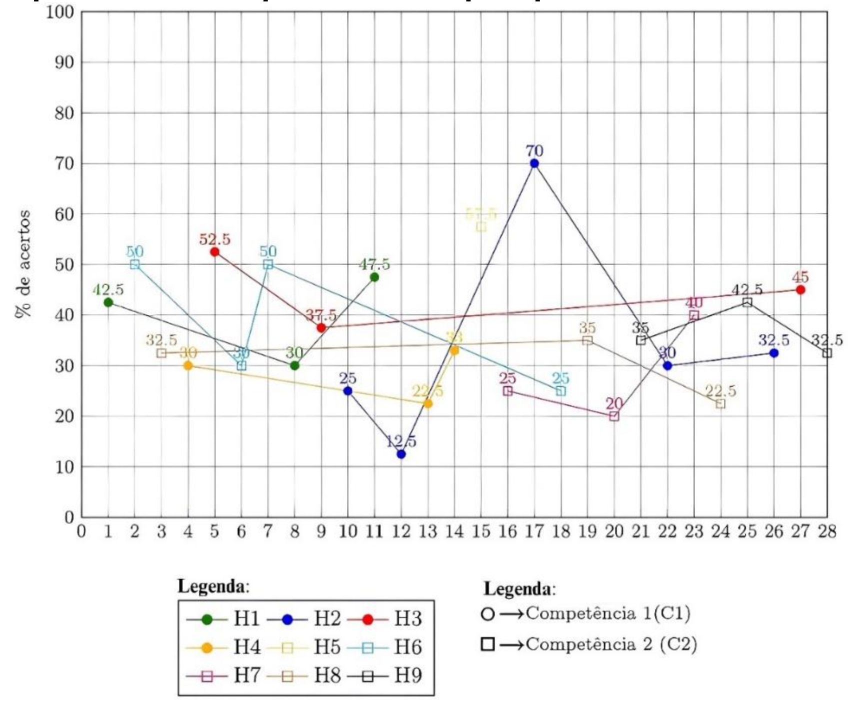
3 Results and Discussion

The students evaluated form a homogeneous sample group, with educational trajectories in basic education that are very similar to each other. During data collection, they had recently finished Middle School and were in the second bimester of the 10th grade of High School. This context is crucial for interpreting the results.

Therefore, this section analyzes in detail the students' performance in each scientific literacy skill assessed. To make it easier to understand the data and highlight the most relevant points, the analysis begins with the skills with the lowest proficiency, gradually progressing to those with the best performance. Therefore, the order in which the skills are presented will not follow the original numbering, but rather the increase in the number of correct answers in the test. The analysis by question, within each skill, reveals varied hit and miss rates, with a moderate standard deviation (graph 1).

Graph 1 – Student performance per question for each skill



Source: Authors (2024).

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The average proficiency in scientific literacy achieved by the students taking part in the study, calculated on the basis of their performance in the nine skills, was 37.6%. This result shows that the sample group is a significant 22.4 percentage points below the score considered minimally ideal, which would be 60%. Based on this data, this research can be compared to others that have also used the TOSLS in different countries and had better results, such as Indonesia, Slovakia and the United States (Utami; Hariastuti, 2019; Čipková; Karolčík; Scholzová, 2020; Shaffer; Ferguson; Denaro, 2019; Waldo, 2014; Nuhfer *et al.*, 2016).

To better contextualize this comparison, it's important to mention the Programme for International Student Assessment (PISA) science test, which was last held in 2022 and is an international assessment of whether students around the age of 15 are able to use their scientific knowledge to solve real-world problems. Brazil scored 403 points, which is below the average of the Organization for Economic Cooperation and Development (OECD) countries (485 points), ranking 62nd out of 81 participating nations. Slovakia (462 points) and Indonesia (383 points) also scored below this average (OECD, 2024). These indicators point to the need to improve science teaching in all three countries. However, the results of both tests – TOSLS and PISA – cannot be directly compared, only contextualized, as they measure scientific literacy in different ways.

In Slovakia, Čipková, Karolčík and Scholzová (2020) applied the TOSLS to students at a level equivalent to the 12th grade of High School in Brazil, obtaining an average proficiency of 51.92%. Meanwhile, Utami and Hariastuti (2019) applied the test to Indonesian students at a stage equivalent to the 7th grade of Middle School and found an average proficiency of 45.80%. Both results are considerably higher than the 37.6% obtained in this study. It should be noted that the Slovak participants were at the end of High School, while the Indonesians were in Middle School. In all cases, the minimum of 60% proficiency was not achieved.

