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Proper, improper and apparent fractions: an analysis of the Visual Grammar of MathLibras videos

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Abstract: The objective of this article is to analyze three videos about fractions from MathLibras, based on the Visual Grammar proposed by Rosado and Taveira (2022). The project MathLibras produces videos that provide Mathematical contents in Libras. The theoretical framework of the videos' analysis is the Visual Grammar for the digital videos in sign languages, which is a description and planning proposal for video's production. This proposal presents seven basic constituent elements that can be analyzed on a frame that is captured. The results indicate that the videos maintain a standard opening, closing and dressing; the captions are optional; there is audio insertion; it is ensured that the number of elements on screen is not excessive and that the images used in the videos are structured to help visualize the concepts. It is suggested that Mathematics videos in Libras can be produced respecting the specificities of Visual Grammar.

Keywords: Teaching Mathematics. Libras Didactic Materials. Deaf. Video Lessons.

Fracciones propias, impropias y aparentes: un análisis de los videos de Gramática Visual de MathLibras

Resumen: El objetivo de este artículo es analizar tres videos sobre fracciones de MathLibras, basados en la Gramática Visual propuesta por Rosado y Taveira (2022). MathLibras produce vídeos para proporcionar contenido matemático en Libras. El marco de análisis de video es Gramática Visual para videos digitales en lenguas de señas, que es una propuesta de descripción y planificación para la producción de videos. Esta propuesta presenta siete elementos constitutivos básicos que pueden analizarse capturando un fotograma. Los resultados indican que: los videos mantienen un estándar de apertura, cierre y vestir; el título es opcional; se produce la inserción de audio; se tiene cuidado para garantizar que el número de elementos en pantalla no sea excesivo; y las imágenes utilizadas en los videos están estructuradas para ayudar a visualizar los conceptos. Se sugiere que se puedan producir videos de matemáticas en Libras, respetando las especificidades de la Gramática Visual.

Palabras clave: Enseñanza de Matemáticas. Libras Material Didáctico. Sordo. Video Aula.

Fração própria, imprópria e aparente: uma análise da Gramática Visual dos vídeos do MathLibras

Resumo: O objetivo deste artigo é analisar três vídeos sobre frações do MathLibras, a partir da Gramática Visual proposta por Rosado e Taveira (2022). O MathLibras produz vídeos para disponibilizar conteúdo de matemática em Libras. O referencial de análise dos vídeos é a

Gramática Visual para os vídeos digitais em línguas de sinais, que é uma proposta de descrição e planejamento para a produção de vídeos. Esta proposta apresenta sete elementos constituintes básicos que podem ser analisados pela captura de um *frame*. Os resultados indicam que: os vídeos mantêm um padrão de abertura, encerramento e vestimenta; a legenda é opcional; a inserção de áudio ocorre; um cuidado para que o número de elementos em tela não seja excessivo existe; e as imagens usadas nos vídeos são estruturadas para contribuir na visualização dos conceitos. Sugere-se que os vídeos de matemática em Libras podem ser produzidos, respeitando as especificidades da Gramática Visual.

Palavras-chave: Ensino de Matemática. Libras Material Didático. Surdo. Videoaula.

1 Introduction

The production of didactic material for the teaching of mathematics directly in sign language is not a simple assignment to organize and to produce, for there are several variables involved in this process. It is necessary to reflect about the conceptual and didactic issues of mathematics itself, as well as to consider the specificities of sign language as a visual-spatial language (Quadros, 2019) and to also consider the target audience of the material that is being produced.

The authors of this article, researchers in the area of Mathematics Education and Deaf Education, have been working, for six years now, in the production of videos for the teaching of mathematics directly in Libras. In these videos, several elements are considered, so that the target audience in question – Deaf students of Early Childhood Education and Elementary School – are able to understand mathematical concepts directly in their L1, the Brazilian Sign Language (Libras). Libras is understood as the L1 of Deaf children, because "by stating that sign language enables the Deaf subject to recognize and put themselves into the world, the constitution of the subject is narrated through language and sign language is thus determined as a subjective and constitutive part of the Deaf child" (Martins & Lacerda, 2016, p. 168, our translation).

In this sense, it is important to highlight that the videos produced for children by the MathLibras project do not present a space for translation in the screen. As will be reported later, the videos are small narratives/challenges signed in Libras by actors/actresses, whose scripts are produced taking into account conceptual issues of mathematics and linguistic issues, such as lexicography, pragmatics, linguistic variation, among others.

It is known that most Deaf children are born in a hearing home, which can interfere with their linguistic development due to poor communication. Quadros (2019, p. 33) states that "since it is not transmitted from the parents to the children – the vast majority of Deaf children are born in families of hearing people that do not know Libras – causing Libras to be susceptible to constant reinventions. Deaf children grow up without an established language."

Despite the importance of sign language for the development of the Deaf person and the linguistic right of access to Libras as L1 as guaranteed by Brazilian legislation, the teaching options for these individuals are still flawed when it comes to their access to it, both due to the often late diagnosis of deafness and the small number of bilingual schools in Brazil. As most Deaf children are born in hearing homes, two alternatives would allow access to sign language: (i) the family's willingness to seek support in the Deaf community; (ii) the government's initiative to provide Deaf teachers and sign language translators/interpreters in schools that can interact properly with children through sign language. Unfortunately, a large number of children are included in the regular education network, that is, they participate in classes taught orally together with the hearing children, often without access to sign language. Hence, without

adequate linguistic tools, the child should learn a language that is not naturally accessible to their conditions.

Thus, the videos produced at the project MathLibras aim to make videos available in Libras for young children, at the beginning of their educational process, seeking to ensure access to mathematical concepts in Libras, with a level of sign language appropriate to their age group. In the videos' production, we seek to articulate mathematics concepts with Libras and with the specificities of deafness, with regard to visuality. Thus, in this article, we aim to discuss the use of Visual Grammar in three videos about fractions produced by MathLibras, according to the proposal of Rosado and Taveira (2022), authors that discuss the production of digital videos in sign language. From this grammar it is possible to analyze what has been produced so far and to reflect about which elements need to be improved during the videos' production.

Therefore, in the second section we contextualize the MathLibras project and list all the videos produced on the topic of fractions. Afterwards, we discuss the teaching of mathematics to the Deaf subject. In the methodological approach we present the Visual Grammar and in the next topic we discuss our analysis of the three videos, as well as our results. Lastly, we present the concluding remarks and the references.

2 The MathLibras Project

MathLibras is the name of the project that involves teaching, research and extension at the Federal University of Pelotas (UFPel). Its origin dates back to 2017, from the CNPq/MCTIC/SECIS Call n. 20/2016 – Assistive Technology –, being financed by the National Council for Scientific and Technological Development (CNPq), in which the approved research project was *Production of mathematics video lessons with translation in Libras*, named as MathLibras. The project was financed by CNPq from June 2017 to June 2019.

