

Impacts of diagnostic assessment on school performance in natural sciences

ABSTRACT

Mayara Barros Bezerra

mayara.fisica.ifce@gmail.com

orcid.org/0000-0003-2957-9979

Instituto Federal de Educação, Ciência e Tecnologia do Ceará (IFCE), Crateús, Ceará, Brasil

Jonas Guimarães Paulo Neto

jonas.guimaraes@ifce.edu.br

orcid.org/0000-0002-4589-5413

Instituto Federal de Educação, Ciência e Tecnologia do Ceará (IFCE), Crateús, Ceará, Brasil

This study, situated within the context of learning assessment in Basic Education, aimed to verify how the adoption of diagnostic assessment influences the teaching and learning process of Natural Sciences, in contrast to a purely summative assessment approach, within an elective subject in the 1st year of High School in a full-time school in Nova Russas, in the interior of Ceará. This was a qualitative-quantitative research, exploratory in nature and documentary procedure that was carried out through the application of diagnostic and summative assessments in classes of the first year of High School, using statistical and qualitative analysis to understand the relationships between the assessment methods and their effects on learning. The results show that diagnostic assessment is an important assessment tool to identify knowledge gaps and plan effective pedagogical strategies, promoting more meaningful learning aligned with the needs of students. The identification of students' prior knowledge and learning deficiencies, made possible by diagnostic assessment, plays a fundamental role in this training process by guiding pedagogical interventions aimed at acquiring new knowledge and developing (new) skills. Thus, this research contributes to the area of Science teaching by reinforcing the importance of integrating reflective assessment practices, capable of transforming the educational context and fostering the integral development of students.

PALAVRAS-CHAVE: Diagnostic assessment; Summative assessment; Natural Sciences; High School; School Performance.

Impactos da avaliação diagnóstica no desempenho escolar em ciências da natureza

RESUMO

Este estudo se insere no contexto da avaliação da aprendizagem na Educação Básica e objetivou verificar como a adoção da avaliação diagnóstica influencia no processo de ensino e aprendizagem de Ciências da Natureza, em contraposição à mesma avaliação na perspectiva somativa, numa disciplina eletiva no 1º ano do Ensino Médio em uma escola de tempo integral em Nova Russas, no interior do Ceará. Tratou-se de uma pesquisa de natureza qualiquantitativa, de caráter exploratório e com procedimento documental. Ela foi realizada mediante a aplicação de avaliações diagnósticas e somativas em turmas do primeiro ano do Ensino Médio, utilizando análise estatística e qualitativa para compreender as relações entre os métodos avaliativos e os seus efeitos no aprendizado. Os resultados encontrados evidenciam que a avaliação diagnóstica é uma ferramenta avaliativa importante para identificar lacunas de conhecimento e planejar estratégias pedagógicas eficazes, promovendo uma aprendizagem mais significativa e alinhada às necessidades dos estudantes. A identificação dos conhecimentos prévios dos educandos e de suas deficiências de aprendizagem, viabilizados pela avaliação diagnóstica, desempenha papel fundamental nesse processo de formação ao balizar as intervenções pedagógicas com vistas à aquisição de novos conhecimentos e o desenvolvimento de (novas) habilidades. Assim, essa pesquisa contribui para a área do ensino de Ciências ao reforçar a importância de integrar práticas avaliativas reflexivas, capazes de transformar o contexto educacional e de fomentar o desenvolvimento integral dos estudantes.

KEYWORDS: Avaliação diagnóstica; Avaliação somativa; Ciências da Natureza; Ensino Médio. Desempenho Escolar.

INTRODUCTION

The field of Natural Sciences plays an important role in the educational development of students in Basic Education, being responsible for developing the ability to understand the natural, social, and technological world. However, there are challenges that prevent this process from being effective for students in both Elementary and High School, such as: the teacher-centered approach, the traditionalism of pedagogical practices, teaching for testing and the disconnect from research in science education (Moreira, 2021).

In this context, the National Common Curriculum Base (NCCB) emphasizes the importance of promoting scientific literacy in civic and critical education, capable of expanding basic knowledge and enabling students to appropriate concepts, procedures and theories from various fields of Natural Sciences (Brasil, 2018). However, studies highlight difficulties in this area regarding the implementation of pedagogical practices that integrate theory with practice, as well as the need for more reflective and inclusive assessment strategies (Rosa, 2012).

Chronologically, science education has progressed from a traditional model, based on the mechanical transmission of content with the teacher playing a central role, to more constructivist and socio-interactionist approaches grounded in the theories of Piaget and Vygotsky, which value the student's active role in the learning process (Rosa, 2012). Despite these changes, many practices remain anchored in expository methods and assessments that prioritize memorization, resulting in disjointed learning that is poorly connected to the students' reality (Hoffmann, 2012). Evidence of these challenges becomes apparent in school assessments, where low performance patterns reveal not only gaps in knowledge but also limitations in the assessment strategies applied (Luckesi, 2011).

According to Libâneo (1996) *apud*. Costa, Silva and Barbosa (2012), evaluation is an essential didactic practice that seeks to verify the achievement of established objectives. It is a multifaceted process that goes beyond simply administering tests for ranking and assigning grades; it is also important in the process of verifying the teacher's work and in analyzing the students' progress and difficulties.

In the current educational landscape, an analysis of assessment types reveals significant nuances, particularly between diagnostic and summative assessment. The relevance of diagnostic assessment goes beyond simply measuring academic performance; it is fundamental for detecting specific areas that require pedagogical intervention, as well as guiding the teaching and learning process by providing the teacher with more data about the (prior) knowledge of their students.

Costa, Silva, and Barbosa (2012) argue that summative assessment, known as traditional assessment, provides an immediate overview of a student's punctual performance, while diagnostic assessment offers a richer and more detailed view over time, fostering more adaptive and flexible teaching (Bueno & Gonzalez, 2019). This point is extremely relevant to the area of Natural Sciences, as this approach not only identifies weaknesses in learning but also enhances the strengthening of students' skills and competencies by adjusting the curriculum to their real needs, where complex and interdisciplinary concepts require a well-founded base at the beginning of high school, the stage that will be studied here.

