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Didactic Relations and Didactic Contracts in the Assessment of Mathematics Learning in Deaf Students

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Abstract: This study investigates the Didactic Relationships emerging from the Didactic Contract in a Mathematics learning assessment scenario for deaf students. To produce the data, we made observations during mathematics lessons in a regular 7th-grade classroom of a public school focused on teaching and assessment of integer numbers. We also recorded the observations in a field diary. A Libras interpreter (IL), a math teacher (P), a boy deaf student (ESo), a girl deaf student (ESa), and hearing students (EO) were the participants of the research. The results show that the presence of the IL and the Deaf Students modify the Didactic Relationships, adjusting the Didactic System to a Pyramidal type system. In addition, they indicate the need to review and renegotiate the Didactic Contract, especially in assessment practices, to promote progress in developing Deaf students' knowledge.

Keywords**:** Learning Assessment. Inclusive Mathematics Education. Didactic System.

Relaciones didácticas y contratos didácticos en la evaluación del aprendizaje en Matemáticas de estudiantes sordos

Resumen**:** Con este estudio, investigamos las Relaciones Didácticas que emergen del Contrato Didáctico en un escenario de evaluación del aprendizaje en Matemáticas para estudiantes Sordos. Para producir los datos, se realizaron observaciones durante las clases de Matemáticas, enfocadas a la enseñanza y evaluación de Números Enteros, que se llevaron a cabo en el séptimo año de una escuela pública en un aula común. Además, las observaciones se registraron en un diario de campo. Los sujetos que participaron en la investigación fueron: un Intérprete Libras (IL), un Profesor de Matemáticas (P), un Estudiante Sordo (ESo), un Estudiante Sordo (ESa) y Estudiantes Oyentes (EO). Los resultados destacan que la presencia de IL y Estudiantes Sordos modifican las Relaciones Didácticas, ajustando el Sistema Didáctico a un sistema de tipo Piramidal. Además, señalan la necesidad de revisar y renegociar el Contrato Docente, especialmente en las prácticas de evaluación, para promover avances en el desarrollo de conocimientos de los estudiantes Sordos.

Palabras clave**:** Evaluación del Aprendizaje. Educación Matemática Inclusiva. Sistema Didáctico.

Relações Didáticas e Contratos Didáticos na Avaliação da Aprendizagem em Matemática de Estudantes Surdos

Resumo**:** Com este estudo, investiga-se as Relações Didáticas emergentes do Contrato Didático em um cenário de avaliação da aprendizagem em Matemática de Estudantes Surdos. Para a produção dos dados, foram realizadas observações durante as aulas de Matemática, centradas no ensino e nas avaliações de Números Inteiros, ocorridas no 7º ano de um colégio público em uma sala de aula comum. Além disso, as observações foram registradas em um diário de campo. Os sujeitos participantes da pesquisa foram: uma Intérprete de Libras (IL), uma Professora de Matemática (P), um Estudante Surdo (ESo), um Estudante Surda (ESa) e Estudantes Ouvintes (EO). Os resultados destacam que a presença da IL e dos Estudantes Surdos modificam as Relações Didáticas, ajustando o Sistema Didático para um sistema do

tipo Piramidal. Ademais, indicam a necessidade de revisão e renegociação do Contrato Didático, especialmente nas práticas avaliativas, a fim de promover um avanço no desenvolvimento do conhecimento dos Estudantes Surdos.

***Palavras-chave*:** Avaliação da Aprendizagem. Educação Matemática Inclusiva. Sistema Didático.

1 Introduction

This paper presents results[1] from a master's thesis investigating the Didactic Relations emerging from the Didactic Contract in evaluating learning in Mathematics for Deaf Students[2]. For this purpose, we made observations during mathematics classes, focusing on teaching and assessing the concept of integers in a 7th-grade elementary classroom of a public school where deaf people are taught from an inclusive perspective. The objective was to analyze interactions between the Teacher, the Libras Interpreters, and the Deaf and Hearing Students, investigating how these elements relate to teaching and learning Mathematics in an inclusive environment.

In the educational context of deaf students in mathematics lessons, the search for inclusion faces specific challenges. For instance, the complexity of mathematical language can prove even more challenging for deaf students due to the need for an adequate translation between sign language and the mathematical context, making understanding concepts difficult. Lacerda (2010) highlights that even when participants consider a model inclusive, it may not really be inclusive. In this context, a deaf student, despite being physically present, is often not considered in several aspects, creating a false idea of success in inclusion. The author also emphasizes that the lack of a common language prevents full participation in discursive events, essential for the integral formation of subjects. This perspective shows the importance of compensating and enhancing inclusive approaches to meet the needs of deaf students effectively.

From our perspective, Mathematics Didactics is a theory that can contribute to inclusion and, according to Brousseau (1986), focuses on analyzing didactic activities to teach specific mathematical content, covering explanations, concepts, theories, and forecasting and analysis methods. This theoretical perspective implies attention to students' cognitive behaviors, the teaching situations, and the forms to communicate knowledge. The investigation of teaching resources, central to Mathematics Didactics, is intrinsically linked to the teaching and learning process, involving understanding formulated concepts and constructing meanings in the classroom.

Mathematics Didactics researchers, such as Brousseau (1986), Brito Menezes (2006), and Pais (2019, 2002), converge in stating that the teacher, when establishing the educational context, has expectations regarding student participation. At the same time, students observe and seek to understand the mathematical rules the teacher delivers, thus guiding their actions in the classroom.

When approaching Mathematics Didactics in this context, it is essential to highlight the importance of investigating Didactic Relations and the Didactic Contract. These elements are fundamental for teaching and student learning effectiveness. Understanding how these relationships are established between teachers, Libras interpreters, and deaf and hearing students is crucial to thinking about teaching strategies that allow the construction of

[1] This paper is an excerpt from a master's thesis defended in the Postgraduate Program in Mathematics Education, written by the first author and supervised by the second author.

[2] The five elements will be written throughout the text in lowercase: teacher, Libras interpreter, deaf student, hearing student, and knowledge. However, we will use capital letters at the beginning of each word when referring to the subjects and elements of analysis: Teacher, Libras Interpreter, Deaf Student, Hearing Student, and Knowledge.

mathematical meanings in an accessible and inclusive way.

Regarding the methodology used, the data are produced from observations during Mathematics classes, focusing on the teaching and evaluation processes of Integers in a 7th-grade elementary school classroom in a public school in the interior of Paraná state. The relationships between the Teacher, the Libras Interpreter, the Deaf and Hearing Students, and the research collaborators were analyzed with the role of Knowledge in this context. This analysis identified how the dynamics between these elements directly influence the learning process of Deaf Students, providing discussions about the promotion of inclusive mathematics education.