In contrast, in the United States, the authors Shaffer, Ferguson and Denaro (2019) investigated a diverse sample of university students, obtaining an average overall proficiency of 65%, significantly higher than that observed in this study, but not much higher than the ideal for students who have already completed High School. It is worth noting that, within the North American sample, first-year students, equivalent to recent Brazilian High School graduates, scored lower on the TOSLS than final-year students. This difference reinforces the influence of educational level on performance in the test.

In addition to age and educational level, other factors may have influenced these results. In the case of the USA, the national average of 499 points in PISA science, higher than the OECD average, suggests a more favorable educational context, which may have contributed to the better overall performance of US students (OECD, 2024). Even so, because they are university students, this average should be higher, showing how much the achievement of scientific literacy is a major challenge for educational systems around the world. International experiences reinforce how far Brazil needs to go to achieve this in its school-age population.

The comparative analysis with data found in other countries highlights that the performance of the students in this study is significantly below the average of students from other nationalities, even considering the different levels of schooling – Middle School, High School and college. Despite this difference, the proficiency of this sample suggests that although the students did not acquire the basic skills of scientific literacy in Middle School, they have considerable potential to develop them throughout High School and reach the minimum desirable proficiency.

Looking individually at the results of the nine skills assessed in this study, it can be seen that the sample members performed best in skills 1, 3 and 5. On the other hand, skills 4 and 7 showed the lowest proficiencies, followed by skills 8, 2, 9 and 6 (graph 2).

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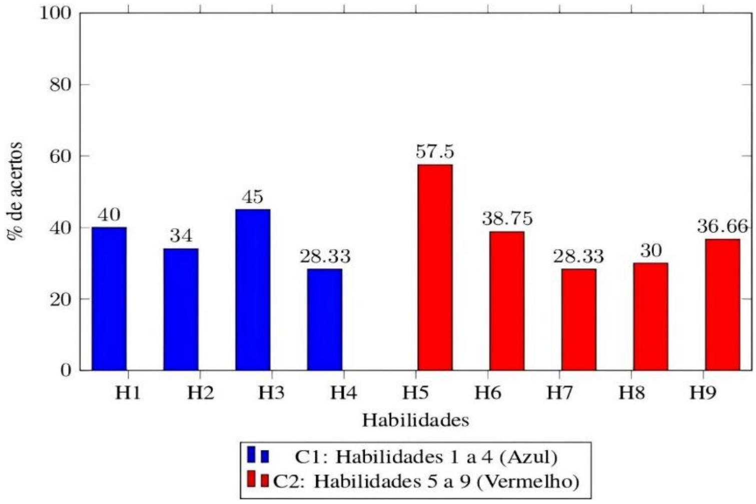
Graph 2 – Student performance by skill



Source: Authors (2024).

By comparison, Sousa's (2019) research with High School students at a campus of the Instituto Federal do Rio Grande do Norte, located around 53 km from the site of this study, also identified skills 1, 3 and 5 as the most prominent. According to Gormally, Brickman and Lutz (2012), developers of the TOSLS, these skills are related to the evaluation of variables and the analysis of information sources.

In this study, there was a balance between Competences I (Understand the research methods) and II (Organization, analysis and interpretation of quantitative data and scientific information), with average proficiency scores of 36.8% and 38.2%, respectively (graph 2). This differs from the study by Waldo (2014), in which Competency II performed around 10% better than Competency I. In the Brazilian sample, the low proficiency in Competency I reveals a weakness in understanding the construction of scientific knowledge, which is just as worrying as the deficiency in mathematics.

In line with the previous analysis, it is understood that the students' low performance in skills 2, 4, 6, 7, 8 and 9 probably comes from deficiencies in two essential areas for scientific literacy: text interpretation and mathematical reasoning, as already mentioned. The absence of these skills prevents the understanding of scientific scenarios and the identification of evidence in texts that prove or disprove a statement.