With this understanding, this study uses these two assessment methods to answer the following research question: How does diagnostic assessment impact on the teaching-learning-assessment process and on addressing in knowledge limitations the early years of high school in Natural Sciences?

To address this problem, this qualitative and quantitative, applied, exploratory and documentary research aimed, as its general objective, to verify how the adoption of diagnostic assessment influences the teaching and learning process of Natural Sciences, in contrast to the same assessment with a summative perspective, in an elective subject in the 1st year of High School, in a full-time school in Nova Russas, in the interior of Ceará. As specific objectives, this research intended to: (1) analyze the performance of students in the first years of High School through diagnostic and summative assessments; (2) investigate whether the adoption of diagnostic assessment impacts the results of subsequent summative assessments.

The justification for this study lies in the need to provide a foundation, make, and guide pedagogical choices that aid the holistic development of students, promoting an assessment that not only evaluates but also generates reflection and transformation, ensuring that students reach their educational potential, as advocated by NCCB.

THEORETICAL FRAMEWORK

Until the 1950s, science education was not widely discussed in schools; on the contrary, it was characterized by the rote exposition of content using the Transmission Model, which constituted a rote learning. Classes were expository in nature and teachers were only responsible for transmitting information, so that students were merely receptive spectators. Practical applications in science teaching were almost nonexistent and activities were generally carried out through evaluative questionnaires (Rosa, 2012).

By the 1970s, science education had its vision broadened from the constructivist teaching model, through Alternative Conceptions, in which the student had the possibility of constructing their own learning and their prior knowledge was considered. Science teaching was seen as a result of the interaction between the learner (subject) and what is to be learned (object) (Rosa, 2012).

As the Alternative Conceptions model led to little change in classroom practice, the 1980s saw a shift towards a focus on scientific knowledge, in which teachers participated as mediators capable of promoting ideas and problem situations to students so that they could refute them (Rosa, 2012). It was then that teaching began to have a constructivist property, through Piaget's theory (Piaget, 2024), having the characteristic of effective learning, leaving aside mechanization and moving towards a characteristic of active student participation, considering their prior knowledge (Baptista, 2010).

At the end of that decade, curricula needed to adapt to a market that focused on valuing schooling and training for the world of work, causing the school curriculum to undergo changes to meet the demands of the time. With the creation of the LDB (Law of Directives and Bases) in 1996, the school should foster

basic preparation for work and the exercise of citizenship, so that the student continues learning, in order to be able to adapt flexibly (Brasil, 1996).

Subsequently, in 1999, the National Curriculum Parameters (NCP) were created, a guiding document primarily based on the interdisciplinarity of content and anchored in competencies, aiming to support the operationalization of the LDB's proposal for High School. Thus, the document discusses in more detail the competencies indicated in the National Common Base for High School and, at the same time, points out that the curriculums should be organized in a way that seeks interdisciplinarity and contextualization of knowledge (Brasil, 1999).

Over time, the need arose for a more comprehensive, democratic, and contextualized update that considered social, cultural, scientific and technological transformations. It was in this context that the National Common Curriculum Base (NCCB) was consolidated, a normative document that, as stated in the document, aims to promote a quality and inclusive education aligned with contemporary demands, reinforcing the continuity and improvement of public educational policies in the country. This document aims to guide the development of curricula for students in Basic Education, with the objective of promoting educational equity and quality teaching through the development of skills and competencies (Brasil, 2018).

Regarding science education, the NCCB commits to the general education of students, so that they can be aware of the types of knowledge generated for human life, both for well-being and quality of life. This document also guides teaching in terms of the skills and competencies to be acquired and developed. It also offers guidance for the guidelines of the Basic Education segments, Elementary School and High School, making the area of Natural Sciences an integral part of the students' comprehensive education, since the initial stage of Elementary School (Brasil, 2028).

For the effective development of the skills and abilities established by the NCCB, the teaching and learning process needs to be anchored in more meaningful didactic-pedagogical strategies, as well as theories that can support teaching practice and mediate the relationship between the subject and the object. This is where Ausubel's Theory of Meaningful Learning (Ausubel, 1968) emerges, which values students' prior knowledge, allowing them to build mental structures anchored in that knowledge.

According to Pelizzari *et al.* (2001) and Ausubel (1968), when school content fails to connect with prior knowledge, the rote learning occurs, as defined by Ausubel. In this case, new information is learned without interacting with relevant concepts already existing in the student's cognitive structure. As a result, the student memorizes formulas and laws but tends to forget them after the assessment, a behavior that is very common in the teaching of Natural Sciences, where students fail to establish adequate associations for the concepts seen in the classroom and create a barrier to integrating these concepts into everyday life.

For meaningful learning to occur, two conditions are essential: first, the student must be willing to learn, because if they choose to memorize the content arbitrarily and literally, the learning will be mechanical; second, the school content/teaching material must be potentially meaningful, that is, it must be logically and psychologically relevant. Logical meaning depends on the nature of

the content, while psychological meaning is an individual experience. Each learner filters the content that is meaningful to them (Pelizzari *et al.*, 2001).

According to Moreira (2012), stating that prior knowledge is the variable that most influences the meaningful learning of new knowledge does not mean that it is always a facilitating variable. Although prior knowledge generally facilitates learning, in some cases it can act as a blocker. In Natural Sciences, for example, some everyday concepts may not be in accordance with the actual scientific definition, requiring the teacher to take special care in identifying prior knowledge and, when necessary, replacing it with scientifically correct knowledge.

The educator themselves, by practicing their area of expertise, becomes an essential tool for student learning. If the teacher is passionate about their field and manages to captivate the students, they may perceive the value of this knowledge and perhaps become interested in following the same path. However, if the teacher merely transmits what they have read in books, without passion, the students will likely perceive this knowledge only as something to be accomplished. Based on this information, it is understood that Ausubel's Theory of Meaningful Learning contributes significantly to the construction of the knowledge society (Pelizzari *et al.*, 2001).

