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External assessment and Mathematics teaching: impacts of Spaece on curriculum practices in Ceará, Brazil

Abstract: The study investigated the impact of external assessments, focusing on the Permanent Basic Education Assessment System of Ceará. The objective was to analyze how these assessments influence curriculum practices and student performance, especially in Mathematics teaching. Using a qualitative approach, the study involved mapping ten academic works selected from the Capes database of theses and dissertations. The works analyzed address the use of educational technologies, pedagogical strategies, and the application of statistical models in external assessments. The results indicate that these assessments significantly affect curriculum organization and the methodologies adopted by teachers. The conclusion is that it is essential to use assessments in a balanced manner, prioritizing diagnosis and pedagogical intervention.

Keywords: External Assessment. Spaece. Mathematics Teaching.

Océlio Fernandes Pereira
Fortaleza Municipal Secretariat of Education
Fortaleza, CE — Brasil
0000-0002-0649-6524
oceliofernandes@yahoo.com.br

Clarissa de Assis Olgin
Lutheran University of Brazil
Porto Alegre, RS — Brasil
0000-0001-5560-9276
clarissa_olgin@yahoo.com.br

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ARTICLE

Evaluación externa y enseñanza de las Matemáticas: impactos del Spaece en las prácticas curriculares en Ceará, Brasil

Resumen: El estudio investigó el impacto de las evaluaciones externas, centrándose en el Sistema de Evaluación Permanente de la Educación Básica de Ceará. El objetivo fue analizar cómo estas evaluaciones influyen en las prácticas curriculares y el rendimiento estudiantil, especialmente en la enseñanza de las Matemáticas. Con un enfoque cualitativo, el estudio incluyó el mapeo de diez producciones académicos seleccionadas de la base de datos de tesis y disertaciones de Capes. Las producciones analizadas abordan el uso de tecnologías educativas, estrategias pedagógicas y la aplicación de modelos estadísticos en las evaluaciones externas. Los resultados indican que estas evaluaciones afectan significativamente la organización curricular y las metodologías adoptadas por el profesorado. La conclusión es que es esencial utilizar las evaluaciones de forma equilibrada, priorizando el diagnóstico y la intervención pedagógica.

Palabras clave: Evaluación Externa. Spaece. Enseñanza de Matemáticas.

Avaliação externa e ensino de Matemática: impactos do Spaece nas práticas curriculares no Ceará

Resumo: O estudo investigou o impacto das avaliações externas com foco no Sistema Permanente de Avaliação da Educação Básica do Ceará. O objetivo foi o de analisar como essas avaliações influenciam as práticas curriculares e o desempenho dos estudantes, especialmente no ensino de Matemática. De abordagem qualitativa, o estudo envolveu o mapeamento de dez trabalhos acadêmicos, selecionados a partir do banco de teses e dissertações da Capes. As produções analisadas abordam o uso de tecnologias educacionais, estratégias pedagógicas e aplicação de modelos estatísticos nas avaliações externas. Os resultados indicam que essas avaliações afetam significativamente a organização curricular e as metodologias adotadas pelos professores. Conclui-se que é fundamental utilizar as avaliações de forma equilibrada, priorizando o diagnóstico e a intervenção pedagógica.

Palavras-chave: Avaliação Externa. Spaece. Ensino de Matemática.

1 Introduction

Educational assessment has established itself as a strategic tool in Brazil, essential for monitoring educational quality and implementing public policies. According to Libâneo (2013), assessment should not be limited to the administration of tests, but rather viewed as an ongoing and complex process aimed at guiding pedagogical decisions. Sant'Anna (2014) complements this view by highlighting the importance of assessment for analyzing changes in student behavior and performance, as well as providing support for adjustments in the teaching and learning process.

Broadening this perspective, this study focuses on large-scale external assessments, such as the *Sistema Permanente de Avaliação da Educação Básica do Ceará* [Permanent Basic Education Assessment System of Ceará — Spaece]. This system, created in 1992, emerged as a response to the educational demands of Ceará, modeled after the *Sistema de Avaliação da Educação Básica* [Basic Education Assessment System — Saeb]. Throughout its history, Spaece has been expanded to encompass various stages of Basic Education, including literacy, Elementary, Middle and High School, allowing for comprehensive monitoring of student proficiency in areas such as Portuguese and Mathematics (Lima, 2007).

These assessments, such as Spaece and Saeb, use statistical models, particularly Item Response Theory (IRT), which enables accurate and comparative measurement of student performance. This methodology not only quantifies student proficiency levels but also allows for a detailed analysis of regional and socioeconomic inequalities that impact academic performance, providing support for the formulation of equitable educational policies (Bonamino and Sousa, 2012).

Despite their importance, external assessments face criticism. One of the main criticisms concerns the excessive use of rankings, which can promote unfair competition among schools (Luckesi, 2011). Furthermore, there is growing concern about the impact of these assessments on the school curriculum, especially in less privileged areas, such as Arts and Physical Education, which tend to be marginalized due to the emphasis on the subjects assessed, such as Portuguese Language and Mathematics (Bauer, 2020).

Given these considerations, this article presents an excerpt from an ongoing doctoral study, focusing on Spaece, focusing on how this instrument has influenced pedagogical planning and student performance. To this end, we mapped research produced between 2013 and 2023, addressing the use of educational technologies, pedagogical strategies, and innovative methodologies aimed at improving mathematics teaching and raising proficiency rates. The analysis of the research aims to understand how these practices can contribute to overcoming the challenges posed by external assessments in the school context.