From the original project, MathLibras has been developed at UFPel and nowadays it involves the research *Inclusive mathematics education: MathLibras and other interlacements and* the extension project MathLibras – *Year V.* The project is an interunit proposal in the institution, being allocated in the Department of Mathematics Education of the Institute of Physics and Mathematics (DEMAT/IFM). The project includes a partnership with the Libras area of the Center for Languages and Communication (CLC) and with the interpreters section affiliated to the Accessibility and Inclusion Center (NAI) of the Dean's Office. Another partnership is the Bilingual Special School Professor Alfredo Dub.

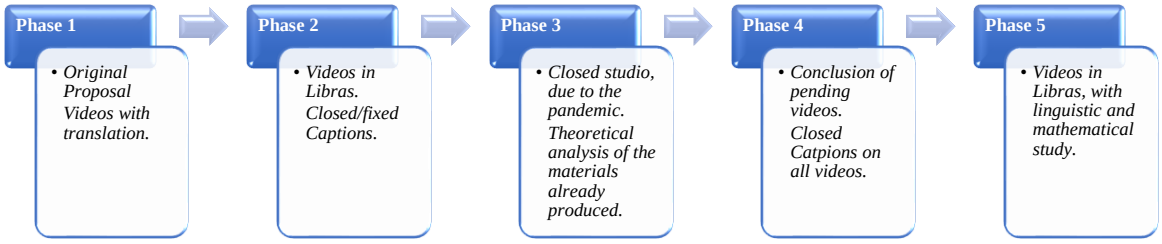
The MathLibras team is composed of scholarship holders and volunteers from different areas of expertise. Nowadays the project is composed by Deaf and hearing professors from the areas of Mathematics Education and Libras, master's students of the Graduate Program in Mathematics Education (PPGEMAT) and PhD students of the Graduate Program in Languages (PPGL), all from UFPel. Two Libras translators/interpreters as well as students from the BA in Mathematics and from the BA in Languages-Libras/Deaf Literature are also part of the project. The scholarship holders are students from the BA in Film and Audiovisual and from the BA in Film Animation. Four teachers from the school Alfredo Dub are also part of the team.

When MathLibras was created in 2017, its main objective was to produce basic mathematics video lessons and to translate them into Brazilian Sign Language (Libras). However, soon after the first recordings, the group realized that the proposal did not directly contemplate the Deaf subject, as there was no production "for" this public, but a translation. After this realization, part of the team visited the National Institute of Deaf Education (INES) in 2018, seeking guidance to better understand the process of producing materials for the Deaf

community. Since then, several changes have occurred until we reached what is currently being developed in the project.

Thus, we consider that the project went through four phases, and is currently in its fifth phase, as illustrated in Figure 1.

Figure 1: MathLibras phases.



Source: Produced by the authors, 2023.

In the fifth phase, before the recording, the videos' production goes through a linguistic and mathematical discussion, concomitant with the technical analysis, which focuses on the animations that will be inserted, that is, on the visual components. At this moment, all the participants that are part of the project participate, jointly and collaboratively. The meetings take place every Tuesday morning, and on one meeting the video script is studied, and preferably on the following Tuesday the video is recorded.

The discussion that has been taking place in the production of the videos is an important step in the creation of the material. Based on the original idea of the mathematical content to be addressed on a video (responsibility of the team of professionals in the field of mathematics), the entire group reflects about the linguistic choices in Libras. Traditionally, materials for Deaf subjects have been produced based on a script in Portuguese, mostly written and translated by hearing people.

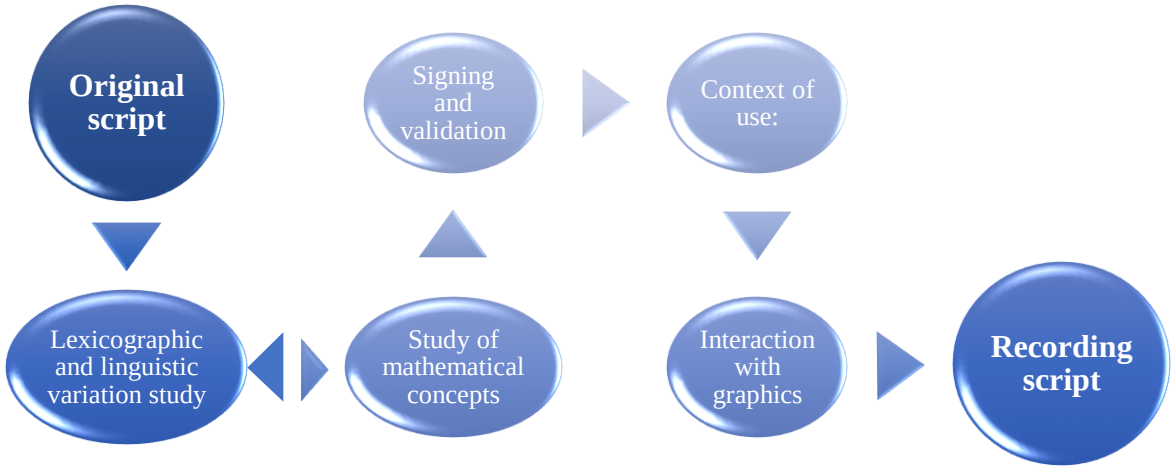
MathLibras, in a differentiated way, thinks and produces the scripts of the videos based on Libras and Deaf visuality, as Lebedeff (2017) states, taking into account elements that contribute and ensure a working methodology of the fundamental concepts of mathematics and aiming at linguistic understanding, while respecting the intrinsic aspects of visual communication with the Deaf. To this end, the elements used in these discussions include, as shown in Figure 2.

1. *Linguistic variation*: Libras, like any other language, presents linguistic variations – diatopic and diastratic. Diatopic variations concern geographical aspects, regionalities in the production and use of signs; and diastral variations refer to social aspects – identity, age, gender, among others – that will influence the production and use of signs (Mussalin & Bentes, 2006). Regarding the Libras linguistic variation, it is important to note, as Silva and Burgeile (2018) comment, that, as it is a natural language, as well as the spoken languages, even if it has another modality, it goes through the same consecutive, gradual process of linguistic variation and change. These changes, according to the authors, can occur either by internal influences or by contact with other sign languages – and even by the contact with Deaf people from different regions of Brazil. Such variations are a complication for the use of didactic materials produced on other regions of Brazil, especially considering initial learners of the language, that may be confused by the variety of signs.

Variations can and should be presented to learners, but this happens more easily when they already have a basic knowledge of the language. At MathLibras, discussions on linguistic

variation focus mainly on the age group and the context of use. Based on these elements, we discuss the different signs used by Libras signers in the school space, and the signing strategies for the comprehension by Deaf children, in the most neutral way possible, concerning the regional signs. This practice has been carried out taking into account the understanding of the implicit elements that build form and discuss the possible rules of signing (Castro Júnior, 2011).