In this educational process, assessment has multiple functions that go beyond simply verifying student performance, primarily serving as a diagnostic tool for students' learning levels, identifying difficulties and guiding future pedagogical interventions (Luckesi, 2011). The diagnosis provided is crucial for understanding which areas students face the most challenges, favoring the development of strategies by educators to address these difficulties. Assessment, therefore, is not limited to an end in itself, but a mechanism for promoting the continuous growth and evolution of students (Hoffmann, 2003).

Costa (2019) understands the assessment process as an integration of learning, being conceived, planned and carried out in an integrated way with this action, continuously, where error is an opportunity for growth and reflection. In the educational field, at all school levels, assessment is present as a fundamental tool in the teaching and learning processes, understood as two sides of the same coin, but with its specificities (Pinto, Almeida & Jung, 2022).

In this sense, it is important to highlight that assessment is not an exam, although these concepts are often used interchangeably. From capitalist production and the social rise of the bourgeoisie, the entrance exam emerged as a form of democratization of the State. Consequently, with the development of the capitalist mode of production, it became a component of the system. Therefore, it is characterized as something classificatory, not a mediator of knowledge (Pinto, Almeida & Jung, 2022). While it is a punctual situation, generally used to verify knowledge acquired at a specific moment, assessment is a continuous and systematic process that involves obtaining and analyzing information over time (Esteban, 2010).

Exams are associated with pressure to achieve results for students, as they are decisive moments that generate many expectations and impacts on educational trajectories. In contrast, continuous assessment provides a more holistic and dynamic view of student development, considering their progress across dimensions over time (Vasconcellos, 2013). Even today, we find school exams in

our schools and learning assessments are not always present (Pinto, Almeida & Jung, 2022).

To better understand and intervene in this scenario, it is necessary to identify the main functions of assessment, which are: diagnostic function, formative function and summative function. (Sant'Anna, 1995).

[...] the diagnostic function, which refers to understanding reality through observation, dialogue and the development of strategies that enable the characterization of spaces, subjects and conditions a priori; the formative function, characterized by evaluative actions that provide continuous and systematic training during the process; and the summative function, a conclusive analysis where all the constituent elements of the evaluation are added together [...] (Duarte, 2015, p. 55).

With this in mind and in close connection with examinations, Luckesi (2005) argues that assessment should not be used simply to pass or fail students, but rather as a diagnostic tool to understand their current situation, in order to guide the path to be followed in their learning. To achieve this diagnostic function, assessment must be carried out as a tool that helps to understand the stage of learning in which the students are and in making appropriate decisions so that they can progress in their educational process (Luckesi, 2005).

The diagnosis involves investigating the student's current developmental status, examining what they have learned and how they learned it. It is an important phase of the teaching and learning process that aims to assess the extent to which prior knowledge has been acquired and to identify difficulties to be overcome. Diagnostic assessment also seeks to detect skills and prerequisites necessary for new learning experiences (Sant'anna, 1995).

On the other hand, summative assessment has become more common and used by teachers. According to Santos (2016), summative assessment is imperative in many countries. Teachers' justifications for resorting to this type of assessment include many variables, such as: time, complexity of preparing new tests, specific questions, among others. "The objective of summative assessment is to evaluate, in general, the degree to which the pre-established objectives have been achieved" (Miquelante *et al.*, 2017, p. 271).

In science education, assessment must consider the challenges posed by the cultural and social diversity of students. As observed by Delizoicov *et al.* (2018), students bring to school a wide variety of experiences and prior knowledge, which need to be valued in the teaching and assessment process. This diversity is a rich source for learning and assessment should recognize the different ways of interpreting and understanding the world, allowing each student to feel valued in their individuality.

METHODOLOGY

This work consisted of a qualitative and quantitative research approach. According to Gil (2007, p. 28), "quantitative research is characterized by the use of quantification both in the methods of data collection and in its treatment through statistical techniques", while "qualitative research is concerned with aspects of reality that cannot be quantified, focusing on understanding and explaining the

dynamics of social relations” (Gil, 2007, p. 29). Regarding its nature, it is applied research, since, according to Gerhardt and Silveira (2009, p. 35), it “aims to generate knowledge for practical application, directed towards solving specific problems. It involves local truths and interests.” Regarding its objectives, it is exploratory, as its goal is to provide greater familiarity with the problem, making it more explicit or helping in the construction of hypotheses (Gil, 2007).

The quantitative results of this work originated from data collected through documentary research, a technical procedure addressed in this study based on information available in tables that presented the students' results in assessments in two modalities (diagnostic and summative) applied in the first school periods of 2023 and 2024, at the school locus of this investigation. As pointed out by Gil (2007), this type of research is characterized by the analysis of previously prepared documents, with the objective of obtaining relevant information that can contribute to the solution of a research problem.

Thus, documentary research was fundamental in utilizing existing data on student performance in applied assessments, allowing for a detailed analysis and understanding of the impact of these assessments on the learning process of students in Natural Sciences (qualitative approach).

Therefore, this study was conducted at a Full-Time High School (FTHS) located in the city of Nova Russas, in the state of Ceará. Assessments were carried out within the elective course “Science from A to Z”, which covers various themes with the “objective of understanding and/or reinforcing acquired knowledge, to support the different objects of knowledge addressed and suggested in the elective's proposal” (Ceará, 2023, p. 239). The analysis focused on data from students enrolled in the 2023 and 2024 school years, whose initial (prior) knowledge was not identified for the purpose of comparing the students' level during the period considered. In 2023, the elective was conducted by three teachers, serving all four first-year classes, due to high demand, which allowed for its simultaneous offering in all of them. By 2024, only one teacher was responsible for teaching the elective, which continued to be offered to first-year students according to their choice. This allowed for the evaluation of the impact of diagnostic and summative assessments on learning in the Natural Sciences subjects (Biology, Chemistry, and Physics).