2 Assessment in the Brazilian educational context

For Libâneo (2013), assessment is a complex process in the educational context, which is not limited to the administration of tests, since it aims, through the verification of results, to guide decision-making regarding educational practices. This perspective is complemented by Sant'Anna (2014), who reinforces the role of assessment in identifying, investigating, and analyzing changes in the behavior and performance of students, teachers, and educational systems, confirming whether theoretical or practical knowledge has been constructed. Thus, assessment is not limited to verifying results and assigning grades, but also presents itself as a process of continuous improvement, capable of promoting necessary adjustments to ensure educational quality.

Besides being a diagnostic tool, assessment plays a strategic role in schools, as it allows us to verify whether the proposed educational objectives are being achieved and guides

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pedagogical decision-making. As Sant'Anna (2014) points out, assessment provides teachers and institutions with specific data on what is working and what needs to be improved in the teaching and learning process, enabling pedagogical interventions if necessary. In the context of external assessments, this strategic role is expanded, as the results obtained from these assessments inform public policymaking, enabling not only large-scale monitoring of educational quality but also the identification of inequalities and the implementation of targeted corrective actions.

Large-scale external assessment in Brazil began to take hold in the late 1980s, when the federal government implemented the *Sistema Nacional de Avaliação do Ensino Público de 1º Grau* [National System for the Assessment of Public Education — SAEP], followed by the creation of the *Sistema de Avaliação da Educação Básica* [Basic Education Assessment System — Saeb] in 1990. Saeb marked the beginning of a systematic assessment policy aimed at monitoring student performance in Elementary, Middle and High School, both in public and private schools. Over time, the system was expanded through the introduction of the *Prova Brasil*, in 2005, and the *Exame Nacional do Ensino Médio* [National High School Exam — Enem], in 1998. These assessments are coordinated by the Instituto Nacional de Estudos e Pesquisas Educacionais Anísio Teixeira [National Institute of Studies and Educational Research Anísio Teixeira — Inep] and seek to provide a diagnosis of national education to support policy formulation (Luckesi, 2011; Bonamino and Sousa, 2012).

The Saeb, in addition to being the first major external assessment initiative in Brazil, pioneered the use of Item Response Theory, allowing for a more accurate comparison of performance among different groups of students over the years. The Prova Brasil, in turn, is a census-based exam, assessing all students in the 5th and 9th grades of public school. Meanwhile, the *Exame Nacional do Ensino Médio* was initially created with the goal of assessing student performance at the end of high school, but it has evolved to become the primary means of accessing higher education in Brazil, especially after the creation of the Unified Selection System (Sisu). These assessments, in addition to providing diagnostic data, help identify regional and social disparities in student performance (Bonamino and Sousa, 2012).

Beginning in the 2000s, Brazil began participating in international assessments, such as the Programme for International Student Assessment (PISA), coordinated by the Organization for Economic Cooperation and Development (OECD). PISA allows for the comparison of Brazilian student performance with that of other countries, providing a global overview of the quality of education in the country. While these assessments have expanded the government's ability to monitor the education system and inform public policies, they have also generated criticism. One of the main concerns concerns the excessive use of rankings and accountability policies based on these results, such as the granting of bonuses and prizes to schools and teachers.

This results-based management model can divert the focus from continuous improvement and educational equity, encouraging practices such as test-driven teaching to the detriment of a broader and more meaningful education (Luckesi, 2011; Bauer, 2020). Therefore, it is considered that, while assessments such as PISA are important for analyzing the education system, their results should be used critically, avoiding simplistic interpretations that reinforce competition between schools and prioritizing actions that promote inclusion and educational quality.

It is therefore argued that external assessments should be used primarily as educational diagnostic tools, providing input for improvement policies, rather than as tools for ranking and competition between schools. One of the frequent criticisms of these assessments is that an excessive emphasis on test results can ignore fundamental aspects of the educational process,

such as the school context and teaching conditions.

In this sense, the use of the *Índice de Desenvolvimento da Educação Básica* [Basic Education Development Index — Ideb] has also been questioned for exacerbating inequality between institutions, favoring those that already have better structural and pedagogical conditions, to the detriment of those facing significant socioeconomic challenges. Luckesi (2011) argues that rankings can generate a misperception about school quality, disregarding the difficulties faced by schools located in vulnerable contexts. Thus, it is emphasized that the results of external assessments should be used to identify gaps in teaching and inform effective pedagogical strategies, ensuring that improvements in educational quality occur equitably and not in a biased manner.

Furthermore, there is growing concern about how these assessments impact the school curriculum. The tendency to focus assessment results on reading and math skills, as is the case with the Saeb, can lead to a narrowing of the curriculum, marginalizing other areas of knowledge, such as the arts, natural sciences, humanities, and physical education. This phenomenon, known as curriculum narrowing, has been observed in several countries that have participated in large-scale studies, and Brazil is no exception. Bauer (2020) argues that, although external assessments can contribute to improving teaching, a balance is necessary so that pressure for results does not compromise the diversity and comprehensiveness of the curriculum.

Another important aspect is the role of external assessments in promoting educational equity. While large-scale assessments can reveal inequalities in performance between different socioeconomic groups and regions of the country, the results are often not followed by effective policies to correct these disparities. Bonamino and Sousa (2012) point out that, despite advances in expanding access to education, the quality of education continues to vary significantly between schools, reinforcing existing inequalities. Thus, the current challenge is to ensure that the data generated by external assessments are used appropriately to promote public policies that truly contribute to educational equity in Brazil.