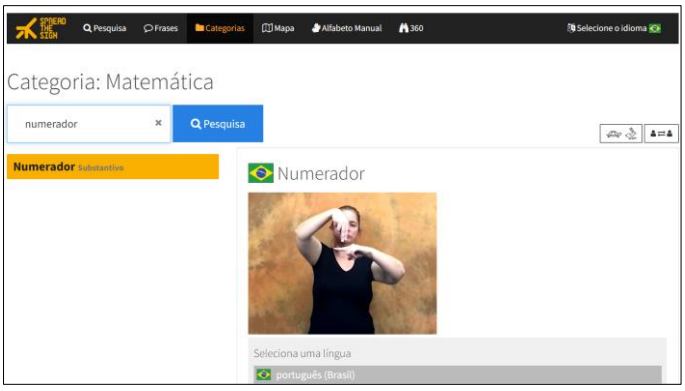
Figure 2: Elements used in the discussion of MathLibras scripts.



Source: Produced by the authors, 2023.

2. *Mathematical concepts*: Libras has a set of specific signs to express mathematical concepts and concepts from other areas. Therefore, during the production of the scripts, these concepts are listed, discussed and understood by the team, since the signing actors need to understand these concepts to sign the video script in Libras. Concomitant with the study of mathematical concepts, a lexicographic and terminological research is carried out in different channels (*online* and printed dictionaries, *online* glossaries, video lessons on YouTube channels, among others), aiming to ensure the proper use of signs for the terms corresponding to the mathematical concepts that will be explored in the videos. Some of the places consulted are *the Brazilian Sign Language Dictionary* (Capovilla; Raphael; Temoteo & Martins, 2017) and the *online* dictionary Spread the sign[1], a project which UFPel is also a partner. Figure 3 presents an example with the term "numerator".

Figure 3: Sign for numerator.



Source: https://www.spreadthesign.com/pt.br/search/. Accessed in: Jan. 23, 2024.

3. Signs *validation: the validation of signs* in Libras is a continuous process, as the language is a live and dynamic organism, and this is an inherent movement for the

[1] *Site*: https://www.spreadthesign.com/pt.br/search/. Acesso em: 23 jan. 2024.

representation of emerging concepts. Therefore, in the project, the presence of Deaf teachers in the discussions and in the elaboration of the scripts, together with the other members of the multidisciplinary team that precedes the recordings, has an important function, that is, to validate the signing through the recognition of its use in the Deaf community. Thus, after studying the script, a "rehearsal" is performed, which is recorded with a smartphone. In this test, the team discuss the signs, that validate, or not, the signing. Also, on the official filming day, there is always a professional proficient in Libras (Deaf or hearing) that follows through all the signing to validate each *take*. After publishing the videos on the MathLibras channel another type of validation is still sought, that is, the opinion of Deaf children from the school Alfredo Dub that use Libras as a first language (L1).

4. *Context of use*: Signs in Libras are also influenced by context and situations of use. The same sign can have different meanings depending on the context in which it is used. Therefore, when producing video content, it is essential to consider the situation in which a specific sign is likely to be used, so that we can choose the most appropriate signs and ensure comprehension by the target audience – in this case, Early Childhood and Elementary School students.

5. *Interaction with graphic elements*: for the construction of the scripts, as already mentioned, we mainly rely on the participation of students from the BA courses in Film and Audiovisual and in Film Animation that are scholarship holders of the MathLibras project. Whenever the insertion of graphic elements is proposed, so that Deaf visuality is contemplated in the visual pedagogy adopted by the methodology of creating the videos, the colors, sizes, location and possible movements of the figures and animations are discussed together. In addition to only presenting an illustrative image on the material, these elements need to produce meaning altogether with the signing in Libras, being in harmony with the chosen *layout*. Therefore, visuality, here, is not limited to placing figures that "match", but that "communicate" something to the target audience, because "the image lacks attributes to act as an educational element" (TAVEIRA & Rosado, 2017, p. 27).

The mentioned elements are the basis that compose the productions carried out in the project and focus on an organized and thought-out methodology for the teaching of mathematics in Libras. Although Libras was legally recognized two decades ago (Brasil, 2002) and is currently more widespread, productions in the area of mathematics, published primarily for the Deaf community, are still incipient to meet current educational demands.

Thus, in this article, we seek to present an analysis of three videos about fractions, considering that, in total, there are already 26 videos on this topic, according to Chart 1. It is noteworthy that videos V17 and V18 are the same as V08 and V09, respectively, but with closed captions, so that all videos on the channel have this option.

Table 1: MathLibras videos about fractions.

Video	Phase	Published
V08 - Fraction - Initial ideas 1 (Captioned)	2	Aug./2018
V09 - Fraction - Initial ideas 2 (Captioned)	2	Aug./2018
V17 - Fraction - Initial ideas 1	4	Sept./2022
V18 - Fraction - Initial ideas 2	4	Sept./2022
V28 - Everything ends in Pizza FRACTION 3	4	Dec./2022
V37 - Reading Fractions 1	5	Jul./2023

V38 - Reading Fractions 2	5	Jul./2023
V39 - Fractions Challenge 1	5	Jul./2023
V40 - Fractions Challenge 2	5	Jul./2023
V41 - Fractions Challenge 3	5	Jul./2023
V42 - Fractions Challenge 4	5	Jul./2023
V43 - Fractions Challenge 5	5	Jul./2023
V44 - Fractions Challenge 6	5	Jul./2023
V45 - Fractions Challenge 7	5	Jul./2023
V46 - Fractions Challenge 8	5	Jul./2023
V47 - Fractions Challenge 9	5	Jul./2023
V48 - Fractions Challenge 10	5	Jul./2023
V49 - Proper Fraction	5	Oct./23
V50 - Apparent Fraction	5	Oct./23
V51 - Improper or Mixed Fraction	5	Oct./23
V58 - Challenge 1 - Fraction Types	5	Dec./23
V59 - Challenge 2 - Fraction Types	5	Dec./23
V60 - Challenge 3 - Fraction Types	5	Dec./23
V61 - Challenge 4 - Fraction Types	5	Dec./23
V62 - Challenge 5 - Fraction Types	5	Dec./23
V63 - Challenge 6 - Fraction Types	5	Dec./23

Source: MathLibras Channel.

The videos were intentionally chosen by topic for analysis. Thus, the following videos will be analyzed: V49, V50 and V51. They address the types of fractions: proper, apparent and improper or mixed. These videos will be described, in the methodology, subsequently. However, previously is important to discuss the teaching of Mathematics for the Deaf.