It should be clarified that the teaching resources used in the “Science from A to Z” elective classes in both years were the same: prepared activities, video presentations, slides, blackboard, markers, TV and concept maps. This continuity in the use of the same resources ensured the necessary uniformity for a fair comparison between the periods, ensuring that the observed variations were attributed to other factors and not to the introduction of new tools or methodologies. However, it is understood that the diversity of teachers (three) in 2023 and the reduction to only one in 2024 may be a limiting factor in this research, insofar as the conduct of the didactic-pedagogical process in the classroom also considers the teacher's identity, which is particular and unique to each teacher.

In 2023, 160 students comprised the 1st grades in four classes (A, B, C and D), of whom 159 took the assessments. In 2024, 125 students were in the 1st grades, divided into three classes (A, B and C), of which only 98 responded to the assessments. Even with this visible difference in the samples, the study is

considered relevant and comparable, since all students in the 1st grades were included. In 2023, the assessments followed a diagnostic approach, with evaluations conducted in two stages: the first in February, to identify the students' skills and gaps in prior knowledge; and the second in August, to assess progress after pedagogical interventions in Natural Sciences. Based on the results of the first assessment, with a diagnostic focus, teachers were able to identify the main student difficulties. Based on this, they carried out specific interventions during classes, which included working on skills considered essential prerequisites for deepening new knowledge in Natural Sciences.

Aware of these gaps, the teachers briefly reviewed the basic concepts in their classes through a short introduction to reinforce the skills necessary for a deeper understanding of the new content. These actions were integrated into the regular lesson plan, without the need for a specific schedule for making up for lost learning. In this way, the second assessment allowed for evaluating the students' acquisition of new knowledge, as well as the didactic-pedagogical choices and approaches adopted in this process. It is noteworthy that the four first-grade classes were homogeneous, without significant differences, and that the actions of the three teachers were planned to be consistent, making it impossible to attribute any results to any specific teacher.

In 2024, the assessment model adopted was summative, with evaluations applied in March and June. That year, the tests were used solely to compose a partial grade for students, without reflective analysis of the results or concern for addressing skills that could be identified as gaps. The content, resources, and strategies adopted were the same, but, unlike in 2023, there were no efforts to ensure that students fully developed the necessary prerequisites before introducing new knowledge. The focus was only on introducing additional (new) content, without pedagogical interventions aimed at correcting or reinforcing the foundations necessary for continuous learning. Therefore, unlike the previous year, the teaching and pedagogical action in the classroom did not start from an identified reality, but considered the elective course program and the content to be covered, adopting the same methodologies for comparison purposes. Furthermore, the application and analysis of the assessments were the responsibility of a single professor, without any in-depth analysis of the data.

The two tests used in both school years were identical, allowing for an analysis of the diagnostic (2023) and summative (2024) approaches. This is fundamental for analyzing and evaluating whether the adoption of diagnostic assessment, with the identification and treatment of learning gaps, impacted student performance in Natural Sciences (Biology, Chemistry, and Physics) and whether the absence of this process in 2024 may have influenced the development of these prerequisite skills, as well as new knowledge. It is important to note that no analysis of individual student performance was conducted, nor of the possible difference in the distribution of correct answers among students, which may represent a limitation of this study.

Thus, the records of the assessments applied by the school comprised the documentary sources used for the analysis of this work, consisting of 20 objective questions distributed among the subjects of Biology (6 questions), Physics (7 questions) and Chemistry (7 questions). Table 1 below details the questions

through the object of knowledge linked to the respective skill developed, in the order Biology (6), Physics (7) and Chemistry (7).

Table 1

Questions, topics and skills related to the subjects

Object of knowledge	Skills
1- Infectious diseases	EF07CI09: To interpret the health conditions of a community, city, or state, based on the analysis and comparison of health indicators (such as infant mortality rate, basic sanitation coverage and incidence of waterborne and airborne diseases, among others) and the results of public health policies.
2- Formation of the Earth	EF07CI15: To interpret natural phenomena (such as volcanoes, earthquakes and tsunamis) and justify the rare occurrence of these phenomena in Brazil, based on the plate tectonics model.
3- Sexual and asexual reproduction	EF08CI07: Compare different reproductive processes in plants and animals in relation to adaptive and evolutionary mechanisms.
4- Photosynthesis	EF06CI02: Identify evidence of chemical transformations resulting from mixtures of materials that produce different products from those that were mixed (mixing ingredients to make a cake, mixing vinegar with baking soda etc.).
5- Basic sanitation	EF07CI09: To interpret the health conditions of a community, city, or state, based on the analysis and comparison of health indicators (such as infant mortality rate, basic sanitation coverage and incidence of waterborne and airborne diseases, among others) and the results of public health policies.
6- Aedes Aegypti (Dengue)	EF04CI08: Based on knowledge of the transmission methods of some microorganisms (viruses, bacteria and protozoa), propose appropriate attitudes and measures for the prevention of diseases associated with them.
7- Changes in the physical states of water	EF05CI02: Apply knowledge about the physical state changes of water to explain the hydrological cycle and analyze its implications for agriculture, climate, electricity generation, the provision of drinking water and the balance of regional (or local) ecosystems.
8- Thermal equilibrium	EF07CI02: Differentiate between temperature, heat and thermal sensation in various everyday thermodynamic equilibrium situations.
9- Heat propagation	EF07CI03: To use knowledge of heat transfer methods to justify the use of certain materials (conductors and insulators) in everyday life, to explain the operating principle of some equipment (thermos, solar collector, etc.) and/or to build technological solutions based on this knowledge.
10- Changes in the physical state of matter	EF09CI01: To investigate the changes in the physical state of matter and explain these transformations based on the submicroscopic model of constitution.
11- Density of bodies	EF05CI01: To explore everyday phenomena that demonstrate the physical properties of materials – such as density, thermal and electrical conductivity, responses to magnetic forces, solubility, responses to mechanical forces (hardness, elasticity, etc.), among others.
12- Types of heat	EF07CI02: Differentiate between temperature, heat, and thermal