Therefore, it is understood that large-scale external assessments in Brazil play a fundamental role in generating data on the quality of education. However, these results must be used judiciously to avoid distortions and deepening existing inequalities. As mentioned previously, these assessments do not fully consider different school contexts, such as infrastructure, student socioeconomic conditions, and the availability of pedagogical resources, which directly influence the results obtained.

Therefore, for external assessments to effectively contribute to promoting educational equity, their data must be used not only to rank schools but, above all, to inform public policies that offer targeted support to institutions. This may include investments in ongoing teacher training, curricular adaptation to regional needs, expanded access to teaching materials and educational technologies, and pedagogical strategies specific to each school's specific needs. Only with an approach that considers these variables will it be possible to transform external assessment data into effective tools for reducing structural inequalities in Brazil.

3 Spaece: impacts and contributions to Education in Ceará

In the context of education in the state of Ceará, the creation of the *Sistema Permanente de Avaliação da Educação Básica do Ceará* (Spaece) stands out. It was established in 1992 in response to the results of the *Sistema de Avaliação da Educação Básica* (Saeb). The main objectives of Spaece are to foster an evaluative culture in the state through the continuous development of the system; to enable those involved in the educational process to effectively monitor school results; and to analyze basic learning needs, with a view to formulating and

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monitoring educational initiatives (Lima, 2007).

According to Magalhães Jr. and Farias (2016), the Ceará State Secretariat of Education (Seduc-CE) initially called the assessment system the *Avaliação do Rendimento Escolar dos Alunos de 4ª e 8ª series* [Assessment of Academic Performance of 4th and 8th Grade Students], popularly known in schools as the *Avaliação das Quartas e Oitavas* [Assessment of the Fourth and Eighth Grades]. Later, this assessment was renamed the *Avaliação da Qualidade do Ensino* [Assessment of the Quality of Education]. According to the authors, it was only in 1996 that the system officially became known as the Permanent System for the Assessment of School Performance of the State of Ceará, although the acronym Spaece was not yet in use.

Furthermore, according to the authors, in the first edition of the assessment system, technical support was provided by the Federal University of Ceará, using as a basic framework the contents of the Curricular References, the National Curricular Parameters, the support manuals for Youth and Adult Education, and tele-teaching textbooks. That year, students from all state schools in the municipality of Fortaleza were assessed using a census method, using standardized tests for the 4th and 8th grades of Elementary and Middle School, currently corresponding to the 5th and 9th grades of Elementary and Middle School. In total, 10,590 4th grade students and 4,010 8th grade students, from morning and afternoon shifts, from 157 schools located in the state capital participated in the evaluation (Magalhães Jr. and Farias, 2016).

Later, in 2007, according to Andrade, Silva, and Santos (2023), the assessment's target audience was expanded to include children in the 2nd and 5th grades of Elementary School, who began to be assessed using the Spaece-Alfa. This exam aims to identify learning difficulties early, enabling the formulation of public policies and the allocation of resources to priority areas, in addition to analyzing student performance developments throughout their school career.

Currently, according to Vidal, Costa, and Soares (2022), the Spaece is structured into three grade levels:

- Literacy Assessment (Spaece-Alfa): an external, census-based, annual assessment designed to assess the reading proficiency level of 2nd grade Elementary School students in public schools in Ceará;
- Elementary and Middle School Assessment: an external census-based assessment conducted at the end of each Elementary and Middle School year to assess students' competencies and skills in Portuguese and Mathematics;
- High School Assessment: an external, census-based assessment administered in the 3rd grade of High School in the state public school system to assess student performance in Portuguese and Mathematics.

According to Andrade, Silva, and Santos (2023), the Spaece and Spaece-Alfa assessment models play an important role in the educational landscape of Ceará, as they allow for the measurement of student performance at different stages of Basic Education. Spaece, aimed at Middle and High School students, provides detailed data on student proficiency in subjects such as Mathematics and Portuguese, allowing for the identification of specific difficulties and the analysis of learning progress over the years. Spaece-Alfa, administered to 2nd grade Elementary School students, focuses on assessing literacy, enabling the early detection of gaps in the teaching and learning process.

These assessments use standardized instruments based on Item Response Theory, ensuring greater accuracy in the interpretation of results. Therefore, the data generated serve as a reference for the formulation of educational policies, the implementation of tutoring

programs, and teacher training in the state of Ceará. It is also worth noting that Spaece provides a comprehensive overview of student performance at different school levels, focusing on Portuguese and Mathematics. Spaece-Alfa, in turn, focuses on literacy assessments at the beginning of Basic Education, providing essential data for early identification of children's difficulties and for formulating public policies. It also guides investments in priority areas of education and enables the implementation of effective pedagogical initiatives (Andrade, Silva, and Santos, 2023).

According to Brandão (2014), the results obtained by Spaece directly influence the distribution of *Imposto sobre Circulação de Mercadorias e Prestação de Serviços* [Tax on the Circulation of Goods and Services — ICMS] quotas among municipalities, as, according to legislation, 18% of ICMS revenue must be distributed based on each municipality's Municipal Educational Quality Index. Linking Spaece results to the distribution of ICMS has encouraged municipalities to seek better results, passing this responsibility on to schools through managers who, in turn, seek to mobilize teachers and students to achieve the best possible results (Brandão, 2014).

Holanda (2006) emphasizes that the history of large-scale assessment in Ceará reflects a trend observed in Brazil and worldwide. Following the implementation of Saeb, Ceará demonstrated interest in using assessment indicators as a tool to support the management of its educational policies. Spaece, in this context, arose from the need to implement a large-scale assessment system that would provide a solid foundation for monitoring the learning of students in the public school system.