3 Mathematics teaching for the Deaf

Professor Nogueira (2013), at the end of her presentation of the work *Deafness, inclusion and mathematics*, of which she is the organizer, points out that:

> it is not enough to translate into Libras, contents and methodological strategies designed for the teaching of Mathematics to hearing people. Deaf people need a pedagogical action that meets their particularities, pushing for good quality in mathematics teaching that can favor the inclusion of Deaf people in society (Nogueira, 2013, p. 15).

Ten years later, together with Fábio Alexandre Borges, Professor Clélia Maria Ignatius Nogueira organizes the second volume of this work, presenting 19 chapters that address research related to the teaching of mathematics to the Deaf (Nogueira & Borges, 2023). This book shows the significant progress of research in the area and the importance of this topic.

It is known that Deaf children can have delays in their development, as “they are not

stimulated in their mother tongue during the period that corresponds to language development and, when they reach school age, school are not yet fully prepared to work with this linguistic specificity" (Bueno, 2021, p. 47). And, due to the often late acquisition of the language, the construction of concepts and learning itself can be compromised, as can the concepts of mathematics, as concluded by Nunes, Evans, Barros & Burman (2013, p. 265):

> The mathematical gap found in Deaf children can perhaps be explained by the limited frequency of interactions that stimulate the development of mathematical reasoning before they enter school. Thinking mainly about language, the adults around them may not direct the necessary attention to promote the construction of informal mathematical concepts.

Thus, as researchers and teachers, one of our priorities of action is to produce quality materials, in Libras, so that mathematics can be made available, in a conceptual and linguistically playful way to Deaf students as soon as they enter school, helping both when it comes to the specific content part and also to language and vocabulary acquisition.

The objective of MathLibras is the production of mathematics videos developed directly in Libras, providing the Deaf student with didactic materials in their first language (L1), as it is perceived that there is also a gap in materials that are about mathematics. In addition, the video is a very useful resource for the Deaf community, precisely because of its visual modality, such as Ferrés (1996, p. 15) states: "audiovisual is not primarily a matter of means, but of language". Although almost 30 years have gone-by, Ferrés' proposal is up to date, since nowadays videos are accessible to mostly everyone at our *smartphones*, and they [videos] assist Deaf people in their communication in Libras. Thus, what Ferrés (1996) predicted as a possibility, today became a reality, namely: the use of videos in our daily lives for the most varied activities.

When it comes to videos, there is the issue of the visual experience. Therefore, this visual experience of the Deaf subject has become increasingly important in the field of Deaf Education studies, especially due to the use of sign language, which is a visual-spatial language, and thus videos are a strong ally of the process. According to Lebedeff (2017), for Deaf people that can see, things are visual for the Deaf, and it is by sight that everything is accessed. For this reason, it is essential to think about the visuality of the Deaf, conceiving that their linguistic construction develops in this visual space, where the body is used as the means of communication.

Rosado and Taveira (2019) have problematized and highlighted the role of visuality in Deaf education, since it is essential for the development and learning of sign language. Thus, the understanding of visuality and visual experience is essential for the development of teaching proposals that take into account the linguistic and cultural specificities of the Deaf. In addition, Lebedeff (2017) suggests that it is necessary to understand the visual experience as a cultural artifact of the Deaf community, since it is from this experience that the Deaf is subjectively constituted. This understanding, therefore, leads us to reflect about pedagogical practices that are based on the constitutive visual experience of these subjects.

The videos produced by the MathLibras project are didactic materials that can be inserted into a pedagogy that also seeks "visual literacy [which] should be a practical concern of the educator, since 'visual decisions dominate most of the things we examine and identify, including reading'" (Dondis, 2007, p. 231 *apud* Taveira & Rosado, 2017, p. 26).

When we regard a visual pedagogy, we conceive a teaching process that considers Deaf educational specificities, which need a pedagogy that uses visuality as a powerful tool for

intervention in the pedagogical organization. In this sense, Grützmann, Alves and Lebedeff (2020) suggest that there is a need to implement visual strategies in the teaching process that involve Deaf people; therefore, a visual pedagogy would be a form of planned intervention, that is, organized and designed for Deaf students. Campello (2008, p. 136) discusses the use of visuality in the classroom, stating that "the answer is not to simply use Brazilian Sign Language, as a simple, mechanized language, but much more. It requires perceiving all the elements that surround Deaf subjects as visual signs".

Thus, reflecting on the use and understanding of visuality/visual experience that is so strongly evidenced in the social interactions of this group, it is necessary to understand how these images are used and perceived. To reflect about these issues, we need to understand that visuality plays an important role in this space and that its protagonism acts at different times in the composition of the analysis of an image. Along the same lines, Viana (2019) states that hearing people are not in a position to have the same visual experience as Deaf individuals:

> We cannot simply ignore our entire hearing construct to make way for moments of Deaf visuality. This is not necessarily a problem, only when we take this limitation so as not to reflect about our pedagogical actions. We are different, yes, and only that. Understanding the metamorphoses necessary for teacher evolution is part of our occupation (Viana, 2019, p. 24).

The production of MathLibras is focused on planning and producing materials in Libras, and not on translating what is already done in Portuguese for the hearing public. There are differences that need to be respected and considered when proposing materials to the Deaf community, including the perspective of a visual pedagogy. According to Taveira and Rosado (2017, p. 25), "the Deaf person in initial contact with sign language needs visual language with which they can interact to construct meanings".

And we put forward the following question: why did we choose fractions as one of the contents to be explored in MathLibras videos? There are several studies on fractions, of which we highlight the works of Abreu and Silva (2023), Silva, Vidal and Carvalho Filho (2023) and Graça, Ponte and Guerreiro (2021), among many others. However, we agree with Nunes and Bryant (1997, p. 191), in stating that:

> With fractions, appearances can be deceiving. Sometimes children seem to have a complete understanding of fractions and yet they don't. They use the right fractional terms; they talk about fractions coherently; they solve some fractional problems, but several crucial aspects of fractions still elude them. In fact, appearances can be so deceptive that it is possible for some students to pass through the school without mastering the difficulties of the fractions, and without anyone noticing.

Thus, there is a concern that Deaf students have the opportunity to study this content in their language, seeking a real understanding of the terms and knowing how to solve problems involving the fractions. The initial videos present some concepts, such as the types of fractions, which will be analyzed in this text, and the scope is to continue exploring this content, in order to cover it in the best possible way.