Object of knowledge	Skills
propagation	sensation in various everyday equilibrium situations. Understand simple machines, thermodynamic principles and identify materials according to their thermal propagation process.
13- Characteristics of body's movement	EF02CI02: To propose the use of different materials for the construction of everyday objects, taking into account some of the properties of these materials (flexibility, hardness, transparency, etc.).
14- Properties of metals	EF02CI01: Identify the materials from which everyday objects are made (metal, wood, glass, etc.), how they are used and research information related to the past use of these objects. Properties and uses of materials.
15- Types of rocks	EF06CI12: Categorize rocks according to their characteristics and origin and associate sedimentary rocks with the formation of fossils in different geological periods.
16- Renewable and non-renewable energy sources	EF08CI01: Identify and classify different sources (renewable and non-renewable) and types of energy used in homes, communities or cities.
17- Water treatment	EF05CI04: To identify the main uses of water and other materials in daily activities to discuss and propose sustainable ways of using these resources.
18- Physical transformations of materials	EF09CI01: To investigate the changes in the physical state of matter and explain these transformations based on the submicroscopic model of constitution.
19- Chemical phenomenon	EF06CI02: Identify evidence of chemical transformations resulting from mixtures of materials that produce different products from those that were mixed (mixing ingredients to make a cake, mixing vinegar with baking soda, etc.).
20- Physical phenomenon	EF05CI01: To explore everyday phenomena that demonstrate the physical properties of materials – such as density, thermal and electrical conductivity, responses to magnetic forces, solubility, responses to mechanical forces (hardness, elasticity, etc.), among others.

Source: Brasil (2018).

Although the assessments from the first and second applications differed in terms of wording and question structure, both addressed the same themes and topics, aiming to evaluate students' progress in the skills and abilities developed throughout the teaching and learning process in Natural Sciences. It is important to note that the data were not processed to verify a (possible) homogeneity in the correct/incorrect answers to the questions, nor to correlate the individual performance of each student with their eventual progress from the first to the second application of the assessments. To ensure uniformity in the approach and analysis of the expected competencies in both assessments, the order, knowledge, and skills evaluated followed the same organization. The topics covered in each area presented a distinct set of competencies and skills that should have been acquired and developed by the students during the Elementary School stage.

Data collection was carried out using spreadsheets provided by the school, which contained each student's results on the applied assessments, indicating the number of correct and incorrect answers per question, as well as performance by subject area (Biology, Chemistry and Physics). The organization of the data allowed

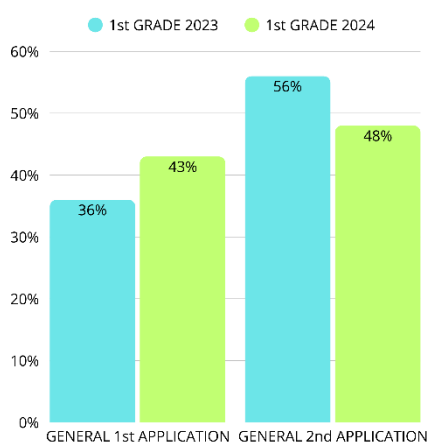
for a detailed analysis of each student's performance, making it possible to verify not only the total number of correct answers, but also the specific performance in each area and on each question.

RESULTS AND DISCUSSION

Figure 1 shows the overall results obtained in 2023 and 2024, from both the first and second applications, obtained from the average of correct answers in the 20 questions of the assessment. For emphasis and differentiation, the data referring to 2023 will always be represented in blue and the data from 2024 in green. It is worth noting that in 2023 the test was diagnostic and in 2024 it was summative.

Figure 1

Average number of correct answers (vertical axis) in the two applications of the 2023 and 2024 assessments (horizontal axis)



Source: Authors' own work (2025).

In Figure 1, the values were obtained by calculating the arithmetic mean of the total correct answers of the students, converting it to a percentage. It can be observed that the students' performance in the first application of the assessment, both diagnostic and summative, resulted in scores below 50% correct answers. That is, in 2023 the students assessed answered only 36% of the test correctly, approximately an average of seven correct questions out of twenty; while in 2024 the students achieved 43% correct answers, with an average of almost nine correct questions out of twenty.

In the second application, it was found that the overall result for 2023 showed a 20% increase, with students achieving 56% correct answers (approximately eleven questions); in 2024, the increase was only 5% compared to the first application, totaling 48% (an increase of one more question, with almost ten questions answered correctly on average). Based on these data, a discrepancy is observed in the evolution of learning when analyzing the assessment from a diagnostic and a summative perspective.

In both years there was an increase in correct answers, albeit subtle in 2024. However, the choice of diagnostic assessment in the first application of 2023 may have contributed more significantly to learning and the acquisition of (new) knowledge and skills, given that it reinforces the importance of diagnosing students' prior knowledge and how it influences learning, as it acts as support for anchoring new knowledge. Furthermore, these results indicate the relevance of considering students' difficulties, verified through diagnostic assessment, during the teaching and learning process, as highlighted in Methodology. This practice can guide teachers and students on a more assertive didactic-pedagogical path, which considers the individual progress of each student, the order (of complexity) of the content (knowledge) and the progression of learning and skills.

Regarding these initial results, it is interesting to note that Natural Sciences face significant challenges in this transition from Elementary to High School. A test with skills related to Elementary School indicates that upon entering High School, students have developed less than half of the assessed skills necessary for this stage, according to the NCCB (Brasil, 2018).

The difficulty in performing in this area persists over time, which can be seen in the average proficiency scores in the National High School Exam (NHSE) in Natural Sciences. Over the last 10 years, these scores have ranged between 477 and 510 points, demonstrating that historically the results fall short of expectations and reflect gaps in learning and consolidating important skills for this stage. The challenges in the transition between elementary and high school continue to impact student's performance until the end of this schooling stage, reinforcing the need for pedagogical strategies that promote more meaningful learning. Even though the NHSE assesses the high school stage, it is understood that the scores are also a result of the teaching and learning processes of elementary school (nine years), which should be consolidated and deepened in high school (three years).