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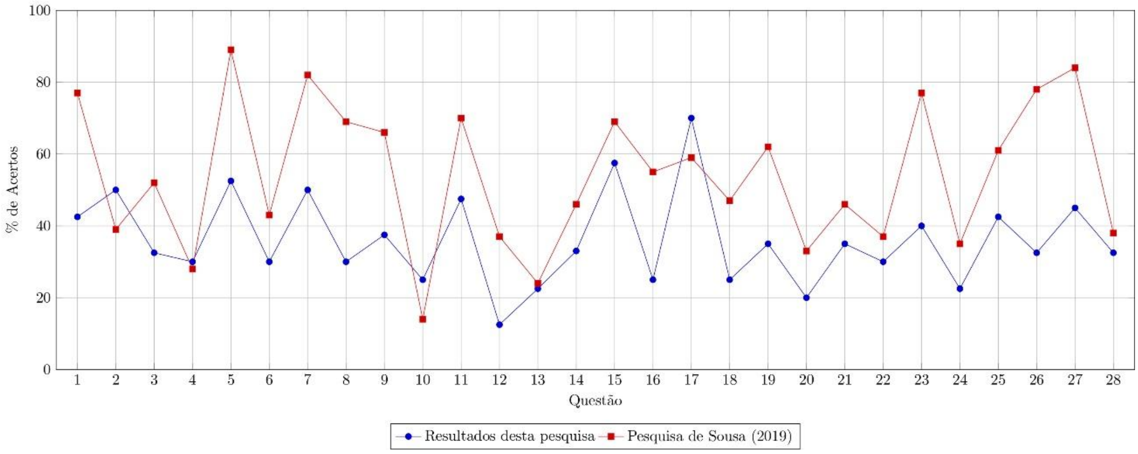
In the application of the TOSLS at IFRN, mentioned previously, students performed significantly better in 8 of the 9 skills assessed, compared to the results of this research (Sousa, 2019). This discrepancy, despite occurring in similar socio-economic and cultural contexts, raises questions about the factors that may have influenced this difference (graph 3).

Graph 3 – Comparison of correct answers per question between this study and that of Sousa (2019)



Source: Authors (2024).

One possible reason for this is that the IFRN students were finishing High School, suggesting that the Ceará sample could still improve their scientific literacy during this stage. In addition, there may be an influence from the difference between the High School curriculum of the institutions surveyed, the workload of the science subjects and the training of the teachers. All these factors vary between the federal school system, to which IFRN belongs, and the state school system in Ceará.

Successful learning in any school system depends on a solid curriculum and quality teacher training (Freire, 2019). However, the Brazilian High School scenario, which has historically been marked by constant structural and curricular reforms, suffers from frequent changes to the curriculum, both at the national level (Ministério da Educação e Congresso Nacional) and at the state level (Secretarias Estaduais de Educação), which creates a

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challenge for schools: how to guide teaching and guarantee student learning in the midst of so many changes?

In more detailed terms, the analysis of the results of this study shows that skills 4 and 7 had the lowest proficiency levels in the sample group, with only 28.33% correct (graph 2). This puts students in a critical situation in terms of their development, requiring significant attention during High School to improve these skills.

The data suggests that the students' school career throughout Middle School may not have provided the necessary conditions for adequate progress in these skills, calling for an approximation of the pedagogical approach promoted in schools to the proposals of the BNCC in relation to the science curriculum and the implementation of personalized strategies that bring these skills closer to the students' daily lives, both in Middle and High School.

With regard to skill 4, it is important to note that it challenges students to understand the structure of scientific research and its impact on discoveries (table 1). To do this, students must demonstrate basic knowledge of statistics and scientific methodology. Based on this knowledge, they need to reflect on research situations, assessing whether data is treated reliably and identifying possible confirmation biases. In addition to the logical reasoning involved in this skill, text interpretation also plays a crucial role.

The limited result in skill 4 is worrying, since its development equips the individual to protect themselves against the manipulation and distortion of research data. According to Cabral and Ávila (2022), this training is fundamental for an adequate understanding of scientific knowledge, which is essential for solving problems and making decisions with social responsibility.

This is important because, as Feitosa, Medeiros and Cavalcante (2020) point out, the internet and social networks have empowered science negationist groups that promote disinformation by distorting data and facts, with the aim of attacking research institutions and the reliability of knowledge and their products. These movements manipulate public opinion and find resonance with non-scientifically literate individuals.

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As for skill 7, it is understood that its development allows the individual to use probabilities, percentages and frequencies to solve problems. As such, this skill requires students to master basic math concepts such as percentages, multiplication and subtraction, as well as the ability to apply them in practical situations. The unsatisfactory performance found in this specific skill highlights the students' weakness in mathematical reasoning. According to Gomes *et al*. (2021, p. 1-2), in Brazil, the poor performance of basic education students in mathematics has been clearly observed in large-scale assessments, as evidenced by the Exame Nacional do Ensino Médio (Enem), the Sistema de Avaliação da Educação Básica (Saeb) and Pisa.

