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**MathLibras in the amusement park: a linguistic, mathematical and audiovisual resource analysis**

**MathLibras no parque de diversões: uma análise linguística, matemática e dos recursos audiovisuais**

**MathLibras en el parque de la diversión: un análisis de recursos lingüísticos, matemáticos y audiovisuales**

**MathLibras au parc d'attraction : une analyse linguistique, mathématique et des ressources audiovisuelles**

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**Abstract**

This article aims to present the analysis of the video Addition in Libras – Sum 5, from the MathLibras project, based on critical events selected by the authors, about the constructed narrative, considering the use of at least one of these three analytical parameters: linguistic, mathematical or audiovisual resources. The MathLibras project is developed at the Federal University of Pelotas and aims to develop Mathematics video lessons in Libras. Note that the video Sum 5 is an original production in Sign Language and not a translation. Some scenes

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were selected for the analysis of the video and considered as critical events by the team: (a) popcorn bag, (b) carousel, (c) ghost train and (d) Ferris wheel. As conclusions, the pattern in the narrative strategy used by the deaf actor stands out, which is the consecutive use of classifiers and imagetic descriptions and also the understanding that the parameters that build the narrative are inseparable, evidencing the joint work done by the team from initial video production, recording, to final editing.

**Keywords:** Mathematics teaching for deaf, Sign language, Video, Video lessons.

### Resumo

O presente artigo tem como objetivo apresentar a análise realizada do vídeo *Adição em Libras – Soma 5*, do projeto *MathLibras*, a partir de eventos críticos selecionados pelos autores, acerca da narrativa construída, considerando a utilização de ao menos um dos três parâmetros: linguístico, matemático ou recursos audiovisuais. O projeto *MathLibras* é desenvolvido na Universidade Federal de Pelotas e tem como objetivo o desenvolvimento de videoaulas de Matemática em Libras. Salienta-se que o vídeo *Soma 5* é uma produção original em Língua de Sinais e não uma tradução. Para a análise do vídeo, foram selecionadas algumas cenas, consideradas como eventos críticos pela equipe: (a) saco de pipoca, (b) carrossel, (c) trem-fantasma e (d) roda-gigante. Como conclusões, destaca-se o padrão na estratégia narrativa utilizada pelo ator/surdo, que é o uso consecutivo de classificadores e descrições imagéticas e, também, a compreensão de que os parâmetros que constroem a narrativa estão indissociados, evidenciando o trabalho conjunto feito pela equipe desde a produção inicial do vídeo, gravação, até a edição final.

**Palavras-chave:** Ensino de Matemática para surdos, Língua de sinais, Vídeo, Videoaulas.

### Resumen

Este artículo tiene como objetivo presentar el análisis del video *Adition in Libras - Suma 5* del proyecto *MathLibras*, a partir de eventos críticos seleccionados por los autores sobre la narrativa construida, considerando el uso de al menos uno de los tres parámetros: lingüístico, recursos matemáticos o audiovisuales. El proyecto *MathLibras* se desarrolla en la Universidad Federal de Pelotas y tiene como objetivo desarrollar videoclases de Matemáticas en Libras. Cabe tener en cuenta que el video *Suma 5* es una producción original en lengua de señas y no una traducción. Para el análisis del video, se seleccionaron algunas escenas, consideradas como eventos críticos por el equipo: (a) bolsa de palomitas de maíz, (b) carrusel, (c) tren fantasma y

(d) noria. Como conclusión, se destaca el patrón en la estrategia narrativa utilizada por el actor sordo, que es el uso consecutivo de clasificadores y descripciones de imágenes, y también el entendimiento de que los parámetros que construyen la narrativa son inseparables, evidenciando el trabajo conjunto realizado por el equipo, desde la producción inicial del video, la grabación hasta la edición final.