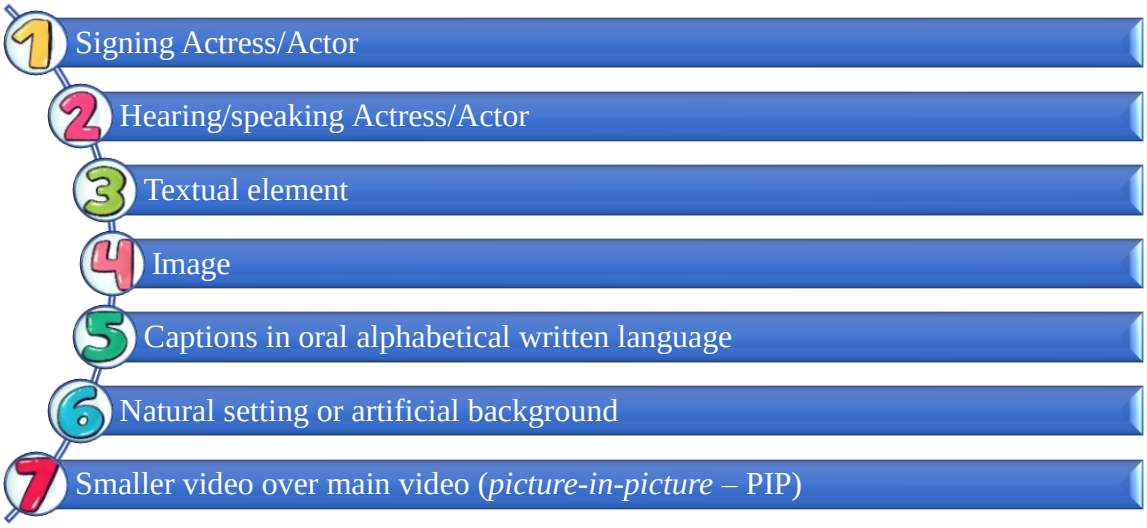
It is important to highlight that "although the concept of fraction is unique, it assumes different aspects in each situation in which it is used" (Smole & Diniz, 2016, p. 28), and it is in this sense that the videos are being produced. It is about showing the concept of fraction beyond the idea of a "part-whole", which is important, but not the only one.

4 Methodological Approach

The methodological approach adopted in this article is the analysis of three selected videos, using the Visual Grammar for the signed videos (Rosado & Taveira, 2022). According to these authors, it is necessary to educate the eye from the perspective of understanding the elements that make up the language of visual communication, thus giving meaning to the visual resources used.

The proposed grammar is composed of seven elements, shown in Figure 4. Subsequently, we present a brief description of each one.

Figure 4: Seven elements of Visual Grammar for signed videos.



Source: Adapted from Rosado & Taveira, 2022.

- *Signing Actor/Actress* uses sign language as the main language to communicate, that is, to convey the message in the video. He/she may be Deaf or hearing.
- *Hearing/Speaking Actor/actress* uses speech, that is, orality as the main language for communication. Might be a sign language translator/interpreter, performing the oral version of a Deaf signer.
- *Textual element*: can be a title or caption or even a longer text, according to the proposal of the video.
- *Image*: can be an illustration, a drawing, a painting, a photography or a graphic. "It is the category of iconic representation that unites the most common types of visual images" (Rosado & Taveira, 2022, p. 71).
- *Captions in oral alphabetical written language*: the text that reproduces the speech of the hearing subject or the signing subject.
- *Natural setting or artificial background*: the setting, in the background, that appears in the video. If we have a natural setting, at the time of its filming, there is no alteration. If the *chroma-key* technique is used, that is, the recording with a blue or green background, after editing it is possible to choose other images to compose it.
- *Smaller video over main video (picture-in-picture – PIP)*: the insertion of a smaller video over the main video.

These seven elements aim to assist in the analysis of the productions of videos signed

in Libras, through the capture of an image (*frame*), taking into account the elementary units of the composition of Visual Grammar. The combinations of elements inserted in the *frames* indicated by the authors to be used in the signed videos, gather characteristics that, according to Deaf users, are not polluted and allow the understanding of the text in Libras.

5 Results Analysis and Discussion

In this section, the Visual Grammar used in videos V49, V50 and V51 will be analyzed, having as analysis parameters the seven basic elements presented by Rosado and Taveira (2022). These videos were chosen because they explore the types of fractions – an important content and in which, often, the students end up having difficulty in understanding.

Thus, some images (*frames*) from the first video were selected, with specific *frames* from the other two, because, as the videos have a very similar structure, they will be analyzed together, when possible. The videos are part of the MathLibras project's collection of productions and are available for free on the project's YouTube channel[2].

Before presenting the analysis, it is necessary to highlight that the project logo, located in the upper right or left corner, is found in all videos produced from 2023 on, so it was not considered as one of the elements of Visual Grammar.

The caption is optional, that is, a closed caption, and the YouTube version is edited by the team. It was considered as one of the elements to be analyzed, according to Rosado and Taveira (2022). The caption is presented in all videos and was carefully thought out, aiming to help both the Deaf student concerning the learning of Portuguese as their second language in the written modality, as well as to help hearing people that are learning Libras and use it produce a link between the speech and the signs.

However, we believe that firstly a brief description of the content of each of the videos is necessary.

V49[3] *- Proper Fraction (Closed Caption)* has 2 minutes and 57 seconds of duration. It starts with the standard opening, featuring the characters and the MathLibras logo. Subsequently, the signing actress appears, presenting MathLibras and showing the sign of the project. She starts by saying that the students will start to learn the types of fractions, three in total – proper, apparent or improper fraction – but that in this video they will learn specifically about the first one. The actress exits the screen, and the title of the video appears. The actress comes back and asks Levi and Sara if they are paying attention and if they know this type of fraction. They first sign that they *do* and afterwards that they do *not know*. She explains that every fraction has a numerator and a denominator and that, in this first case, the numerator is smaller than the denominator, highlighting the sign of this type of fraction. Then, she asks if the viewer understood. After that, a challenge is proposed: the viewer should point out which of the three fractions presented on the right side of the screen is a proper fraction, and then the corrected answer is showed. Finally, it is said that on the MathLibras channel the viewer can find more videos about the other types of fractions, as well as activities, and the viewer is invited to visit the project's channel and watch other videos. The actress leaves the scene and enters the screen with the credits.

V50[4] *- Apparent Fraction (Closed Caption)* has 3 minutes and 29 seconds of duration. The video starts with the standard opening, featuring the characters and the MathLibras logo.

[2] https://www.youtube.com/@mathlibras6223/videos.
[3] V49: https://youtu.be/rW1pb1djyJ8?si=fYtFtr-1RpVxdwho.
[4] V50: https://youtu.be/q_tVOKFmdCk?si=4m5M7L8tl98FSkul.

Subsequently, the signing actress appears, presenting MathLibras and showing the sign of the project. The actress exits the screen, and the title of the video appears. The actress comes back and says that they will learn about the second type of fraction, the apparent fraction, and shows the sign in Libras. Sara appears, at her desk, and in the background, there is a classroom setting. The actress asks her to pay attention. There is a quick revision showing that every fraction has a numerator and denominator. Then, the actress reflects about the reason for the specific sign of apparent fraction and recalls that fraction means division. Then, she explains the concept, saying that whenever the division was a whole number, that is, zero remainder, we will have an apparent fraction. Some examples are shown, such as the fractions 2/2 and 6/3. The video ends by proposing two challenges: asking which of the three fractions presented is an apparent fraction and indicates the answer shortly after. The video finishes similarly to V49.