2 Pyramidal Didactic System and Inclusive Assessment: theoretical foundations

The Didactic System, as described by Brousseau (1986), is the interaction between three fundamental elements, collectively called the Didactic Triad: teacher, student, and knowledge. This system represents a dynamic scenario in which connections are formed, dialogues are established, and learning develops.

Within this context, Didactic Relations are constructed by the complex interaction between the elements of the Didactic Triad, as cited by Brousseau (1986). These relationships are not limited to the simple transmission of knowledge but incorporate collaboration shared understanding, and the construction of knowledge. The quality of these exchanges is essential for the development of knowledge and for the active involvement of all participants in the educational process.

From that, Brousseau (1986) addresses the Didactic Contract, which refers to the explicit or implicit rules that regulate interactions between teacher and student knowledge management. The Teaching Contract establishes the expectations, responsibilities, and norms of interaction between participants in the educational environment. These clauses not only define classroom dynamics but also influence the construction of knowledge and interactions between those involved in the learning process.

The Didactic Contract, as defined by Brousseau (2008), represents a specific set of behaviors expected from both the teacher and the student, mediated by knowledge. Brito Menezes (2006) complements this idea and emphasizes that a convention involves negotiation between the parties. This negotiation implies the acceptance of specific roles and obligations, with the possibility of punishment if the established rules are not followed (Brito Menezes, 2006). More comprehensively, according to Brito Menezes (2006), the Teaching Contract refers to a convention established between the parties, requiring respect for the rules, prior negotiation, and complete adherence to the clauses by all parties involved.

According to Brousseau (1986), the Didactic Contract has four essential characteristics: the division of responsibilities, the implicit aspect, the relationship with knowledge, and didactic communication. This contract establishes obligations for both the teacher and the student based on the division of responsibilities. The dynamics of the Didactic Relationship are not unilateral, as both have active responsibilities. Furthermore, the Teaching Contract operates predominantly with implicit aspects rather than explicitly defined rules.

Didactic communication is an essential part of this relationship. During the interaction between teacher and student, negotiations occur, including in moments of tension, which may require adaptations. Thus, the Didactic Contract is crucial to the development of knowledge and learning, allowing the identification of obstacles and facilitators for access to knowledge and the active participation of students in the educational process.

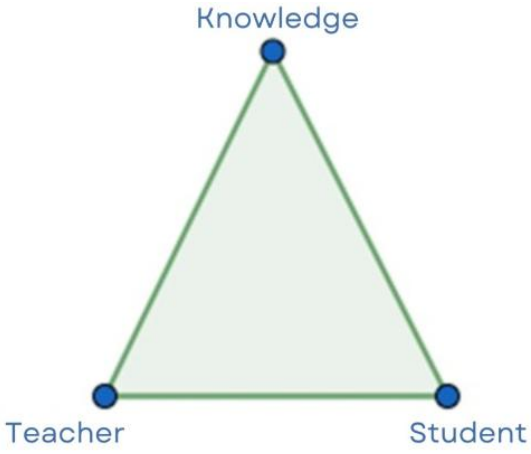
Ruptures in the Didactic Contract occur when established rules are challenged, creating contradictory situations in the relationship with knowledge. These moments of rupture are not aimed at the stability of the contract, but rather at the possibility of possible changes. These ruptures lead to a new contract, which can benefit or harm both parties.

The Contract Effects, explored by Brousseau (1986), Brito Menezes (2006), and Pais (2019), are triggered in an attempt to avoid learning failure. These effects arise when the teacher, in pursuit of student success, tends to facilitate the understanding of tasks in various ways, providing abundant explanations and favoring the memorization of content, which can divert learning from the targeted knowledge.

These effects include the *Topaz Effect*, consisting of the teacher subtly suggesting answers to the students, *the Jourdain Effect*, in which common student behaviors are interpreted as scientific knowledge, the *Metacognitive Shift*, when the teacher replaces his scientific discourse with common sense, and the *Abusive Use of Notation*, when the student replaces the study of complex concepts with analogies, resulting in limited perceptions. These effects cause ruptures in the Didactic Contract, shifting the focus away from student learning. They are examples of practices that affect the relationship between teacher and student, compromising the teaching and learning objectives.

These elements - teacher, student, and knowledge - form a triangular relationship, which Brousseau (1986) referred to as the Didactic Triangle (Figure 1).

Figure 1: Didactic Triangle



Source: The authors, based on Brito Menezes (2006).

It is in this dynamic scenario that the interactions, expectations, and negotiations that shape the Didactic Contract take place. The relationships between these components influence knowledge construction and trigger unique effects in the learning process. Analyzing these interactions reveals the importance of understanding not only the classroom dynamics, but also how the relationships between teacher, student, and knowledge impact teaching effectiveness.

The Didactic System which compounds the teacher-student-knowledge triad, expanded including Libras interpreter in Decree 5.626/2005, recognizing Libras as a sign language (Libras), adding a new element to the relationship. Educational legislation, which includes the Salamanca Declaration (Unesco, 1994) and the National Education Guidelines and Bases Law (LDBEN, Law no. 9.394/96), reinforces Brazil's commitment to inclusion by allowing the presence of support professionals, such as Libras interpreters, in ordinary classrooms. The National Policy for Special Education from the Perspective of Inclusive Education (Brazil, 2008) extends the guidelines, offering specific roles such as instructor and Libras

translator/interpreter, and requiring monitors to help with the daily activities of classes with students supported by Special Education. This normative instrument promotes an adapted and accessible educational environment for all students.

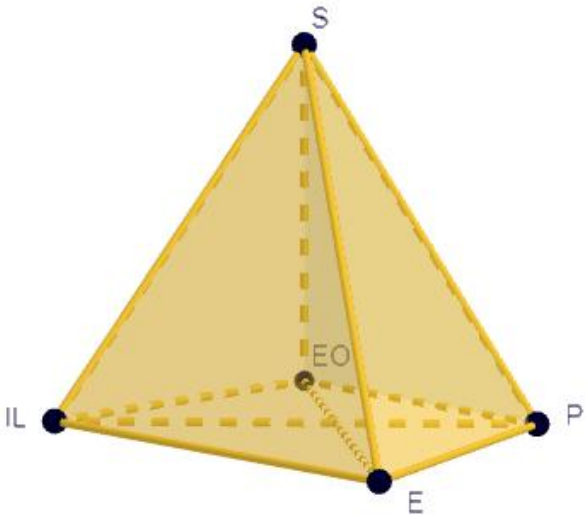
In the pedagogical context, the Libras interpreter not only translates the communication between teacher and deaf student but also acts as a mediator, facilitating interaction between deaf and hearing students. The interaction between the teacher, Libras interpreter, and deaf and hearing students results in a new classroom configuration.