Finally, Andrade, Silva, and Santos (2024) emphasize that Spaece, over its more than thirty years of existence, has continuously improved, serving as a barometer of the quality of Basic Education in the state and informing public policies in Ceará. The data generated by this assessment are used to inform strategic decisions in educational management, enabling adjustments to teaching programs, teacher training, and resource allocation.

4 Methodology

The study adopted a qualitative approach, aiming to understand the impact of external assessments on student performance and curricular practices in the state of Ceará, Brazil, specifically within the context of Spaece. To this end, research discussing the impact of these assessments in the educational context of Ceará was analyzed, especially regarding pedagogical practices and the use of external assessment results in school management. The research does not aim to directly measure the impact of assessments on student performance, but rather seeks to understand, based on the literature reviewed, how data generated by Spaece are used in pedagogical planning and the formulation of educational strategies.

The methodology was developed in two main stages. The first, exploratory, involved a preliminary study on educational assessment and the context of external assessments in Brazil, focusing on Spaece. The second stage involved mapping academic works in the theses and dissertations database of the *Coordenação de Aperfeiçoamento de Pessoal de Nível Superior* [Brazilian Federal Agency for Support and Evaluation of Graduate Education — Capes]. For this mapping, the period from 2013 to 2023 was delimited, using the keywords *Permanent System for the Assessment of Basic Education in Ceará (Spaece)* and *Mathematics*. In the end, 19 papers were identified, of which, after reading the titles and abstracts, 10 were selected for this study.

The selected papers were organized by common themes, as illustrated in Table 1.

Table 1: Organization of selected research

Subjects	Description	Author and Title
External assessment and academic performance	Research analyzing the impact of external assessments (Saeb, Spaece) on academic performance and the use of results for pedagogical interventions	Neyara Oliveira Lima: Análise dos descritores do Spaece com baixos índices de acertos *[Analysis of Spaece descriptors with low accuracy rates]* Daniel Tabosa Alves de Oliveira: Detalhamento da Matriz de Referência de Matemática do 1º ano do Ensino Médio *[Details of the Mathematics Reference Matrix for the 1st grade of High School]*
Development and analysis of the Reference Matrix	Studies focused on the detailing and analysis of the Mathematics Reference Matrices used in external assessments and their implications for teaching	Alan de Souza Sampaio: Detalhamento da Matriz de Referência de Matemática do 3º ano do Ensino Médio *[Detailed Mathematics Reference Matrix for 3rd grade High School]* Luiz Felipe Araújo Azevedo: Detalhamento da Matriz de Referência de Matemática do 9º ano do Ensino Fundamental *[Detailed Mathematics Reference Matrix for 9th grade Middle School]*
Educational technology and digital tools	Research investigating the use of technological tools in the teaching-learning process and in preparation for external assessments	David dos Santos da Costa: Desenvolvimento do aplicativo S3BIMat para avaliações externas *[Development of the S3BIMat application for external assessments]* Lucas Emanuel de Oliveira Maia: Uso do *software* Modellus para o ensino de funções polinomiais *[Use of Modellus software for teaching polynomial functions]*
Pedagogical strategies to improve performance	Studies that analyze and propose pedagogical strategies to increase student proficiency in subjects such as Mathematics, especially in external assessments	Maria Jéssyka Almeida dos Santos: Estratégias para elevação da proficiência em Matemática nas Avaliações Externas *[Strategies for improving Mathematics Proficiency in external assessments]* Francisco Egilberto Faustino: Análise dos resultados da preparação para o Spaece utilizando regressão linear *[Analysis of Spaece preparation results using linear regression]*
Data mining and statistical analysis in Education	Research that uses statistical methods or data mining to predict and analyze student or municipal performance in external assessments	Herlane Martins Araújo: Mineração de dados educacionais para prever o desempenho em Matemática *[Educational data mining to predict Mathematics performance]* Francisco Egilberto Faustino: Regressão linear simples para análise de resultados da preparação para o Spaece *[Simple Linear Regression for analyzing Spaece exam preparation results]*
Pedagogical strategies for improving performance	Research exploring the impact of external assessments on teachers' pedagogical practices and curricular organization	Robert David Fernandes de Sousa: Historiografia das práticas pedagógicas de Matemática e avaliação externa Spaece *[Historiography of Mathematics pedagogical practices and external evaluation Spaece]*

Source: Own elaboration

The next section presents the selected studies and corresponding analyses.

5 Studies on the external evaluation of Spaece and the teaching of Mathematics

According to Luckesi (2011) and Sant'Anna (2014), external assessments play a strategic role, providing a detailed diagnosis of student performance and serving as a basis for pedagogical interventions that seek educational quality. In this sense, Neyara Oliveira Lima's dissertation, entitled *Learning in Mathematics: an analysis of Spaece Descriptors with low scores in two state schools*, investigated the relationship between the results of the Spaece external Mathematics assessment and the pedagogical practices of two state schools, located in the municipalities of Jaguaruana and Itaiçaba. In addition to document analysis, Lima (2023) interviewed teachers to analyze how these results can contribute to improving pedagogical practices. The study focused on the Mathematics descriptors that demonstrated low performance in 3rd grade High School classes, using data from the 2022 Spaece survey. Lima (2023) revealed that these descriptors are recurrent between the two schools, highlighting specific challenges in mathematics learning. The author concluded that, although large-scale assessments, such as Spaece, are an important tool for educational diagnosis, there is an urgent need for more specific pedagogical interventions to improve student performance.