V51[5] – *Improper or Mixed Fraction (Closed Captions)* has 4 minutes and 44 seconds of duration. The video starts in a similar way to V49, until the title appears, indicating that the third type of fraction, the improper fraction, will be studied. Then, the sign in Libras is shown. Levi appears, and the actress asks him to pay attention, to which he signs in Libras that he *will pay attention*. The actress recalls that the fraction has a numerator and denominator, and, by the sign of the improper fraction, it is clear that the numerator is higher than the denominator in this type of fraction. She asks Levi and the viewer to check if they understand. After that, a challenge is proposed: the viewer should point out which of the three fractions presented is in agreement with that was studied in the video. The indicated fraction is 5/4. Then the actress asks Levi what the visual representation of this fraction would be. It is shown that the figure should be divided by 4, but there are 5 parts, so two figures should be drawn. All the parts are counted and 5/4 is reached, indicating that we have a whole figure plus ¼ of the other figure. It indicates that there may be another sign to represent the same situation as the improper fractions, that is, the mixed fraction, indicating how many whole numbers and how many divided parts there are in the improper fraction. From the example, it is explained that 5/4 is the same as 1 ¼ in the form of mixed fraction. The video finishes similarly to V49.

After describing the three videos to be analyzed, we present the selected *frames*. Using the same pattern adopted by the authors Rosado and Taveira (2022), on the right are presented the screens captured from the video under analysis, and on the left the iconic representation of the original frame was inserted, accounting for the variables or elements that appear in each one. The iconic representations are those that Rosado and Taveira (2022) use in their book to guide readers in understanding the suggestions for inserting the constituent elements of the signed videos.

In the first *frame* (Figure 5), there is the project logo in the center (1), and the two characters below, one on the left (2) and the other on the right (3). This is the standard opening in videos from V37 on, starting on July 2023.

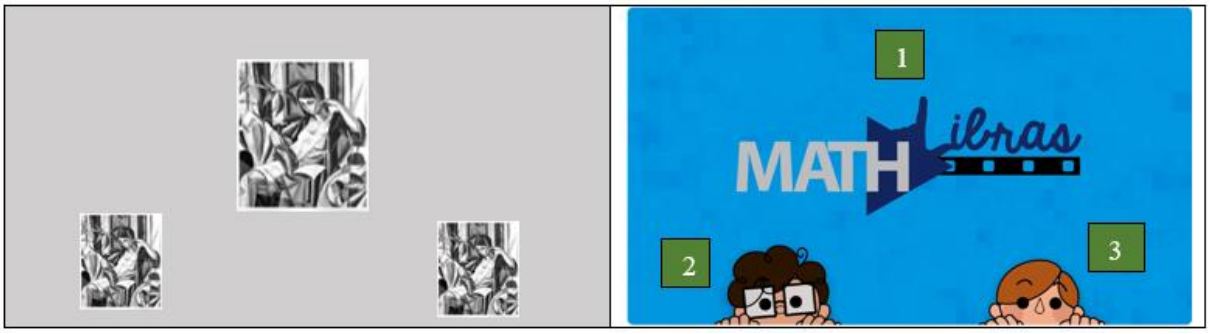
In this first *frame*, the background was not considered, as it is neutral and does not interfere with the presentation. Only three elements of the images category appear. It is important to highlight that the standardization of videos is essential for the student to have a reference to follow, in addition to a logical line in their development.

Levi and Sara, that appear in the opening, are the two MathLibras characters, created in 2018. They appear in the videos, sometimes together, sometimes separately. They are elementary school children and interact with the signing actress (or actor) during the videos. The characters underwent a *redesign* in 2023 (Medeiros; Bohn; Gomes; Lebedeff & Grützmann,

[5] V51: https://youtu.be/eicVjCwJgk4?si=minOpFIDGUI37OtL.

2023), based on the work developed by one of the scholarship holders.

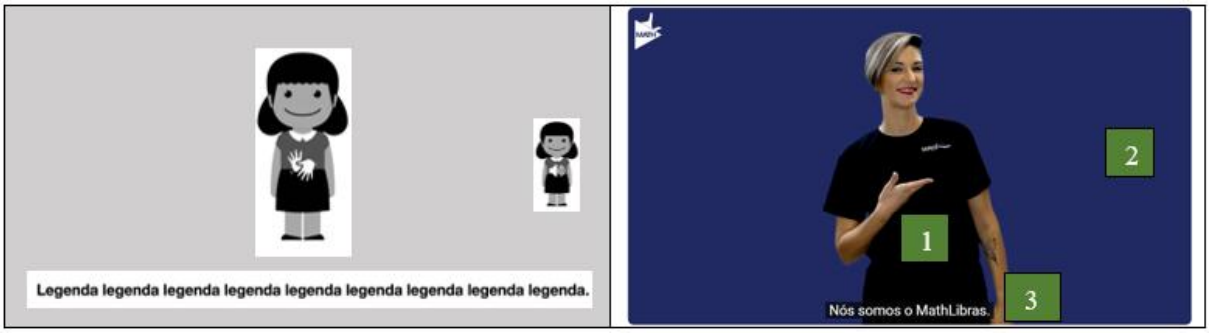
Figure 5: *Frame* 1 – logo at the opening of videos V49, V50 and V51.



Source: Produced by the authors, 2023.

In the second *frame* (Figure 6), the frame has a signing actress in the center (1), a hearing/speaking actress (2), represented by the video audio, and the caption (3) (closed caption) at the bottom. The recording of the signing person is cut to a mid-close-up.

Figure 6: *Frame 2* – logo at the opening of videos V49, V50 and V51



Source: Produced by the authors, 2023.

In this context, the background was not considered, as it is neutral and does not interfere with the presentation. The actress is presenting the name and sign of MathLibras. It should be noted that, in all MathLibras videos, the presenter/signing actress wears a uniform T-shirt, maintaining a standard. Also, in these three videos, this part of the video is the same, only changing the color of the background.

In the third *frame* (Figure 7), the frame has a signing actress shifted to the right (1), a hearing/speaking actress (2), represented by the video audio, the caption (3) (closed caption) at the bottom, and a textual element, with the three types of fractions (4). The recording of the signing person is cut to a mid-close-up.

Figure 6: *Frame* 3 – Video V49.

Source: Produced by the authors, 2023.

It is noteworthy that the textual element assists the Deaf student in the written visualization of the three types of fractions that will be studied. This is important since the explanation of the video is presented in Libras, however there is the reinforcement of the Portuguese language in the written modality, which is so necessary for a bilingual subject (Lins & Cabello, 2019).