The presence of the Libras interpreter changes the Didactic Relationships conditioned by the teacher-student-knowledge triad, introducing a new Didactic System into the inclusive classroom. This new educational dynamic highlights the importance of the Libras interpreter as an additional element in the Didactic System, expanding the possibilities for interaction and learning in the inclusive classroom.

Santos (2019) highlights a new dynamic in the Didactic System, introducing the Libras interpreter as a fourth element, changing the model proposed by Brousseau to a didactic tetrahedron. In this scenario, interactions are variable through visual communication, evolving into a Didactic Relationship with specific educational objectives for the deaf student's learning.

The research suggests a five-pole Didactic System: teacher (P), Libras interpreter (IL), deaf students (ES), hearing students (EO), and knowledge (S). This approach aims for a more comprehensive understanding of the complex interactions in the inclusive classroom. Figure 2 shows a graphic representation of this system.

Figure 2: Didactic Triangle



Source: The authors, based on Santos (2019).

In the Didactic Pyramid System, which contains five poles (teacher, Libras interpreter, deaf student, hearing student, and knowledge), the classroom significantly influences the deaf student's learning through objectives, methods, and assessments. At the base of this pyramid are the human poles of the Didactic Relationship, in which dynamic interactions form the classroom.

The teacher plays a crucial role as an intermediary between the knowledge and the students, both deaf and hearing. They are responsible for conducting classes, adapting content and methods to meet the needs of all students, and managing relationships between the hubs. The role of the Libras interpreter is crucial in the classroom, facilitating the deaf students' access to the knowledge discussed by the teacher. These complex interactions between the hubs are

essential to understanding the teaching and learning process.

Deaf and hearing students are the recipients of knowledge. Their interactions with the teacher, the Libras interpreter and the knowledge shape their learning process. They are responsible for engaging with the lesson and making meaningful connections with the content. The edges represent the communication links between these hubs, involving negotiations, responsibilities and rules that affect the teaching and learning process. Each hub has a specific and interdependent role in building an inclusive educational environment.

Knowledge is at the top of the Didactic Pyramid System, being central to the didactic relationship, influencing the interaction between the hubs of the inclusive education system, and representing the knowledge and the content, information, and concepts discussed during the teaching process.

Within the Pyramidal Didactic System, in which Knowledge is on the top, playing a vital role in the Didactic Relationship, it is essential to understand how learning assessment fits into this inclusive education context. Learning assessment is a fundamental tool in the educational context and is not limited to measuring knowledge. It reflects and shapes the school's relationships, revealing its social and individuals conceptions. Baldino (1994) affirms that this assessment is often based on an implicit Didactic Contract, generating the mistaken idea that the proposal is linked only to following rules, not constructing knowledge.

Learning assessment has historically been associated with terms such as grades, exams and classifications, playing a central role in education, although this practice has often become more of an act of examination than assessment. The idea of “Exam Pedagogy”, according to Luckesi (2011), predominantly in past periods, emphasized the classification of students through tests and grades, creating an exclusionary and classificatory dynamic in school. Authors such as Luckesi (2011) and Mantoan (2003) have proposed a change in this paradigm, advocating a more formative, inclusive and reflective assessment. They emphasize the importance of distinguishing between examining and evaluating, promoting an approach that prioritizes diagnosis in order to guide teaching practice and develop competencies in students.

Traditional assessment practice often ignores the process of learning evolution, valuing grades excessively, leading to a logic of classification based on a standard of excellence, which is not in line with inclusive processes in education. Buriasco (1999) and Luckesi (2011) emphasized the role of error in the learning process and the importance of analyzing students' mistakes to understand their difficulties.

In this scenario, to become inclusive, assessment needs to consider the singularities of the students, especially the deaf. It must transcend the traditional testing approach, valuing strategies that allow participation and understanding of mathematical knowledge, especially through the mediation of the Libras interpreter. This agrees with the principles of the Didactic Pyramid System, which proposes a learning environment in which interactions between the hubs - teacher, Libras interpreter, deaf and hearing students, and knowledge - are essential for understanding and adapting teaching.

According to Luckesi (2005), the basic principles of inclusive assessment are flexibility and consideration of the particularities of all students. This approach is not limited to rigid rules but seeks to dynamically challenge and adapt assessment structures. In this way, assessment becomes a more flexible and interactive process, enabling a more meaningful interaction between students, knowledge, and teachers. This flexibility is essential for the greater success of the Didactic Pyramid System in the inclusion and learning process of deaf people.

3 Methodological Procedures

The research is based on a qualitative approach according to the assumptions of Lüdke and André (1986). It was performed in a 7th-grade elementary school class in a public school in the countryside of Paraná, Brazil, during a mathematics lesson, particularly when discussing the Integers. The class consisted of 12-year-old thirty-two students, including two 15-year-old deaf students. Further details are given below:

Chart 1: Research collaborators

Research subjects	Description
A Math Teacher (P)	26 years of experience in the classroom and 18 years at the research site. The first experience with deaf students occurred after implementing legal provisions for school inclusion, such as the Statute of Persons with Disabilities.
A Libras Interpreter (IL)	Degree in Science and Mathematics and expert in Literature and Inclusive Special Education.
A male Deaf Student (ESo)	A 15 year old boy, fluent in Libras, whose parents are not fluent in the language. She had been at school for two years, since the sixth year of elementary school, and considered a deaf singer.
A female Deaf Student (ESa)	An almost 15-year-old girl fluent in Libras, enrolled in school in the year of research, 2021. Little information is available about her family. She is also considered deaf signing.
Hearing Students (EO)	The other students in the room were not fluent in Libras.

Source: Research data.

Before the research began, we obtained approval from the Research Ethics Committee of State University of Paraná (Unespar). The participants involved were a Math Teacher, a Libras interpreter, a Deaf Student, and Hearing Students, all participating in the observed classes.

We chose a methodological strategy based on classroom observation as the primary method for producing data, supported by the contributions of Vianna (2003) and Selltiz et al. (1987). This method is pertinent for capturing information on Didactic Relationships in the desired context. Vianna (2003) highlights four essential issues during observation: what to observe, how to record it, ensuring validity, and the nature of the observer-observed relationship.