Similarly, Alan de Souza Sampaio's dissertation, entitled *Permanent System of Assessment of Basic Education in Ceará (Spaece): detailing the Mathematics Reference Matrix for the 3rd grade of High School*, investigated the structure and role of Spaece in assessing Mathematics teaching. The study focused on a detailed analysis of the Reference Matrix, seeking to understand how the evaluated descriptors related to the curriculum content and how the assessment results could inform reflection and improvement of pedagogical practices. The dissertation addressed the evolution of Spaece, the formulation of assessment items, and the Proficiency Scale, discussing their relevance for diagnosing learning and developing educational strategies that contribute to teaching quality, going beyond simple test preparation.

Sampaio's (2018) study presented an in-depth analysis of the Mathematics Reference Matrix descriptors, discussing the strategies used by students in solving test items and proposing pedagogical practices. The results indicated that Spaece has helped monitor Basic Education in Ceará, providing data for teachers and administrators. Sampaio (2018) concluded that it is essential for teachers to be familiar with the Reference Matrix and the Proficiency Scale so they can use these tools to identify student difficulties and develop pedagogical strategies that can contribute to improving Mathematics teaching and learning.

Following this line, Daniel Tabosa Alves de Oliveira, in his dissertation *Permanent Assessment System of Basic Education in Ceará (Spaece): detailing the Mathematics Reference Matrix for the 1st grade of High School*, presented a similar analysis, but focused on the 1st grade of High School. The objective of this study was to provide an in-depth understanding of the Spaece Mathematics Reference Matrix and how it can be used to improve teaching and learning at this level. The research covered the evolution of Spaece, the descriptors of skills assessed, and provided practical examples of questions associated with these descriptors. The author detailed how teachers can use this information to identify student difficulties and plan more effective pedagogical interventions.

The results of Oliveira's (2023) research indicate that Spaece has proven to be a relevant tool for monitoring academic performance and for formulating strategies to improve education in the state of Ceará. However, for the results of external assessments to be used appropriately, it is essential that they are not limited to measuring student performance alone, but that they serve as a basis for reviewing and improving pedagogical practices. This involves adapting teaching plans, developing differentiated strategies to meet the specific needs of each class, and providing ongoing teacher training, ensuring that assessment fulfills its diagnostic and

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improvement function in the educational process, rather than merely serving as a ranking or performance control mechanism.

In the same field, Luiz Felipe Araújo Azevedo, in his dissertation *Ceará's permanent assessment system: detailing the Mathematics Reference Matrix for 9th grade Middle School*, explored the pedagogical application of descriptors for this level of education, providing examples of assessment items and suggesting strategies to improve student learning. The research addressed the characteristics of large-scale assessment, including the Reference Matrix, the Proficiency Scale, and specific Mathematics descriptors (Azevedo, 2022). The dissertation presented ways to pedagogically explore each descriptor, offering example questions and discussing different strategies to help students understand the mathematical content being assessed.

Furthermore, the author proposed activities and interventions that not only prepare students for external assessments but also contribute to the development of mathematical competencies in a broad and meaningful way. According to Azevedo (2022), the research results indicate that Spaece has played a fundamental role in diagnosing the mathematical abilities of 9th grade students, providing valuable information for administrators and teachers. However, the study also highlights the need for a deeper understanding of the Reference Matrix by teachers, allowing assessment data to be used as a tool for reflection and restructuring pedagogical practices. This ensures that the learning of descriptors occurs in a contextualized manner, avoiding being limited to mere test preparation.

The dissertations by Sampaio (2018), Azevedo (2022), and Oliveira (2023) emphasize the role of external assessments, such as Spaece, in identifying students' difficulties in Mathematics, providing support for pedagogical planning. However, it is important to emphasize that these diagnoses are not absolute, as they do not fully consider factors such as the socioeconomic context, the structural conditions of schools, and the individual specificities of students.

As Libâneo (2013) and Sant'Anna (2014) argue, assessment should be understood as a continuous process of improvement and reflection, going beyond measuring results and serving as a tool to support pedagogical actions. In this sense, pedagogical interventions should not be limited to preparing students for tests, but should include diverse strategies, such as active methodologies, contextualized teaching, and individualized monitoring, aiming to consolidate learning and develop mathematical skills applicable beyond external assessments.

Continuing teacher training, as pointed out by Oliveira (2023), is essential so that the results of these assessments can be critically analyzed and used as tools to improve teaching, without reducing the educational process to simple exam training. These studies directly align with Luckesi's (2011) view, arguing that the objective of assessments should be educational diagnosis and the promotion of teaching quality, rather than the creation of rankings or competitions between schools.

However, for external assessment data to be used appropriately, they must serve as a basis for pedagogical reflection and the improvement of teaching practices, not simply as a means for students to improve their results in future assessments. In agreement with Bonamino and Sousa (2012), studies indicate that the correct use of external assessment data should focus on identifying recurring difficulties, planning diverse pedagogical strategies, and developing teaching that fosters learning beyond performance on standardized tests.

Therefore, understanding the Reference Matrix should be used by teachers not as a test-taking training plan, but as a tool to guide practices that foster the construction of mathematical knowledge in a contextualized and applicable manner beyond the assessment environment.

The use of technologies in the context of external assessments was addressed by David dos Santos da Costa in his dissertation *S3BIMat: web application as a simulation tool in the student training process for external assessments (Saeb/Spaece) with a focus on Mathematics*. The study investigated the development of a computer application aimed at preparing students for external assessments, such as Saeb and Spaece, through simulations based on the reference matrices of these tests.