In the fourth *frame* (Figure 8), the frame has a textual element (1) of two lines, in the center, and two images, one to the left (2) and one to the right (3).

Figure 7: *Frame* 4 – title of videos V49, V50 and V51.

Source: Produced by the authors, 2023.

In this *frame*, the title of the video appears, as a textual element. Also, on the left side, Levi (image) appears, and on the right side, Sara (image) appears – characters of the project – and they act out a dialogue with the viewers, talking about the mathematical contents that are presented on the video. The screen with the title of the videos is standard.

In the fifth *frame* (Figure 9), the frame has a signing actress shifted to the right (1), a hearing/speaking actress (2), represented by the video audio, the caption (3) (closed caption), at the bottom, a textual element with the type of fraction under study (4), and two images on the left (5) and (6). The recording of the signing person is cut to a mid-close-up.

Figure 8: *Frame* 3 – Video V49.

Source: Produced by the authors, 2023.

In this *frame*, Levi and Sara have one of their hands in the handshape in "*s*", which, in

the continuity of the video, it is possible to perceive by the movement that they sign *yes*, in Libras, in response to the actress's question. The inclusion of signing characters is recent, based on the work developed by one of the scholarship holders of the Film Animation course.

Levi and Sara do not stay on the screen throughout the whole time, so as not to "pollute" the videos. They enter, interact and exit, as if they were following the explanation that will be given. This is one of the ways the team found to provide a cleaner video to the viewer.

In the sixth *frame* (Figure 10), again, we have the signing actress shifted to the right (1), the hearing/speaking actress (2), represented by the video audio, the caption (3) (closed captions), at the bottom, and a textual element, with the representation of fraction (4).

Figure 9: *Frame* 3 – Video V49.

Source: Produced by the authors, 2023.

The idea of the grammatical construction of the videos is to highlight the signing actress. Next to the actress, the visual elements that help in the video are presented. In this case, there is the definition of fraction, from the presentation of the numerator and the denominator, teaching where each of the elements should be in the writing of the mathematical language.

After that, this textual element (4) is replaced by an image (4), which presents an example of a proper fraction, as can be seen in *frame* 7 (Figure 11). The other elements remain the same.

Figure 10: *Frame* 3 – Video V49.

Source: Produced by the authors, 2023.

In the other videos, there are images similar to this one that present the other types of fractions, which is not necessary to describe here. However, in V51, which addresses the improper or mixed fraction, in addition to the representation in fractional form, the signing actress asks about the visual representation, as it aims to "transform" the fraction from improper to mixed.

Thus, *frame* 8 (Figure 12) shows the signing actress shifted to the right (1), the hearing/speaking actress (2), the caption (3) (closed captions), at the bottom, and two images (4) and (5), the first being related to the fraction representation, and the second to the character

Levi.

Figure 11: *Frame* 8 – Video V51.

Source: Produced by the authors, 2023.

The image used to represent fractions (4) is one of the traditional proposals, the circle, which was chosen because it is easy to recognize when searching for this content in textbooks. Still, it is possible to notice that the speaking actress (1) is checking if the viewer understood what was explained. This interaction can already be seen in the proposals for the use of videos in education, in Ferrés (1996, p. 17), when the author states that "a key concept in the didactic use of video [is] communication".

Another *frame* to be highlighted here is V50, referring to the apparent fractions. This is composed of the signing actress almost in the center (1), the hearing/speaking actress (2), the caption (3) (closed captions), at the bottom, and an image (4).

Figure 12: Frame 9 – Video 50.

Source: Produced by the authors, 2023.

In this *frame*, the signing actress explains that the fraction 6/3 means 6 divided by 3, which results in 2 with a 0 remainder, justifying that this is an example of an apparent fraction. Note that the image shows the division algorithm in the way it is taught in most schools, because "with the status of language, notation uses signs and conventions and, with regard to the symbology of mathematics, it is a universal and objective notation" (Silva, 2010, p. 61), which needs to be learned by everyone.

It is important to highlight once more that the use of Libras as the language of instruction in the videos seeks to provide the student with the opportunity to learn mathematics in their L1 (Cruz; Morais; Alves & Franca, 2020). However, since mathematics is a language (Machado, 2011), it is important that the student also becomes familiar with its form of writing, based on a specific symbology, such as the one used.

In the tenth *frame* (Figure 14), the challenge proposed in video V49 appears. The signing actress is shifted to the left (1), a hearing/speaking actress (2), represented by the video audio, the caption (3) (closed captions), at the bottom, an image (4) and a textual element, with the

options for the proposed challenge (5).

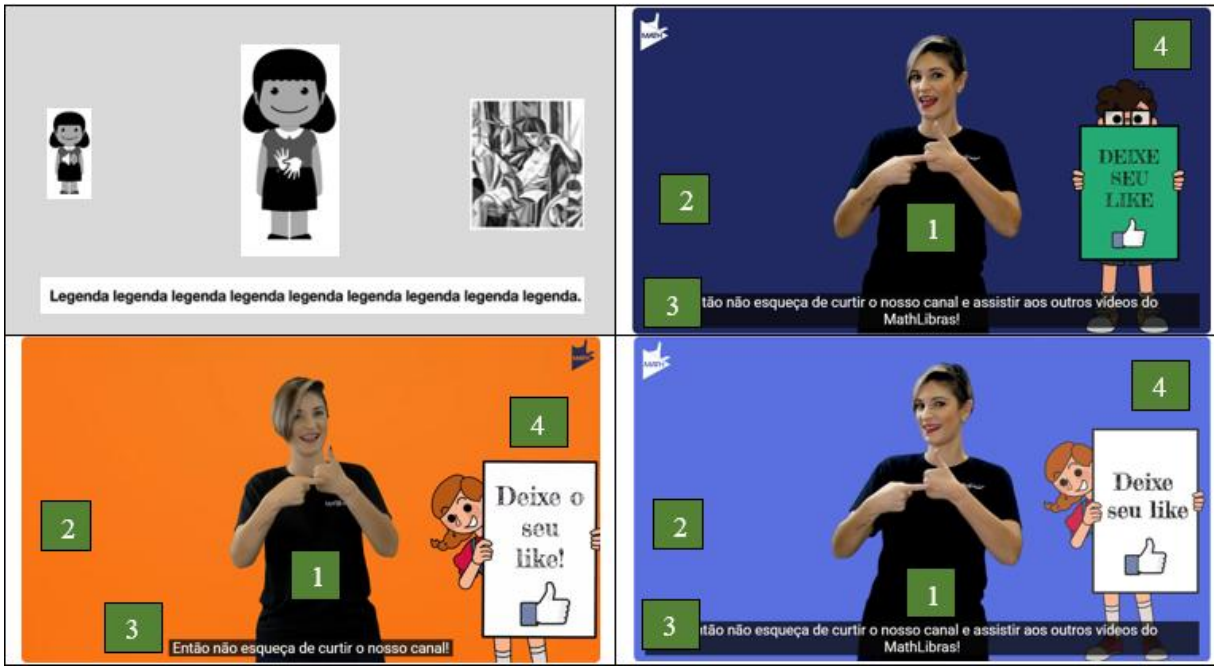
Figure 13: *Frame* 10 – the challenge of V49 video.