Therefore, to keep the focus on the investigation of assessment practices, a quarter of time was set aside to remain in the classroom, and the field diary was used as the principal tool for producing data. This choice was supported by Fiorentini and Lorenzato (2009), who highlight the usefulness of a field diary for documenting observations, events, and dialogues that take place in the classroom. The field diary, in our case a notebook for taking notes, is considered a favorable instrument for recording various information during the work, allowing the researcher to record observations and describe people, scenarios, episodes, and dialogues.

During the first quarter of 2022, we observed 14 maths lessons: 6 focused on teaching whole numbers and 8 on assessment activities, such as written tests and multiplication tables. The observations happened on Mondays and Tuesdays, recording details of class dynamics, student participation, and activities performed by the teacher and the librarian interpreter, among other aspects.

The records detailed the students' participation, the teacher's and the Libras interpreter's behavior, the activities in progress, and other aspects relevant to the research. Thus, for the analysis, we prioritized including pertinent information from the transcripts and clippings of episodes that were significant to our research objective, according to Vianna's guidelines (2003).

All of our data production and analysis aims to understand the Didactic Relationships resulting from the Didactic Contract in the assessment of Deaf students' learning in Math classes. The following section will discuss the results and discussions obtained through these procedures.

4 Results and Discussion

The observations began in March 2023, with an afternoon 7th-grade class assigned by the school's pedagogical team, in which there were two Deaf Students (ESa and Eso), one (1) Libras Interpreter (IL), a Hearing Teacher, and another Hearing Students. Initially, the interaction between the teacher and the deaf students was cordial but limited. When there was a need for communication, the teacher turned to the IL, who acted as a mediator between them. The deaf students felt more comfortable communicating with the SL, who offered support in expressing their doubts and needs.

The dynamics of the lessons followed a constant pattern: the teacher used the textbook, and the students copied the exercises in their notebooks and corrected them on the blackboard. The students couldn't do the exercises directly from the textbook due to the need to preserve the material for future use. Even during the pandemic, the teacher reported following the same pattern; however, introducing resources, such as the tablet, was essential to facilitate distance learning. This device allowed mathematical symbols to be highlighted in different colors, making the content more accessible to understand, especially for deaf students.

The teacher's approach to assessment was quarterly and included tests, multiplication tables, and exercises from the textbook. However, for the assessment of the deaf students, she reported constantly adjusting the number of exercises, thus reducing the load compared to other students.

During the observations of the Integers' content, we realized that the SL played a fundamental role in the interaction between the teacher and the deaf pupils. The students usually did not do their homework, and the SL helped them correct it in class. The class routine consisted of presenting the content on the blackboard, copying the exercises, correcting them together, and assigning the homework. The deaf students were corrected last, and ESa had more difficulty understanding the concept, so he received more help from the IL than ESo.

In the learning dynamic, the deaf students showed similar difficulties to complete the tasks and to focus on the proposed activities. Thus, IL was crucial in mediating interaction and communication for these students. For this analysis, two moments of learning assessment are examined: the written assessment and the multiplication table test proposed by the teacher. In sections 4.1 and 4.2 we provide a more descriptive overview of these two assessment moments and then analyse the data as generally as possible.

4.1 Observations from writing assessments

The heading of the written assessment went beyond the content questions. It set out guidelines for the students' behavior and the order in the classroom. The heading instructed that the answers should be written in pencil, specified the color of the pen, and warned of complaints

if the answers were written in pencil. In this sense, the teacher established rules that directly influenced the students' behavior in the assessment context.

Due to the time it took for students to solve the activities, the assessment was divided into two days. Upon arriving at the room on the first day of the Mathematics assessment, the Teacher instructed the Students to organize their desks in numerical order according to the frequency list. It is important to note that the Deaf Student (ESo) and the Libras Interpreter (IL) were not present at the beginning of the class. While ESa remained at her desk, observing the other students, IL's arrival relieved Esa, which was evident in her facial expression. This initial dynamic highlights the importance of mediators during an assessment and the influence of the social and interpersonal context in the assessment environment.

During the assessment, the deaf student (ESa) received guidance from the librarian interpreter (IL) in completing the mathematics test. The interaction between ESa and the IL was remarkable. The IL helped correct incorrect answers, provided visual cues related to mathematical operations, and encouraged ESa to solve the problems. ESa frequently depended on the IL and sought guidance even on tasks that could have been solved independently. The IL anticipated some answers, not wanting the deaf student to get the assessment incorrectly. Meanwhile, the hearing students remained silent and completed the exercises without questioning the teacher. During the assessment, the teacher observed ESa but did not actively interact with her or the IL.

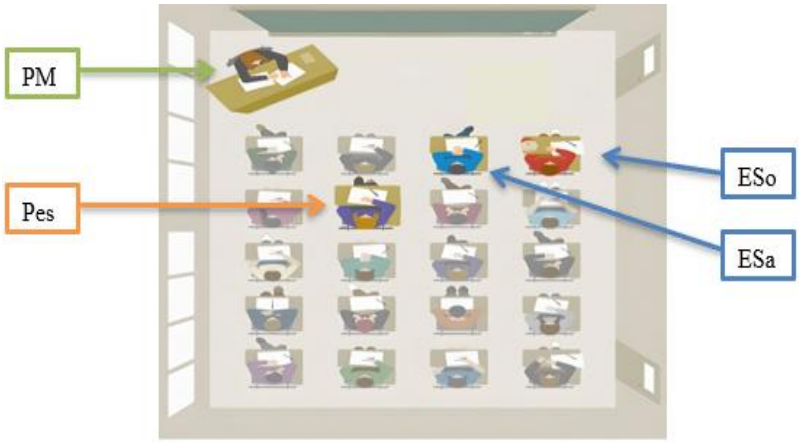
ESa's dependence on IL during the test and IL's tendency to provide solutions suggest a limitation in developing her independent problem-solving skills, similar to what Brousseau (2008) calls the *Topaz Effect*. This effect highlights the situation in which IL anticipates answers and solutions, limiting ESa's learning opportunities and preventing them from developing critical and independent problem-solving skills.

As the end of the lesson approached, the hearing students expressed concern that they might not finish the exercises and asked if they could hand them in at the next lesson. Meanwhile, ESa tried to do the exercises with the help of the IL, who erased notes from the test several times and made gestures pointing to the test. However, ESa gave up on the IL's explanations and leaned back on her desk. It was noticeable that ESa found coping with the time pressure during the assessment more challenging. In response to her complaints, the teacher allowed her to finish the next lesson.