The lack of basic mathematical skills, due to educational deficiencies from Middle School onwards, significantly hampers the development of students' scientific literacy. Therefore, a quality science education cannot be widely offered to the Brazilian people until the educational systems improve the mathematics learning of the school-age population. Mathematics is the language of science.

The difficulty with mathematical reasoning is also reflected in skill 8, which assesses the individual's ability to understand and interpret basic statistics, correctly relating them to the conclusions derived from research. Such skills are crucial for decision-making in a globalized world where information and communication are instantaneous. The students obtained one of the lowest proficiencies in the test, with only 30% correct in this skill (graph 2), placing them at a critical performance level and requiring special attention throughout High School to improve.

With regard to this performance, it is important to note that “In the BNCC for Middle School Mathematics, the skills are organized according to the knowledge units of the area itself – Numbers, Algebra, Geometry, Quantities and Measures, Probability and Statistics” (Brasil, 2018, p. 527). This suggests that these students should already be more familiar with these mathematical skills, as well as the others related to Competence II (table 2).

Skill 2 assesses students' ability to discern between different types of sources and identify elements of prejudice, authority and reliability. It is therefore essential for people to be able to evaluate information rationally and logically in the digital age, especially in the

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context of social networks. Despite its importance, only 34% of students demonstrated mastery of this skill (graph 2), making it the third lowest proficiency level in the test and also placing it at a critical level.

In the view of this research team, this skill plays a central role in measuring the scientific literacy of the sample. Its poor result demonstrates what Silva and Sasseron (2021) point out as the fragility of adolescents in the face of the avalanche of information, misinformation and manipulation of facts, which is very common on the internet today. According to Batista and Bezerra (2020), the pandemic context of COVID-19 has shown us how ignoring science can be lethal for humanity, so developing this skill gives individuals the tools to combat misinformation and the manipulation of facts.

The sample group showed progress in skills 9 and 6 compared to the previous ones. Skill 9 means being able to interpret mathematical data to evaluate hypotheses and recognize flaws in arguments. The sample's proficiency in this skill was only 36.66% (graph 2). Skill 6 involves students' ability to interpret graphs in order to draw conclusions about scientific research. The proficiency demonstrated was 38.75% (graph 2). Despite the progress, there is still a difference of more than 20 percentage points between the current results of the sample and the minimum level required for these two skills.

To reduce the gap in mathematical skills in students' scientific education, Proença *et al*. (2022) advocate practical and contextualized teaching. Silva and Lins (2021) emphasize the importance of pedagogical practices connected to the students' reality, highlighting the relevance of mathematical skills. As for working with graphs, although they are valuable tools for visualizing data, Viseu *et al*. (2022) note that students often struggle, focusing on specific points rather than analyzing the data broadly and considering the relationship between the elements and the overall narrative.

As mentioned earlier, in a world that is increasingly connected virtually, where social networks and audio and video content influence opinions and decisions, skill 1 enables the individual to recognize scientific evidence and identify its support for hypotheses, making it essential to combat fake news and the proliferation of pseudoscience. However, the results of the survey revealed that this skill, which is crucial

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for citizen education, had a proficiency rate of only 40% (graph 2). Although it is not one of the most critical skills, this rate is sub-optimal.

In skill 3, in which the sample achieved 45% proficiency, students were challenged to identify the appropriate, impartial and ethical use of science in social decisions made by entities such as governments, companies and the media. The increase in the hit rate is a positive result, as this skill is fundamental for scientific literacy, understood as the "acquisition of the ability to respond authoritatively, through the scientific method, to the demands of a knowledge-intensive society" (Santos; Angelo; Silva, 2020), which is the main objective of science teaching.

Despite this, 55% of the students surveyed still haven't fully mastered this skill. Without this capacity, these individuals can become more susceptible to manipulation on issues of collective interest, such as the violation of human rights, denial of climate change, resistance to vaccination and political radicalization, which can lead to a series of social conflicts in various spheres of the community in which they live.

Among the TOSLS skills, 5, which assesses students' ability to identify the appropriate format for graphing data, stood out with 57.50% proficiency (graph 2), significantly outperforming the others. It is important to note that the assessment of this skill was based on a single question, 15, which was considered easy and had an intuitive graphic, which may have positively influenced the results.

Of the nine skills assessed in this study, only one (skill 5) had a higher rate of correct answers than errors. Thus, the results of this study showed that the two competences assessed by the TOSLS – (I) the ability to understand the relationship between the scientific method and the production of knowledge and (II) the understanding of mathematical data that corroborates scientific information – are not developed among the students in the sample (tables 1 and 2).