The research aimed to create the S3BIMat tool, which allows students to take tests, receive feedback, and monitor their performance in Mathematics, using Item Response Theory to estimate their proficiency (Costa, 2023). However, a critical analysis of this approach raises questions about whether the use of tools like this actually promotes meaningful learning or simply trains students to achieve better test scores.

As discussed by Libâneo (2013), assessment should be understood as part of an ongoing pedagogical process, not as an end in itself. Therefore, the adoption of educational technologies must go beyond the logic of exam preparation, promoting contextualized learning aligned with the real needs of students.

Therefore, it is necessary to differentiate the use of technologies aimed at analyzing educational data and developing pedagogical strategies from those aimed exclusively at improving performance in external assessments. As Bonamino and Sousa (2012) point out, technological tools can be fundamental for a more accurate analysis of student performance, providing support for pedagogical reflection and adjustments in teaching. Therefore, it is argued that technology in education should play a formative role, contributing to the improvement of teaching practices and the development of students' mathematical skills, and not just for preparing for external assessments.

Maria Jéssyka Almeida dos Santos' dissertation, entitled *Strategies used to increase Mathematics Proficiency in external assessments: a case study at Professor Aloysio Barros Leal State High School*, investigated the pedagogical strategies adopted at a public school in Ceará to increase student proficiency in external assessments, specifically in Spaece and Saeb. The research covered 9th grade Middle School, 3rd grade High School, and Youth and Adult Education (EJA) classes, analyzing math performance data from 2017 to 2022.

Santos's (2023) study focused on analyzing formative and recreational activities, including simulations, mini-tests, and diagnostic assessments, with the goal of preparing students for external assessments. The dissertation detailed how these pedagogical strategies influenced mathematics proficiency rates and, consequently, the increase in the school's Índice de Desenvolvimento da Educação Básica [Basic Education Development Index — Ideb] (Santos, 2023). The results indicated significant growth in student proficiency rates on the Spaece and Saeb assessments, resulting from the strategies implemented by the school (Santos, 2023). Nevertheless, the study also suggests the need for continuous monitoring and adjustments to methodologies to maintain and/or improve these results over time.

Analysis of external assessment data can contribute to the improvement of pedagogical practices, provided it is used critically and reflectively. However, caution is needed to ensure that this process is not reduced to merely feedback on student test performance, merely reinforcing preparation for future assessments. As Sant'Anna (2014) points out, assessment should be understood as a tool that guides educational action, providing support for adjustments in teaching and learning, without being limited to simply measuring results.

Therefore, for the use of assessment data to be effective, it is essential that it be focused on meaningful learning, enabling curricular adaptation and the adoption of pedagogical strategies that meet students' needs, not just improving performance on standardized tests.

The use of statistical models was the focus of Francisco Egilberto Faustino's dissertation, entitled "Analysis of the Results of Spaece Preparation and External Assessment Using Simple Linear Regression." The research investigated the relationship between student performance on diagnostic assessments and the results obtained on Spaece. The study used simple linear regression statistical models to analyze learning patterns and identify recurring difficulties, with the goal of understanding how assessment data can inform pedagogical practices.

The author questions the extent to which this approach contributes to the development of learning or merely reinforces concerns about assessment performance. For the use of statistical models in education to be truly beneficial, it is essential that the data be interpreted critically, serving not only to predict test results but, above all, to guide pedagogical interventions that meet students' real needs.

Thus, the study proposed adjusting a simple linear regression line to describe the relationship between pre-test scores and Spaece performance, as well as to analyze student learning patterns. The main results showed a significant correlation between these variables, suggesting that the data may indicate recurring student difficulties in certain mathematical subjects (Faustino, 2016).

However, the analysis should not be limited to predicting results in external assessments, but should serve as a basis for pedagogical practices aimed at improving learning. Such practices may include strategies such as differentiated instruction, active methodologies, and contextualized tutoring, aimed at meeting students' specific needs, not only to improve their test performance but also to consolidate their understanding of mathematical concepts.

The use of statistical methods highlights the importance of educational data in formulating policies that meet the real needs of students and schools. However, caution is needed to ensure that these policies are not limited to strategies aimed exclusively at improving results in external assessments. As discussed by Bonamino and Sousa (2012), data analysis should allow for an understanding of the structural challenges of education, guide the implementation of pedagogical practices that promote learning, and ensure that educational interventions are planned with a focus on equity and quality of education, and not simply on improving performance indicators.

In Herlane Martins Araújo's dissertation, *Educational data mining: a study on Mathematics Proficiency in Ceará*, the focus was on the use of data mining applied to education, specifically on the Mathematics proficiency results of Ceará municipalities measured by Spaece in 2019. Araújo's (2022) objective was to develop a predictive model capable of classifying and predicting the performance of Ceará municipalities in the Spaece Mathematics assessment, using educational indicators provided by the Instituto Nacional de Estudos e Pesquisas Educacionais Anísio Teixeira [Anísio Teixeira National Institute of Educational Studies and Research — Inep].

In this study, a Knowledge Model based on data mining was developed to analyze the factors that influence mathematics learning. The model identified educational indicators, such as school infrastructure, teacher qualifications, and student socioeconomic status, as relevant variables for understanding the challenges of teaching this subject. The research showed that, rather than simply predicting student performance on external assessments, data mining can inform pedagogical strategies and educational management initiatives aimed at equity and the comprehensive improvement of mathematics teaching.