On the second day of the assessment, the students were anxious. ESo, this time present in the room, showed interest in the test items and asked a classmate to look at the textbook. Then, at his desk, he started flicking through his notebook. When the teacher entered the room, she asked for silence and organization, and the students had already taken their seats according to the previous day's rules. ESa was at the first desk in the second row, ESo was at the first desk in the first row, and IL's desk was empty because she was late (see Figure 3). After receiving the tests and drafts, IL entered the room and said she had to leave and would be right back, leaving ESa and ESo without their interpretation and apprehensive.

Looking for IL, ESa alternated between looking at the test and the door. She tried to solve the exercises but gave up and got busy with her notebook and pencil for other activities. ESo wanted to help her, but ESa gave up on the explanation and tried to copy a classmate's exercises. The teacher called ESa's attention, but she seemed to give up on the test, looking anxiously towards the door. Meanwhile, ESo was concentrating on solving the exercises as he hadn't turned up for the first stage of the assessment. He tried to ignore ESa's attempts at dialogue as she tried to interact with her classmates. The teacher ignored these attempts and didn't try to help the deaf students, nor did they ask the teacher for help at any time.

Figure 3: Arrangement of desks during the assessment, with emphasis on Teacher, ESa, ESo and researcher (Pes).

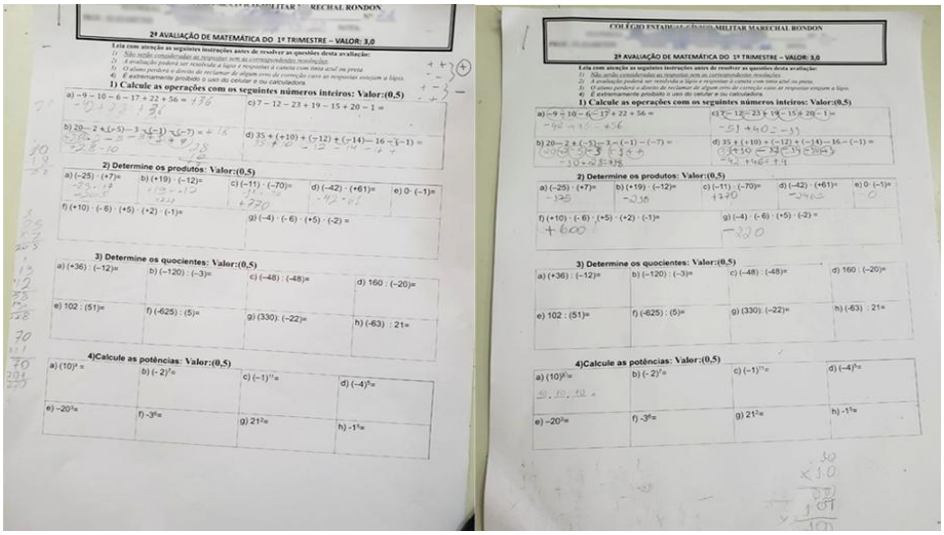


Source: Research data.

With the time allotted for the assessment running out, ESa showed no initiative to solve the exercises, continuing to stare at the door. Meanwhile, ESo was playing with a classmate next to him who had already taken the test. The teacher saw the play, which was silent, but didn't intervene. Both ESa and ESo, without the presence of IL, were distracted from doing the exercises.

Towards the end of the lesson, the IL arrived, which relieved ESa. She seemed to question the IL's tardiness, who scolded and instructed her to focus on the test. Meanwhile, ESo tried to show that she had done the exercises, but IL blanked out and started solving them together. In the meantime, the teacher announced that the time for the test was up and began to collate the tests and drafts. Below is a photo of the deaf students' assessment.

Figure 4: ESa and ESo assessments



Source: Research colletion.

The assessment was not adapted to meet the needs of the Deaf students, such as adding illustrations. The only agreement was that, of the four statements presented, the Deaf students would only did the activities relating to the first two.

By analyzing the tests taken by the Deaf students, illustrated in Figure 4 (ESa test on the left and ESo test on the right), it is possible to see that both face difficulties in solving the exercises. One of the probable causes of the errors in solving the exercises with operations on

integers lies in the basic rules: difficulty in calculating the addition between two whole numbers, adding instead of subtracting; errors in calculations involving more than two numbers and operations; failure to complete the exercises with blank calculations, etc.

These difficulties can be attributed, in part, to the teaching methodology used, which may not have been favorable, with the provision of valuable tools to encourage deaf students to develop mathematical calculation skills around the appreciation of visual aspects. These errors also reveal the need to rethink the pedagogical approach to meet these students' specific needs better, facilitating the construction of mathematical concepts.

4.2 Observations from the multiplication table assessment

While the Hearing students had prepared beforehand by bringing the multiplication table to study, ESa and ESo didn't have copies of the table at hand and interacted with the IL. This initial contrast already indicated a potential challenge for Deaf students in preparing for the test.

The teacher in charge of the assessment changed the arrangement of the desks, placing two chairs at the back of the room and calling on the students to solve the drawn tables. For the Deaf students, the IL sat next to the teacher to translate her words into Libras. When it was ESa's turn, she was asked about 4×3 multiplication. The student expressed difficulties in performing the calculation. With this difficulty, ESa turned to IL for help solving the mathematical problem. But without help, she gave the incorrect result '6'. Her strategy for arriving at this result showed confusion in operating, signaling a possible difficulty in performing simple calculations and understanding the fundamental properties of multiplication.

On ESo's turn, he was asked the result of 7×9. Instead of answering instantly, ESo showed a practical technique, using his fingers to count nine sets of seven. This way of counting showed that he was looking for his solving strategies, given the lack of memorization of results, which was common among the listening students. During the process, ESo missed his way a few times when counting, but ultimately, he reached the correct result.

During the test, it was evident that the IL was called upon to help solve the operations, playing an active role in the teaching and learning process. In contrast, the teacher seemed to expect the Deaf students only to memorize the multiplication tables, without a clear focus on understanding or practical application of the mathematical concepts.

At the end of the test, the teacher told the SL that the deaf students should study more, indicating that they had not understood the content, as evidenced by their unsatisfactory grades in the assessments, including the multiplication table test. This demand suggests an expectation that the IL would be primarily responsible for the deaf students' learning and, at the same time, points to the teacher's perception that the deaf students did not achieve the desired performance. This dynamic reinforces the teacher's dependence on the IL for the Deaf students' academic success. In other words, there is an exchange of responsibilities and a diversion of functions.