Source: Produced by the authors, 2023.

In the other videos, the proposed challenges are similar, so they were not included. In all challenges, there are three alternatives, one for each fraction types.

In the eleventh *frame* (Figure 15), the centralized signing actress (1) appears, the hearing/speaking actress (2), represented by the video audio, the caption (3) (closed captions), at the bottom, and an image on the right (4).

Figure 14: *Frame* 11 – give us your like on the videos V49, V50 and V51.

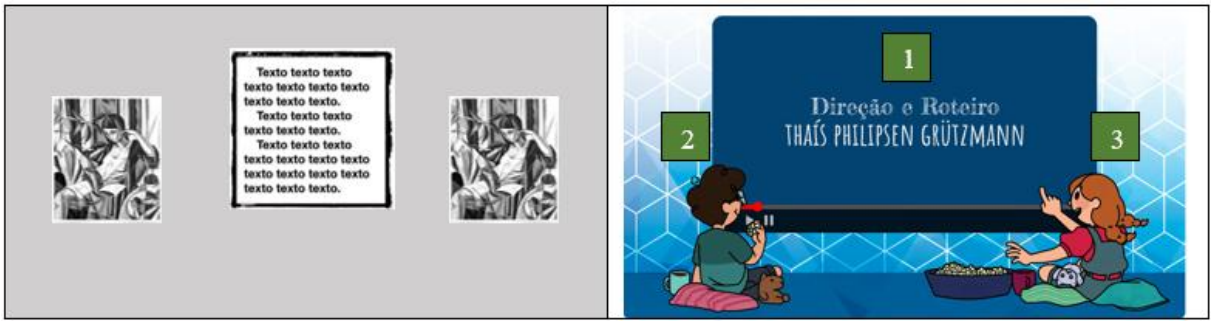


Source: Produced by the authors, 2023.

In this *frame*, it is possible to notice that the actress invites the viewer to visit the MathLibras channel and, subsequently, to watch the other videos of the channel. There is a variation in the neutral color of the background, that does not interfere with the video, and there is the use, occasionally, of Sara and sometimes Levi, both with a signboard in hand.

The twelfth *frame* (Figure 16) is standard in the videos, as it refers to the credits. The frame has a central textual element (1) and two images, one on the left (2) and one on the right (3).

Figure 15: *Frame* 12 – credits of videos V49, V50 and V51.



Source: Produced by the authors, 2023.

On each screen, the names of the authors and their role in the team are displayed. In this example, the main follow-up of the video and the script are in charge of the same person.

The thirteenth *frame* (Figure 17) is also standard in the videos, as it concerns the partners of the project. In the frame, there are two larger images, one on the left (1) and one on the right (2), and eight small images in the center, arranged in two lines, with the logos of the partners (3), (4), (5), (6), (7), (8), (9) and (10).

Figure 16: *Frame* 13 – logos of MathLibras partners.

Source: Produced by the authors, 2023.

It is important to note that the presenting the institution's logos, units, graduate programs, and others involved, legitimizes the work and assists in its dissemination. It is common for colleagues themselves not to be aware of everything that is developed by the group of teachers in the same area.

Finally, it should be noted that only a few *frames* of the three videos selected for this analysis were presented. Of these, it is possible to highlight some relevant considerations:

- The videos maintain a pattern in the opening and in the closure, with the insertion of the logos, which shows a certain rigor of the project;
- A pattern in the clothing of the signing actress/actor is established, from the use of the t-shirt with the MathLibras *logo*;
- The videos present closed captions, one of the seven elements described by Rosado and Taveira (2022), seeking to assist as many viewers as possible and their needs;
- We are concerned so that the number of elements presented on the screen is not excessive, as this would cause visual pollution, jeopardizing the students' learning process;
- The use of textual elements, another element of the visual grammar, is not exaggerated, being presented only in small topics, which helps in the process of visual experience;
- All videos feature the speaking actor, another element of the used grammar, from the insertion

of the audio, which helps the hearing audience that is interacting with the Deaf community;

- The images used in the videos, in addition to the characters Levi and Sara, are structured in such a way that they can contribute to the understanding of the concepts presented in each video, as in the case of the division algorithm and the visual representation of the fraction 5/4, an example used during the text;
- One of the team's precautions is that the images and animations used in the production of the videos are not a "collage" of the textbooks, but that they are able to visually follow the reasoning of the signing actor/actress. We try to conceive images and animations that are able to produce meaning in a combined action with the signing and with the textual element.

However, the MathLibras team is aware that its contribution is still small compared to the size of the area of mathematics education, Deaf Education and an entire community that uses the Brazilian Sign Language. Nevertheless, it is understood that if more researchers and teachers join this purpose, that is, produce quality material from different areas directly in Libras, the entire community, Deaf and hearing, will benefit from it.

6 Concluding remarks

The MathLibras project has produced its materials from a committed study between the areas of Mathematics Education and Libras, considering the technical aspects of animation, in order to develop basic mathematical concepts for the teaching of Deaf children in their first language – students that sometimes are in the school environment without having had experiences that help them in this construction.

The whole proposal is based on the perspective of Nunes and Bryant (1997, p. vii), that consider it is important “how children learn mathematics as to what learning mathematics can do for their thinking”. Understanding mathematics and thinking mathematically is fundamental for any child in the school phase of the first years of instruction. Furthermore, we believe that offering mathematical concepts in Libras, with imagery support (Visual Pedagogy), can help to break down communication barriers that may still exist for the learning of the Deaf.

Considering the development of each subject, the MathLibras project has been deepening studies on the subjectivity of the Deaf, to increasingly qualify our productions, based on the specificities of this community learning process. The analysis carried out in this text, based on the Visual Grammar for digital videos in sign language, based on Rosado and Taveira (2022), prioritized concepts that support the visuality of Deaf subjects and their education towards visual aspects, based on elements carefully included in the videos.

In order to analyze three videos on fractions produced by MathLibras, based on the Visual Grammar, proposed by Rosado and Taveira (2022), it is suggested that using the assumptions of this grammar in the production of videos is important, since the basic constituent elements of the Visual Grammar for digital videos in listed sign languages constitute a guideline for researchers and teachers that produce videos in Libras, from any field of knowledge. Producing videos for the Deaf community requires knowledge about the field and about the specificities of the subject, as well as technical production skills. The purpose here was to encourage the practice of incorporating these seven elements into signed videos production, fostering more discussions and research around Visual Grammar, which is so important and constitutive of the Deaf experience.

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