The results demonstrated that this tool allows for the identification of patterns and trends that aid in the formulation of public policies more aligned with the real needs of schools, promoting pedagogical interventions that aim for meaningful learning, not simply improving

assessment scores (Araújo, 2022).

It is important to emphasize that this approach can significantly contribute to the formulation of public policies, provided that the data obtained are used critically and contextually, going beyond the simple measurement of student performance. Proper use of this information involves identifying structural factors that impact learning, such as access to teaching resources, teacher training, and students' socioeconomic conditions.

As Bonamino and Sousa (2012) point out, data from external assessments can support actions aimed at educational equity, such as allocating investments to schools with greater difficulties, implementing continuing education programs for teachers, and developing pedagogical methodologies that meet the specific needs of different school contexts. Therefore, the analysis of test results should serve as a starting point for educational interventions that consider not only improving academic performance but also building a more inclusive education system.

Robert David Fernandes de Sousa's dissertation, entitled *A historiography of the present time between Mathematics pedagogical practices and the external assessment of Spaece in a Basic Education School in Ceará*, investigated the pedagogical practices of Mathematics teachers at a public school in Ceará, focusing on the impact of Spaece's external assessment. The objective of the study was to create a historiographical record of the relationship between Mathematics teaching and external assessment, observing how this assessment influences educational practices and the organization of teaching.

The results of the study revealed that large-scale external assessments, such as Spaece, are culturally embedded in school practices and influence curriculum planning and the methodologies adopted by teachers (Sousa, 2023). However, the extent to which this embeddedness is positive for education is questionable, as it can lead to the prioritization of content covered in assessments to the detriment of broad and meaningful training. For the author, one of the main strategies adopted by teachers is the simulation of previous exams to prepare students for these assessments, which sometimes results in the adaptation of the school curriculum to align with the external assessment matrices.

This focus on assessments in pedagogical practice contradicts the theoretical perspective presented in the study, which emphasizes assessment as a tool for diagnosis and reflection on teaching, rather than as an end in itself. Thus, it is argued that external assessments should be used as a tool to understand the learning process and support improvements in teaching practice, without reducing teaching to mechanical test preparation.

Furthermore, the study found that this assessment model creates a climate of tension among teachers, who feel responsible for students' success or failure in the assessments. As part of Sousa's (2023) work, an Educational Product was developed — a guide for the development and use of teaching sequences — which aims to support Mathematics teachers in developing pedagogical practices aligned with students' needs and the demands of external assessments.

This scenario highlights one of the greatest challenges of large-scale external assessments: their direct impact on curricular organization and pedagogical practice in schools. Although assessments like Spaece provide relevant diagnostics on student performance, it is observed that, in practice, their influence often leads to the prioritization of assessed content over broad, contextualized education.

This phenomenon, described by Luckesi (2011), transforms assessment into an end in itself, limiting teaching to test preparation, which significantly compromises the construction of knowledge. In this sense, the question arises as to whether it is truly possible to achieve a balance between the need to meet assessment requirements and the promotion of teaching that

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encompasses the complexity of the educational process.

The literature analyzed shows that, although some initiatives point to ways to strategically use assessment data, such as the teaching sequence guide developed by Sousa (2023), there are still difficulties in implementing practices that guarantee teacher autonomy and a curriculum that goes beyond the logic of exams. Therefore, a critical reflection is needed on how the results of external assessments are used and how they can be reinterpreted to effectively contribute to the qualification of teaching, without this resulting in a restricted adaptation to what is required on the tests.

Lucas Emanuel de Oliveira Maia, in his dissertation *Constructions of didactic situations using Modellus software and its connection with didactic engineering and mathematical modeling in light of the Spaece Functions knowledge object*, explored the use of Modellus software as a pedagogical tool in teaching first- and second-degree polynomial functions. The objective was to evaluate how the use of this technology, combined with Didactic Engineering and Mathematical Modeling, can contribute to student learning in a 9th-grade elementary school class, focusing on external assessments, such as Spaece.

The research used the Theory of Didactic Situations as a theoretical framework, exploring how teaching activities mediated by Modellus software helped in the construction of mathematical concepts and in overcoming learning difficulties. According to Maia (2023), the use of Modellus software, in conjunction with Mathematical Modeling, contributed to the understanding of content related to polynomial functions, as students demonstrated improvements in their problem-solving skills and in the use of graphical and algebraic representations, making teaching more interactive and dynamic, highlighting the importance of technology in Mathematics Education.

The research analyzed highlights the relevance of investigations into the impact of external assessments on mathematics education in the state of Ceará, with a focus on Spaece. Studies indicate that these assessments directly influence the curriculum organization and the methodologies adopted by teachers, raising questions about pedagogical autonomy and the diversity of approaches in teaching the subject.

It appears that, in many cases, pedagogical practices and school planning are adjusted to meet the demands of these assessments, which can limit the exploration of content not covered in the assessment frameworks. This panorama reinforces the need for critical reflection on the role of external assessments in the educational process, ensuring that their use contributes to the promotion of meaningful learning, not merely to meeting the demands of exams. The research thus reveals the breadth and depth of analyses focused on the effects of these assessments on mathematics teaching in the Ceará context, especially within the scope of Spaece.