4.3 Our analyzes

This pyramidal didactic system requires an in-depth understanding of the Didactic Relationships and Didactic Contracts established between the Teacher, the Libras Interpreter, and the Deaf and Hearing Students to guarantee more prosperous and inclusive learning. From this perspective, we will examine the fundamental didactic relationships present in didactic contracts and their impact on Deaf students' learning; the Teacher's primary responsibilities in inclusive environments and how they are realized; the Teacher's specific responsibilities towards Hearing students in inclusive contexts; the crucial role of the Libras Interpreter and her

obligations towards Deaf students; and the process of negotiating Didactic Contracts, especially during learning assessments.

During the research, four implicit characteristics outlined the Didactic Contract in force in the observed classes:

- *Emphasis on Oral Explanations*: the teacher's prioritization of oral explanations is presumed to be sufficient for the learning of both deaf and hearing students, neglecting the students' active participation in the learning process. This observation contradicts the view of Vygotsky (1993), who emphasized the importance of social interaction and the active involvement of students in the construction of knowledge.
- *Restriction of student participation:* Limiting the space for students to express themselves or reflect on the content does not allow for the active construction of knowledge since the Teacher and the IL answer the questions themselves. According to Brousseau (2008), such interactions reflect a set of behaviors expected by the Teacher and IL in their relationship with Hearing and Deaf students, restricting their autonomy and active participation.
- *Strict control of attendance and homework*: Attendance at classes and homework completion are regular. However, Deaf students cannot solve them independently and need the SL's help. This behavior interferes with their autonomy and restricts their engagement with the content. Nogueira and Borges (2012) discuss this practice, emphasizing the transfer of responsibility for Deaf students' learning to the Libras interpreter.
- *Learning assessment*: Assessment of learning is fundamental, although there is often a lack of clarity on responsibilities in this process. According to Lacerda (2010), the presence of a Libras interpreter does not transfer the teacher's responsibility to them

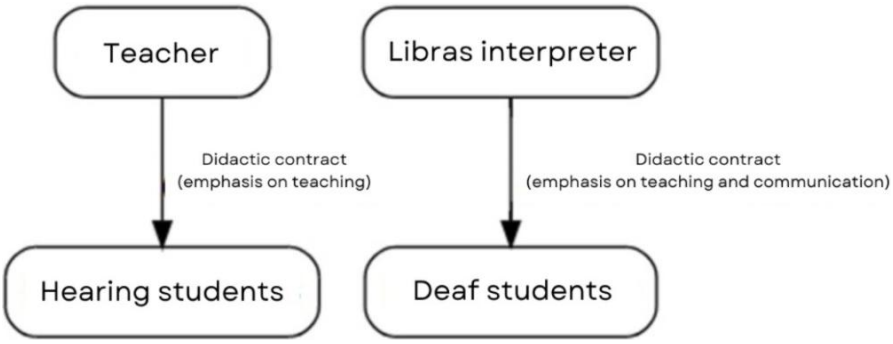
In a more detailed analysis of the classes' daily life and the learning assessment scenario, we observed the roles and responsibilities of the IL and the Teacher. The teacher holds the knowledge and directs her teaching to the hearing students during lessons. On the other hand, the Libras interpreter acts as a mediator of communication for the Deaf students and ends up teaching them, given their lack of interaction with the others.

During the lessons, the Deaf students faced communication difficulties, depending almost exclusively on the Libras interpreter. The teacher's attention was more focused on the hearing students, leaving the deaf students in a passive position, waiting for the information transmitted by the IL. It reflects a lack of inclusion in discussions, highlighting the need for a more active and inclusive role on the part of the Teacher.

This approach points to a transfer of educational responsibility, in which the interpreter is seen as a determining factor in the success of Deaf students, which can lead to overload and imbalance in the educational dynamic. This dynamic not only highlights the sharing of responsibilities but also refers to the manifestation of different Teaching Contracts, as represented in the diagram of figure 5.

Nogueira and Borges (2012) also observed this transfer of responsibility in their research, highlighting the lack of dialogue between hearing math teachers and deaf students. In this context, Borges (2013) warns of the frequent confusion between the roles of interpreters and teachers, emphasizing that a Libras interpreter should not be burdened with educational responsibility but should act as a communication facilitator. Although this separation of roles is difficult when it comes to a school environment, which is different, we understand, from a lecture, a religious service, etc., that the teacher should not shy away from their commitment to teaching everyone.

Figure 5: Teaching Contracts Diagram



Source: Research data.

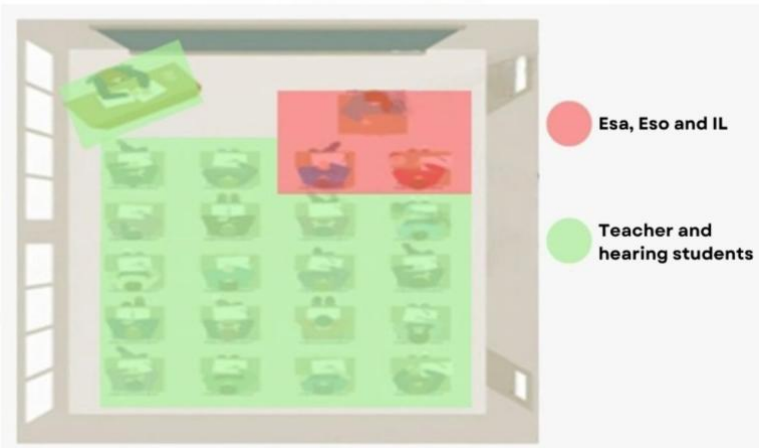
It is understood that the transfer of responsibility for Deaf students' learning to the Libras interpreter can occur due to various factors, such as the lack of curricular adaptation, limitations in communication, the absence of inclusive strategies, and a lack of teacher training. These factors, which are predominant in Deaf students' dependence on the interpreter, jeopardize their autonomy and engagement in learning.

Lacerda (2010) emphasizes that the responsibility for teaching lies primarily with the teachers, with the Libras interpreter being just a collaborator in the educational process. Collaboration between these elements should focus on eliminating language barriers and promoting an inclusive and accessible environment for all students. In this sense, in the context analyzed in this article, the teacher must adapt the strategies to meet the needs of Deaf students. At the same time, the Libras interpreter must contribute to understanding the content and maintaining a balance of responsibilities to ensure equitable education.

The Didactic Relationship in the Pyramidal Didactic System emphasizes the separation between the Teacher and the Hearing Students and between the Libras Interpreter and the Deaf Students. Thus, the geometric figure representing this situation is no longer a pyramid but two distinct triangles, one between IL-ES-S and the other between P-EO-S. This configuration demonstrates different Didactic Contracts and points to the coexistence of partial relations of responsibility between the partners in the Didactic Relationship.