The evident weakness of the students in understanding scientific texts and mastering basic mathematical concepts distances them from the idea of competence, defined by Batista and Bezerra (2020) as the ability to apply knowledge in a practical way, promoting ethical behavior. In view of the many skills needed for a citizen to achieve the

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competences intrinsic to a solid scientific education, Sasseron and Carvalho (2011) recognize that the complete development of the skills needed for a solid scientific education is not feasible until the end of Middle School, but argue that the training process should begin at this educational stage.

According to Silva and Lorenzetti (2020, p. 19), from Middle School onwards, science teaching needs to "[...] enable students to problematize and investigate phenomena linked to their daily lives, so that they are able to master and use the knowledge built up in the different spheres of their lives [...]" and thus overcome once and for all the mere reproduction of scientific concepts during lessons.

Given the complexity of this educational objective, High School plays a crucial role. At this stage of basic education, students are already more mature, which favors the development of scientific skills and the ethical and autonomous application of these skills in their daily lives and in matters of collective interest. The studies by Waldo (2014) and Nahfer *et al.* (2016) corroborate this analysis, showing that students with more opportunities to study science subjects and with a higher level of schooling demonstrate better proficiency in science skills tests.

The final stage of the research, which consisted of feedback to the students on their individual performance on the TOSLS, highlighted aspects that require attention in order to develop their scientific literacy. The students reported that the length of the questions distracted them throughout the test. As hypothesized by Shaffer, Ferguson and Denaro (2019), this difficulty may have resulted in accelerated reactions, making it difficult to understand the texts and leading to random answers in some questions, which may distort the results. This hypothesis highlights the existence of gaps in the training process of High School students, pointing to the need for improvements in order to achieve more effective scientific literacy.

4 Conclusions

The educational challenges faced by the students taking part in this research reflect the reality of a large proportion of Brazilian students, making the results relevant beyond the local level. This study can be replicated in other contexts and serves as an important diagnostic tool. For this reason, it can be read by education professionals and researchers in the field of science teaching and can encourage analysis that enables the design of effective strategies to bring the schools' Political Pedagogical Project and teaching practice closer to the educational paradigm that is constituted as scientific literacy.

A closer look at the students' performance in each of the nine skills assessed here reveals that they bring with them from Middle School little familiarity with the concept of research and the scientific method, distancing them from the ability to critically analyze information and question scientific knowledge – Competence I. This means that they may find it difficult to distinguish reliable information from fake news, fraudulent narratives and confirmation bias, directly affecting citizen education and decision-making on issues that are important to society. If this lack of training persists, it will compromise the conscious action of these individuals in spaces of political, social and cultural participation.

The sample group also has difficulties in applying mathematical knowledge to interpret scientific data, limiting their understanding of research that uses graphs and statistics – Competence II. From this, it is possible to say that, despite the emphasis given to the study of Portuguese language and mathematics in Middle School, and the presence of science in the curriculum of the final years of this educational stage, these students have not yet developed the two scientific competences measured by the TOSLS. Therefore, the sample in this research did not reach adequate proficiency in any of the nine skills assessed to be considered scientifically literate.

High School is not the only stage of basic education responsible for promoting scientific literacy in individuals. In this sense, it is important to emphasize that a solid foundation, built from Kindergarten to the end of this educational cycle, is the ideal path for the efficient development of the skills and competences analyzed here.

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The data from the study in question also invites us to go beyond the mere transmission of content in Ciências da Natureza classes. In order to do this, science teaching needs to be more engaging and make sense to students. For this to happen, teachers need to use methodologies and teaching resources during lessons that promote: argumentation, scientific reasoning, evaluation of evidence and data, critical reflection and verification of the quality of scientific information and arguments.

Although the average proficiency of the students in the science skills assessed was 37.6%, considerably below the level expected for basic education graduates, it is important to note that the sample is made up of students at the beginning of their High School career. In this context, current proficiency offers a starting point by revealing the main weaknesses of the sample group in relation to their training in science, as indicated by the results of this research. Throughout High School, students will have the opportunity to develop the skills and competences necessary for scientific literacy, with the aim of achieving the desired minimum of 60% proficiency.

It's worth pointing out that scientific literacy is a continuous process. It begins in childhood, even before school, and continues throughout life. This means that students can and should continue to improve their scientific knowledge and skills after High School, in college and in adulthood.

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