Another important piece of data is the analysis of the results of Pisa (Program for International Student Assessment), which has indicated that student performance continues to be below the OECD (Organization for Economic Cooperation and Development) average in Science, according to INEP (2020). Between 2000 and 2022, the average for OECD countries was between 485 and 501, while Brazil's average fluctuated between 375 and 405, with the country having occupied positions between 32nd and 64th during this period, with this last one being the last possible position (INEP, 2022). This scenario reflects the persistence of difficulties in learning Science throughout Basic Education. The PISA report highlights that Brazilian students face challenges in applying scientific concepts to practical contexts, a result that points to the need to improve pedagogical strategies to promote more effective and meaningful learning from elementary school onwards, which also involves the assessment process.

Within this context, the results verified here, when placed against the backdrop of PISA and OECD data, corroborate studies that highlight the historical difficulties faced by Brazilian students in learning Natural Sciences (Costa, 2019). According to Silva (2013), one of the main barriers to learning in this area is the disconnect between the content covered and the students' daily context, which generates a distancing and a lack of engagement with scientific topics. Furthermore, Rosa (2012) argues that science education still faces structural challenges, such as the predominance of expository approaches and assessments

that prioritize memorization over conceptual understanding, as well as the fact that the assessment process can contribute to student failure by not considering their prior knowledge and its specific nuances and characteristics. This study reinforces these discussions by demonstrating that diagnostic assessment can act as a tool to reduce these difficulties, allowing for more targeted and effective pedagogical interventions.

A return to the results in Figure 1 clearly shows the impact of the types of assessments on the teaching and learning process. The contrast between the two types indicates that diagnostic assessment, in this case, significantly improved the percentage of correct answers, suggesting the acquisition of new knowledge and skills, while summative assessment showed a more modest increase. These findings are consistent with the arguments of Luckesi (2005), who defends diagnostic assessment as a continuous process of regulating learning, unlike summative assessment, which often is limited to a one-off measurement of student performance.

Furthermore, Perrenoud (2002) argues that assessments that do not consider the individual learning paths of students tend to reinforce educational inequalities, since they assume that all students possess the same knowledge base when entering new stages of learning. The data from this study reinforces this perspective by demonstrating that the diagnostic approach contributed to more consistent and progressive learning.

It is crucial to emphasize that the purpose of this work is not to establish a comparison between diagnostic and summative assessments with the aim of devaluing one in favor of the other, but rather to recognize that both play distinct and complementary roles in the teaching and learning processes. Both have their value, importance and applicability, contributing in different and specific ways to the understanding and development of student learning. What the data suggests, and what is argued here, is that by more precisely identifying students' difficulties and prior knowledge, the diagnostic approach allows for more assertive and targeted pedagogical interventions, favoring more continuous learning. This reinforces the importance of integrating this practice into the educational process to optimize results in different types of assessments.

Pinheiro and Rebouças (2018) have previously discussed how different types of assessments are reflected in student learning:

The evaluation process, when it understands evaluation as a cycle and not just as an instrument, needs, among its functions, to provoke reflective and transformative action in teaching practice, enabling the formation of dialogues and strategies that bring students and teachers closer together in pursuit of knowledge acquisition (Pinheiro & Rebouças, 2018, p. 3).

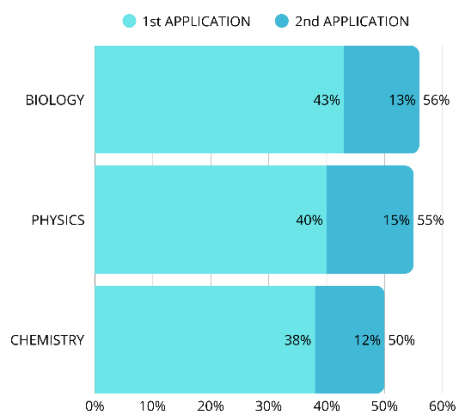
In this sense, Perrenoud (2002, p. 51) states that “demanding that all students have ‘the same foundations’ at the beginning of the curriculum is the typical requirement of a frontal pedagogy, incapable of managing heterogeneity, except through the failure of the slower or less disadvantaged”. This reinforces the importance of diagnostic assessment at the beginning of the pedagogical process, because, recognizing that students arrive with different foundations, we cannot demand that everyone start from the same point. In this sense, diagnostic assessment allows us to identify the prior knowledge of each student, enabling

personalized teaching that addresses their difficulties and gaps, adjusting the pedagogical path according to individual needs.

To enhance the analysis and discussion of the data, Figures 2 and 3 below show the evolution in the number of correct answers per subject in the years 2023 and 2024, whose percentages were obtained through the average number of correct answers in the block of questions of the curricular component.

Figure 2

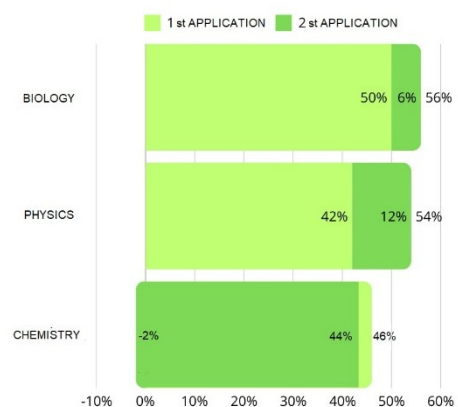
Average scores (horizontal axis) by subject (vertical axis) in diagnostic assessments in 2023



Source: Authors' own work (2025).

Figure 3

Average scores (horizontal axis) by subject (vertical axis) in summative assessments in 2024



Source: Authors' own work (2025).

In 2023, the percentage of correct answers across the three subjects in the first assessment was very similar, and all curricular components showed a percentage increase in the number of correct answers, with the skills related to Physics showing the highest percentage increase. In that year, the average increase

in correct answers was approximately 13% from the first to the second assessment, across all subjects.