The complex dynamics of the Didactic Relationships in the Pyramidal Didactic System show a possible Dual Didactic Contract, separating the classroom between the Hearing Students and the Deaf Students, each under the distinct responsibilities of the Teacher and the Libras Interpreter, as represented in the figure 6:

Figure 6: Didactic Relations in the Classroomt



Source: Research data.

The relationship between the Teacher and the Libras Interpreter reveals an apparent asymmetry, in which the Teacher delegates the education of the Deaf Students to the IL. This significant transfer of responsibility means that the IL not only translates but also plays an active role in the educational process. With the overload of obligations imposed on the IL, it is common for the students to expect them to take on this role as they become accustomed to it. In other words, one of the characteristics of the Didactic Contract is this, even during learning assessments, such as the written test and the multiplication table test.

The Dual Didactic Contract becomes more evident during the assessments, with different interactions between the groups. In the Teacher and Hearing Students group, the search is for clear guidelines for solving exercises, with the Teacher being the primary motivator of knowledge. In the group with the Libras interpreter and the Deaf students, the interpreter's role is based more on transmitting knowledge and, worse, taking the student's place, as in several situations where the Libras interpreter filled in the tasks in the notebooks.

The *Topaz effect* becomes more noticeable in this context, especially between the Deaf students and the Libras interpreter. There is an anticipation of responses due to the difficulties created, producing a dynamic in which ESa and ESo seek immediate answers to overcome challenges in the activities, reflecting an occasional dependence on the answers promptly provided by the Libras interpreter. This division in the learning process, in which different expectations and interactions occur in parallel, highlights the need to rethink these Teaching Contracts and seek more inclusive and participatory approaches to ensure more excellent learning for all students, regardless of their specific educational needs.

During the observations, we noted that the teacher's approach on the day of the assessment was the same as in regular lessons. The continuity of the oral lecture and the mechanical revision of the exercises did not change significantly. This continued practice led the Deaf and Hearing students to develop a mechanical learning of the content centered on the teacher and the repetition of exercises without stimulating a deeper or more interactive understanding of the subject. It culminated in difficulty solving the assessment and the multiplication table test, especially for Deaf students.

ESa had not assimilated the content she had been taught and was subsequently ‘asked in the test.’ This difficulty was evident in how she approached solving the exercises in the assessment without the mediation of the Libras interpreter. The educational approach did not allow ESa and ESo to achieve results similar to those of their hearing colleagues. This fact points to the need for the teacher to be aware of the specificities of Deaf students and their linguistic differences, as well as practices consistent with their educational needs.

Substantial differences between students require a differentiated approach. Studies by Fernandes (2010), Nunes (2012), Talmag (2018), Pereira (2014), & Pereira (2009) emphasize the lack of tools and strategies for assessing the learning of deaf students. They emphasize assessment as a critical inclusion strategy, both legally and pedagogically. Formative assessment is the most appropriate model for assessing the learning of people with disabilities in Inclusive Education.

Perrenoud (1999) states that formative assessment is a broad approach that guides and optimizes learning, focusing less on grading or certification. These studies emphasize the importance of planned assessment strategies adapted to students' specific needs, promoting meaningful learning and favoring cognitive development. They also emphasize the need to adjust assessment instruments to meet students' particularities and the diversity present in the school environment.

Borges (2013) emphasizes that using Libras as a first language does not guarantee good quality in teaching and learning mathematics for deaf students. He proposes a more assertive practice that requires ongoing, committed training and alternative teaching mechanisms. Profound knowledge of deaf students is seen as one of the fundamental pillars of the Teaching Contract.

Oliveira (2005) argues that the teacher must rely on three pillars: sign language, mathematical knowledge, and an inclusive methodology. He stresses the importance of considering deaf students' prior knowledge and encouraging them to express their knowledge, either in signs or in writing, thus creating a dialogical relationship between teacher and student.

The assessment practice adopted by the teacher for the Deaf students, although it included the presence of a Libras interpreter, focused more on the mechanical application of tests than on a practical assessment of the hearing students' learning. We identified some critical aspects: a lack of attention to the specific forms of communication of ESa without the presence of the Libras interpreter, an absence of more appropriate assessment tools, and a failure to communicate the different forms of expression of ESa and ESo. It highlights the need to re-evaluate the everyday lessons and the assessments and for the latter to be coherent with the former, but a coherence favorable to the student's understanding of mathematical concepts, all of which go beyond the simple ability to operate mathematically with algorithms.

Analyzing this information suggests that educational practices need to be reevaluated and adapted to include Deaf students better. The failure to adjust assessment strategies and overreliance on the librarian's interpreter highlight the absence of an inclusive approach in the classroom. Understanding the linguistic needs of Deaf students and implementing adapted educational methods are crucial to ensuring a more inclusive and effective teaching and learning process.

5 Final considerations

This research investigated the Didactic Relations emerging from the Didactic Contract while assessing Deaf students' mathematics learning. This involved analyzing the interactions between the teacher, the sign language interpreter, the deaf students, and the hearing students and how these elements relate to teaching and learning mathematics in an inclusive environment.

In the context of the Pyramidal Didactic System, composed of the research subjects, there was a need to restructure the Didactic Relationships. It became clear that the prevailing classroom dynamic tended to reproduce a traditional teaching model, which imposed obstacles to the effective participation of Deaf students. Redirecting this system towards a more inclusive and equitable approach proved crucial to guaranteeing these students' full participation and autonomy in the educational process. Equitable here is understood as thinking about methodological tools and tasks that consider the characteristics of deaf students and favor their potential, such as the exploration of visual aspects.

The Didactic Contract, the central element investigated, proved fundamental in the dynamics of Didactic Relationships. It establishes the responsibilities of the subjects involved in the educational process, outlining the rules that govern the interaction between the research subjects. The actions emphasize the importance of the Didactic Contract in managing the negotiation of meanings and the appropriation of knowledge. A well-defined and flexible Didactic Contract can facilitate active student participation, promoting a more inclusive and collaborative learning environment.

Two distinct Didactic Contracts coexist the Teacher and the Hearing Students, the Deaf Students, and the Libras Interpreter. The first contract establishes a dynamic in which the Teacher holds the knowledge, resulting in a regulation that limits the active participation of the Students. The second Didactic Contract, between the Libras Interpreter and the Deaf Students, goes beyond translation, taking on an educational role and sometimes leading the IL to act as an educator. Although this approach seeks efficiency by providing ready-made answers, it can jeopardize Deaf students' autonomy, preventing them from developing independent skills. This Dual Contract reveals the complexity of inclusive education, where academic pressures on the Teacher and the expectation of effective facilitation by the Interpreter to promote Deaf learning can influence more authoritarian and direct educational dynamics.