Analyses of low-performance descriptors, as demonstrated by Lima (2023), and detailed studies of Reference Matrices from different school years, conducted by Sampaio (2018), Azevedo (2022), and Oliveira (2023), reinforce the importance of a thorough understanding of the items assessed for implementing effective strategies. Furthermore, the use of educational technologies and digital tools, as evidenced in the dissertations of Costa (2023) and Maia (2023), highlights the crucial role these innovations can play in improving the teaching and learning process, as well as in preparing for large-scale assessments.

Research also highlights the importance of pedagogical strategies for improving student learning. Santos (2023) explored practices such as active methodologies, blended learning, and personalized interventions, demonstrating their effectiveness in strengthening mathematical understanding. At the same time, the use of statistical methods and data mining, presented by Faustino (2016) and Araújo (2022), has enabled the identification of performance patterns and

factors that impact learning, such as students' socioeconomic status and school infrastructure.

These analyses provide important insights for planning more targeted educational initiatives, such as tutoring programs and investments in ongoing teacher training. Finally, Sousa's (2023) study reveals the impact of external assessments on pedagogical planning, showing that teachers adjust their teaching plans based on descriptors assessed by Spaece. This practice can positively guide teaching, but it can also restrict the coverage of content not covered in the assessment frameworks. These results, therefore, highlight the need for a reflective use of external assessments, so that they contribute to improving teaching quality without compromising pedagogical autonomy.

Research also highlights the relevance of pedagogical strategies for increasing student proficiency, as explored by Santos (2023), while the use of statistical methods and data mining, as presented by Faustino (2016) and Araújo (2022), offers new perspectives for analyzing educational outcomes and formulating policies. Finally, Sousa's (2023) study reveals the impact of external assessments on pedagogical planning, highlighting the central role these assessments play in organizing teachers' work.

Overall, these studies reaffirm the importance of external assessments not only as diagnostic tools but also as resources capable of informing reflections on mathematics teaching in Ceará. However, the question remains to what extent teaching improvements can be reduced to increasing proficiency rates, given that the educational process involves multiple factors beyond assessment performance.

For teaching quality to be effectively improved, it is essential to invest in ongoing teacher training, the development of meaningful pedagogical practices, and the promotion of teaching that values critical thinking and problem-solving in different contexts. Furthermore, the implementation of educational technologies must go beyond test-oriented training, seeking to expand teaching and learning possibilities and contribute to the comprehensive development of students.

Therefore, teaching improvements must be understood from a broad perspective, encompassing cognitive development, student autonomy, and the construction of knowledge applicable to reality—and not just improving results on external assessments.

6 Final considerations

Over the past few decades, external assessments, such as Spaece, have established themselves as important instruments for monitoring student academic performance in Ceará. However, these assessments do not provide direct data on teaching and learning processes, but rather on student results on standardized tests. Based on this data, administrators and teachers can identify performance trends and educational inequalities, which can inform the formulation of public policies aimed at equity. However, as Bonamino and Sousa (2012) point out, it is essential that the results of these assessments be interpreted critically, avoiding their use solely as performance metrics and ensuring that they serve as one of the elements for reflection on the quality of education.

The research analyzed in this paper reveals that the use of educational technologies, such as the S3BIMat application, developed by Costa (2023), and the Modellus software, explored by Maia (2023), can contribute to the construction of mathematical knowledge by enabling the interactive exploration of concepts and the practical application of content. These tools offer resources that allow students to visualize and experiment with different problem-solving approaches, fostering meaningful learning.

Analysis of the data generated by these software programs can also help teachers

diagnose conceptual difficulties, enabling them to adapt pedagogical practices to meet students' specific needs. Therefore, the use of technology should go beyond preparation for external assessments, incorporating it as a didactic resource that expands teaching and learning possibilities, promoting the understanding of mathematical concepts in a contextualized way.

In addition, pedagogical strategies implemented in state schools, such as those described by Santos (2023), show that the use of simulations, diagnostic assessments, and activities focused on external assessment descriptors improves proficiency rates. However, the continuity of these practices requires constant monitoring and adjustments to methodologies based on the results obtained.

External assessments also raise important discussions about their impact on the school curriculum. As Bauer (2020) warns, pressure for results in specific areas, such as Portuguese and Mathematics, can lead to curricular narrowing, marginalizing other areas of knowledge. To mitigate this effect, schools and teachers must adopt a balanced approach that values all disciplines and contributes to the comprehensive development of students, without losing sight of the assessment objectives.

Another critical point is the excessive use of rankings and the holding of teachers and administrators accountable for assessment results, without considering the socioeconomic and structural conditions of schools. Luckesi (2011) warns that the competitiveness generated by these rankings can divert the focus of assessment as a formative and diagnostic process, compromising the implementation of inclusive educational policies.

Therefore, assessments must be used in a balanced manner, prioritizing diagnosis and pedagogical intervention rather than competition between schools. In short, external assessments, such as Spaece, play a significant role in monitoring students' academic performance in Ceará. However, their contribution to improving education is not automatic, requiring a critical look at how these data are interpreted and used. While they can inform educational policymaking, their relationship with promoting equity and quality in education depends on how these results are applied.

For them to truly contribute to reducing educational inequalities, it is essential that assessment data be used not only to measure performance but also to identify structural factors that impact learning. This implies directing investments to schools with weaknesses, strengthening teacher training, and encouraging contextualized pedagogical practices. Therefore, the effectiveness of these assessments depends on the commitment of administrators and teachers to use the results as a tool to understand the needs of the educational system and propose concrete actions that foster knowledge development.

Conflicts of Interest

The authors declare that they have no conflicts of interest that could influence the results of the research presented in the article.

Data Availability Statement

The data collected and analyzed in the article will be made available upon request to the authors.

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