In 2024, growth was observed in Biology and, as in 2023, the second application reached 56% correct answers, in addition to greater growth in Physics (54%), reaching almost the same percentage of correct answers as in 2023 (55%). However, something different happened: Chemistry experienced a drop in the percentage of correct answers. In the first application, the performance was 46%, and in the second application, there was a 2% drop, totaling 44% correct answers.

There are no elements available here to explain this (intriguing) fact, but regarding performance in Chemistry, Silva (2013) states, “the problems in learning Chemistry that are pointed out at all levels of education are not new: from generation to generation, Chemistry occupies the position of the most difficult and hated subject, which makes its assimilation difficult for students” (Silva, 2013, p. 16133). The author further adds that many students disapprove of the subject because it contains content that requires greater effort and that, due to its complexity, it generates many learning difficulties.

According to Menezes *et al.* (2017), the difficulties encountered go beyond the students' lack of skills in this subject, as they also encompass basic concepts of Portuguese and mathematics, as well as the teaching methodology adopted by teachers, which is a limiting factor, since few relate chemistry to everyday life and other natural sciences. However, these are possible causes of this result, as the data available, both on methods and results, do not allow for broader conclusions.

A detailed analysis of the curriculum components using 2023 data revealed an average increase of slightly more than 13% in Biology questions from the first, diagnostic assessment, to the second. It is understood that, in this way, students were able to assimilate new knowledge and skills related to Biology, indicating, to some extent, possible signs of meaningful learning. Furthermore, this data reinforces the adoption of diagnostic assessment in the teaching and learning process and the recognition of students' prior knowledge and difficulties.

When analyzing the 2024 data, the average growth in Biology questions across applications was approximately 7%, which is slightly less than half the percentage growth compared to the 2023 data. By specifying the knowledge conveyed in the problems, it could be inferred that the skill related to “dengue fever” showed the best performance in both years of application, while the skills related to sexual reproduction, photosynthesis and basic sanitation were more complex, considering the performance in 2023 and 2024.

Applying the same analysis to the Physics component, the average growth was 14.5% between the 2023 applications, with the first application being diagnostic in nature, exceeding the average growth in Biology (13%) in the same year. On the other hand, the average growth in correct answers in Physics between the two 2024 applications was slightly over 9%, exceeding the average growth in Biology in the same year (7%), but falling short of the 2023 growth in Physics, which was 14.5%. The breakdown of knowledge indicates that the skill related to “changes in the physical state of water” was the one that performed best in the first application in the years 2023 and 2024, revealing that this skill seems to have been well consolidated in Elementary School, which may also be related to the role that

water plays in everyday life. Meanwhile, the ability related to “changes in the physical state of matter” proved to have weaknesses and, possibly, confusion in the application of knowledge and in problem-solving.

Finally, in the Chemistry component, in 2023, the average growth per question was around 11%, lagging behind Biology (13%) and Physics (14.5%) in the same year. In 2024, the average (un)growth of questions in the second application was approximately -2% between the first and second applications, representing the worst performance of all subjects in 2024. In that year, students showed considerable difficulty in recognizing the properties of metals and with physical phenomena, while the skill related to “renewable and non-renewable sources” seemed to be well developed and strengthened. It is believed that more information about the teaching and learning process of knowledge and skills concerning Chemistry in that year could reveal possible clues to the factors that led to this scenario.

The analysis of the set of results from the assessments of the 1st-year high school classes at the FTHS in Nova Russas demonstrated that the students showed specific difficulties in certain skills, as indicated in the data presented, where some of the questions answered did not reach 50% correct answers in each subject, reflecting the existence of large gaps in the teaching and learning process, mainly in elementary school, or in the complexity of the content covered. Thus, the data support Luckesi's (2005) argument for assessment as a dynamic process that should diagnose difficulties and redirect pedagogical practices, rather than being limited to classifying students. The results found in the 2023 assessments reinforce the author's ideas and the adoption of diagnostic assessment in the educational process.

Thus, the results of this research confirm the importance of diagnostic assessment in identifying students' prior knowledge and difficulties. As advocated by Ausubel's Theory of Meaningful Learning, learning occurs more effectively when new knowledge is incorporated into existing cognitive structures (Pelizzari *et al.*, 2001). In this sense, by allowing teachers to identify gaps in students' learning, diagnostic assessment aligns with the need to offer potentially meaningful content, avoiding rote learning and favoring the active construction of knowledge (Moreira, 2012).

Furthermore, a careful analysis, question-by-question, of the data also revealed that students showed a higher error rate in the final questions of the exams, a phenomenon that can be explained by fatigue or the increasing complexity of the items, as highlighted by Vasconcellos (2013), who reinforces the importance of an assessment that considers the students' pace and the impact of external factors. According to the author, the arrangement of questions and the planning of the exam need to consider the cognitive load of the students, seeking strategies that mitigate the impact of fatigue throughout the assessment.

This aspect is particularly important when the objective is an assessment aimed at stimulating critical thinking and the practical application of what has been learned throughout the teaching and learning process. The pattern of increasing errors in the final questions, identified in 2023 and 2024, may indicate the need to reformulate the arrangement of the questions and/or to better balance the complexity throughout the assessment. Esteban (2010) corroborates this by

stating that assessment should be planned in a way that minimizes external factors, such as fatigue, that may interfere with the students' performance.

While some questions showed a balance between correct and incorrect answers, others revealed a clear predominance of incorrect responses, especially in more abstract or complex topics. This was particularly evident in the 2024 assessments, where the tests were purely summative, meaning no feedback was given to students, and the areas of poor performance were not identified and addressed later. This result reinforces the need to consider the specificities of each group when planning pedagogical and evaluative activities. As Hoffmann (2012) points out, assessment should be adaptive, considering the distinct realities and contexts of each class, so that it can effectively contribute to the students' holistic development.