In this sense, the learning assessment scenario revealed a predominance of a traditional model, limiting the active participation of Deaf students and showing an excessive dependence on the Libras interpreter. It shows the need to redefine assessment as a tool not just for measuring knowledge but for promoting the active participation of students in the construction of knowledge. Inclusive assessment strategies must be developed to consider individual needs and enable diverse forms of expression and demonstration of knowledge.

In conclusion, the results reinforce the urgent need for more inclusive educational strategies adapted to the potential of deaf people, emphasizing the importance of reviewing pedagogical practices to create an inclusive learning environment. The implications of these results can direct future research and training programs, updating the educational experience to meet the diversity of students. Future research suggests analyzing pedagogical strategies that encourage the active participation of deaf students and improving collaboration between teachers and Libras interpreters. In addition, the importance of teacher training programs focused on inclusive methods that meet the diverse needs present in the educational environment and explore the role of the interpreter as a pedagogical mediator is highlighted.

References

Baldino, R. R. (1994). *Assimilação solidária onze anos depois*. Grupo de Pesquisa-Ação em Educação Matemática. Unesp: Rio Claro.

Borges, F. A. (2013). *A educação inclusiva para surdos: uma análise do saber matemático intermediado pelo intérprete de Libras*. 259f. Tese (Doutorado em Educação para a Ciência e a Matemática). Universidade Estadual de Maringá. Maringá, PR.

Brasil. (2008). *Política Nacional de Educação Especial na Perspectiva da Educação Inclusiva*. Brasília: MEC/SEESP.

Brito Menezes, A. P. A. (2006). *Contrato Didático e Transposição Didática: Inter-relações entre os Fenômenos Didáticos na Iniciação à Álgebra na 6ª série do Ensino Fundamental*. 411 f. Tese (Doutorado em Educação). Centro de Educação, Universidade Federal de Pernambuco. Recife, 2006.

Brousseau, G. (2008). *Introdução ao estudo da teoria das situações didáticas: conteúdos e métodos de ensino*. Apresentação de Benedito Antônio da Silva. São Paulo: Ática.

Brousseau, G. (1986). *Fundamentos e Métodos da Didática da Matemática*. In: Didactique des Mathématiques, *7*(2), 33-116.

Buriasco, R. L. C. (1999). *Avaliação em Matemática: um estudo das respostas de alunos e professores.* 238 f. Tese (Doutorado em Educação). (Universidade Estadual Paulista) Marília.

Fernandes, T. L. G. (2010). *Avaliação da aprendizagem de alunos com deficiência: estudo documental das diretrizes oficiais*. 155f. Dissertação (Mestrado em Educação Brasileira). Fortaleza.

Fiorentini, D. Lorenzato, S. (2009). *Investigação em educação matemática: percursos teóricos metodológicos* (3ª ed.). Campinas, São Paulo: Autores Associados.

Lacerda, C. B. F (2010). *Intérprete de libras: em atuação na educação infantil e no ensino fundamental.* Porto Alegre: Mediação.

Lüdke, M., & André, M. (1986). *Pesquisa em educação: abordagens qualitativas* (1ª ed.). São Paulo: EPU.

Luckesi, C. C. (2011). *Avaliação da aprendizagem: componente do ato pedagógico*. São Paulo: Cortez.

Luckesi, C. C. (2005). *Avaliação da aprendizagem na escola: reelaborando conceitos e recriando a prática* (2ª ed.). Salvador: Malabares.

Mantoan, M. T. E. (2003). *Inclusão escolar – O que é? Por quê? Como fazer?* São Paulo: Moderna.

Nogueira, C. M. I. Borges, F. A. (2012). *Uma análise das aulas de matemática para alunos surdos inclusos em uma turma do 9° ano de Ensino Fundamental.* Revista Educação e Linguagem (Online). (1). 99-198.

Nunes, L. S. (2012). *Os alunos surdos e a matemática: um projeto de intervenção em geometria.* 273 f. Dissertação de mestrado. (Instituto Politécnico de Lisboa, Escola Superior de Educação de Lisboa). Lisboa.

Oliveira, J. S. de. (2005). *A comunidade surda: perfil, barreiras e caminhos promissores no processo de ensino aprendizagem em matemática*. Dissertação de Mestrado. (Centro de Educação Tecnológica Celso Suckow da Fonseca CEFET). Rio de Janeiro.

Pais, L. C. (2019). *Didática da Matemática: uma análise da influência francesa*. Dissertação (Mestrado em Ensino de Ciências e Educação Matemática), Universidade Estadual da Paraíba, Campina Grande.

Pais, L. C. (2002). *Didática da matemática: uma análise da influência francesa* (2ª ed.). Belo Horizonte: Autêntica.

Pereira, P. V. (2014). *A surdez no ambiente escolar: um estudo das representações sociais de professores de Matemática, intérpretes e alunos*. Dissertação (Mestrado em Matemática). (Universidade Federal de Mato Grosso do Sul – Campus Três Lagoas, Programa de Pós-Graduação em Matemática). Três Lagoas-MS.

Pereira, V. A. (2009). *Consultoria colaborativa na escola: contribuições da Psicologia para inclusão escolar do aluno surdo*. Tese (Doutorado em Ciências Humanas). (Universidade Federal de São Carlos). São Carlos.

Perrenoud, P. (1999). *Avaliação: da excelência à regulação das aprendizagens – entre duas lógicas*. Porto Alegre: Artmed.

Santos, W. F. D. (2019). *A transposição didática interna no ensino do conjunto dos números naturais para surdos: um estudo numa sala de aula inclusiva*. Dissertação de Mestrado. (Universidade Estadual da Paraíba). Campina Grande.

Selltiz, C. Wrightsman, L. S. Cook, S. W. (1965). *Métodos de pesquisa das relações sociais*.

São Paulo: Herder.

Talmag, A. F. A. (2018). *Avaliação da aprendizagem de alunos surdos no ensino superior: estudo de caso em um curso de graduação em Letras Libras*. Dissertação (Mestrado Profissional em Políticas Públicas e Gestão da Educação Superior). (Universidade Federal do Ceará, Programa de Pós-Graduação Profissional em Políticas Públicas e Gestão da Educação Superior). Fortaleza.

Vianna, H. M. (2003). *Pesquisa em Educação: a observação*. Brasília: Plano Editora.

Vygotsky, L.S. (1993). *Pensamento e linguagem*. São Paulo: Martins Fontes.