Another relevant aspect is the influence of assessment strategies on student motivation. As discussed by Santos, Lima and Caxito (2024), assessment should be designed to integrate students' prior knowledge with new concepts, promoting an environment where error is seen as an opportunity for growth, not as failure. However, high error rates, especially in more challenging questions, suggest that assessment practices may be contributing to student demotivation and insecurity, factors that negatively impact overall performance. From this perspective, the adoption of diagnostic assessment allows error to be used as an element of teaching and learning, as the teacher becomes aware of the overall panorama of students' prior knowledge and plans their didactic-pedagogical interventions to act upon it, aiming to modify it, but without disregarding it.

The progress observed in 2023 in diagnostic assessments, such as the increase in the percentage of correct answers in subsequent tests, is a positive indication that pedagogical adjustments can be effective when well-developed and applied. The results showed that, among the applications, the one that achieved the greatest success in effectively increasing correct answers per skill was in fact the diagnostic assessment, which indicated, to a greater extent, the acquisition of new knowledge and evidence of meaningful learning.

However, the persistence of difficulties in specific areas reinforces the need for a more focused and continuous approach. Perrenoud (1999) argues that assessment should play a regulatory role, guiding both students and teachers on the next steps in the teaching and learning process. In this sense:

We must consider the daily lives of our students, their life experiences, their knowledge and skills, their desires and abilities. A school that only evaluates quantitatively loses sight of the human being by observing but failing to consider the minute details inherent in the evaluation process. In this way, we fail to achieve objectives that result in meaningful learning for our students. Therefore, the school needs to adopt a dialectical approach, reflecting on and reinterpreting its pedagogical practice (Pinto, Almeida & Jung, 2022, p. 101).

Pinheiro and Rebouças (2018) also offer reflections on evaluation:

The evaluation process, when it understands evaluation as a cycle and not just as an instrument, needs, among its functions, to provoke reflective and transformative action in teaching practice, enabling the formation of dialogues and strategies that bring students and teachers closer together in pursuit of knowledge acquisition (Pinheiro & Rebouças, 2018, p. 3).

Therefore, the results presented point to the need for a review of pedagogical and assessment practices, focusing on strategies that value the active participation of students, the development of critical thinking and the integration of prior knowledge. The incorporation of different assessment strategies can contribute to overcoming the identified difficulties and promoting more consistent and visible learning.

FINAL CONSIDERATIONS

This research aimed to analyze the importance of diagnostic assessment in Natural Sciences among high school students in the 1st year of a full-time high school in the municipality of Nova Russas, Ceará, during the school years of 2023 and 2024. The study was conducted with a sample of 237 students, using a quantitative-qualitative and documentary approach. Data collection was carried out through the results of two assessments, one diagnostic and the other summative, applied to students in 2023 and 2024, allowing the verification and analysis of knowledge gaps inherited from elementary school.

Through the analysis of the results presented, it was possible to achieve the overall objective of the research, providing a study of the impacts of diagnostic assessment on the teaching of Natural Sciences in the first years of High School, raising important reflections on teaching and learning processes and assessment strategies.

The main results indicated that the application of diagnostic assessments can have a positive impact on student performance. It is emphasized that this practice was carried out at the beginning of the year to identify and understand the prerequisites (prior knowledge and skills) brought from Elementary School by students in the first years of High School, as well as to consider them as guiding elements of/in the teaching and learning process. This experience indicated the acquisition of new knowledge and the development of (new) skills, as demonstrated throughout the work.

Discussions of the results revealed from the application of diagnostic assessments in 2023 and summative assessments in 2024 indicate that the integration of varied types of assessment (Paulo Neto & Macedo, 2023), as well as reflection and intervention throughout the classes, contribute to mitigating knowledge gaps stemming from elementary school and, consequently, promoting a better transition between these stages of basic education. These aspects show that the objective of this study was achieved, revealing both some challenges and progress related to the teaching-learning-assessment of Natural Sciences in the 1st year of high school.

This research contributed to the field of learning assessment in Natural Sciences by analyzing the results of assessments, seeking to understand some factors that influence students' performance, highlighting the importance of diagnostic assessment. By integrating theoretical and practical concepts about teaching Natural Sciences and types of assessments, this work offers insights for teachers and educational managers in the implementation of assessment practices, especially those that can engage students and enhance their learning. Furthermore, the critical analysis of assessment practices considering the NCCB

guidelines reinforces the need to align teaching with the contemporary demands of a more inclusive, conscious and reflective education.

However, this study has some limitations that should be considered. The analysis was based exclusively on assessment data and did not include an in-depth investigation into the socioeconomic, emotional and cultural context of the students, which can also significantly influence their performance. Furthermore, it did not verify the students' prior knowledge in 2023 and 2024 to compare their levels, also considering the difference in sample size between the two years.

Furthermore, the focus on assessment strategies did not allow for a comprehensive view of the role of structural conditions, such as school resources and teacher training, in the teaching and learning process, nor was student feedback gathered through any data collection instrument. Another point to highlight is that in 2023 three teachers were in charge of the elective course, while in 2024 only one teacher assumed this role. Thus, it was not possible, nor was it the subject of study, to verify if and how the performance of any of the teachers in 2023 directly influenced the results obtained.

However, we understand that these factors do not diminish the relevance of this research, insofar as the data collected in the diagnostic and summative assessments suggest the importance and necessity of adopting the former at the beginning of the instructional processes, as well as the analysis and consideration of the results obtained through them, but they indicate the need for further studies that may address, among other things, these shortcomings.

For future research, it is suggested to expand the investigation to include the collection of qualitative data, such as interviews with students and teachers, which can offer a broader view of the challenges and potential of assessments in science teaching and learning processes. Longitudinal studies that track the impact of pedagogical interventions over time would also be valuable for validating the effectiveness of the strategies studied, as well as expanding the samples and research contexts. Finally, exploring the integration of other types of educational assessments can contribute to enriching pedagogical practices and promoting teaching aligned with the demands of the 21st century, as advocated by the NCCB.

NOTES

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