**Palabras clave:** Enseñanza de matemáticas para sordos, Lengua de señas, video, Lecciones en video.

### Résumé

Cet article a pour but de présenter l'analyse réalisée de la vidéo *Adição em Libras – Soma 5* (Addition en Libras – Somme 5), du projet MathLibras, à partir des événements critiques sélectionnées par les auteurs, à propos du récit construit, en considérant l'utilisation de, au moins, un des trois paramètres : linguistique, mathématique ou ressources audiovisuelles. Le projet MathLibras est développé par l'Université Fédérale de Pelotas et est destiné au développement de cours vidéo de Mathématiques en Langue des Signes Brésilienne. Il faut noter que la vidéo Somme 5 est une production originale en Langue des Signes et il ne s'agit pas d'une traduction. Pour l'analyse de la vidéo, ont été sélectionnées quelques scènes considérées comme des événements critiques par l'équipe : (a) sac de popcorn, (b) carrousel, (c) train fantôme, (d) grande roue. Comme conclusions, on souligne le modèle de stratégie narrative utilisée par l'acteur/sourd, c'est-à-dire l'usage consécutif des classificateurs et des descriptions imagétiques, aussi la compréhension que les paramètres qui construisent le récit sont indissociables, ce qui met en évidence le travail conjoint réalisé par l'équipe, de la production initiale de la vidéo à l'enregistrement et à l'édition finale.

**Mots-clés :** L'enseignement des mathématiques pour les sourds, Langue des signes, Vidéo, Cours vidéo.

## **MathLibras in the Amusement Park: a Linguistic, Mathematical and Audiovisual Resource Analysis**

The process of teaching Mathematics can take place in different ways, being one of them mediated by visual materials and technologies. From this perspective, this article presents an analytical description of a video lesson from the MathLibras project, which produces videos for teaching Mathematics in Brazilian Sign Language<sup>5</sup> (Libras), from the Federal University of Pelotas (UFPel).

Libras is recognized by Law No. 10.436 (Brazil, 2002) and regulated by Decree No. 5.626 (Brazil, 2005). This decree guarantees the right to education for Deaf people in schools and classes of bilingual education, both to Deaf and hearing students, with bilingual teachers in kindergarten and in the early years of Elementary School, as for the final years of Elementary School and High School, the presence of a Sign Language Translator and Interpreter (TILS) is guaranteed. According to the decree, schools or classes of bilingual education are those in which Libras and the written form of Portuguese are the languages of instruction used in the development of the entire educational process, and the Portuguese language, in that decree, is understood as a second language. Subsequently, Law No. 13.146 (Brazil, 2015), which is the Brazilian law for the inclusion of People with Disabilities, regards Libras as the first language of Deaf students, mentioning the provision of bilingual education. Thus, it is clarified that the Brazilian legislation highlights the *status* of Libras as the mother tongue or first language (L1) and written Portuguese as a second language (L2) for Deaf students (Brazil, 2015). Therefore, in this text we will use the definition of mother tongue which “is generally defined, for legal purposes, strictly, as the first language that an individual learns, communicates and identifies with” (Skutnabb-Kangas, 2006, p. 212).

However, it is known that there are few mathematics teachers with specialized training that would allow them to teach mathematics in Libras. Furthermore, the Licentiate Degree in Mathematics undergraduate courses lack modules that offer the licentiate knowledge and practices on how to teach Deaf students. There is only one mandatory Libras module (Brazil, 2005), which is not enough to meet all the demands for the training of Mathematics teachers for the Deaf.

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<sup>5</sup> According to Law No. 10.436/2002 (Brazil, 2002), Libras is recognized as a legal means of communication and expression, that is, the forms of communication and expression which presents a linguistic system of a visual-motor nature, constituting a linguistic system for transmitting ideas and facts from Deaf people’s communities in Brazil.

In this context, the MathLibras project was developed with the goal of elaborating didactic materials to promote the teaching-learning of Mathematics for Deaf students in order to prioritize teaching in their first language, Libras. MathLibras is the short name given to the project **Production of Mathematics video lessons with translation to Libras**, resulting from the call CNPq / MCTIC / SECIS nº 20/2016-Assistive Technology, funded by the National Council for Scientific and Technological Development (CNPq), between 2017 and 2019. During the project's duration with CNPq funding, twelve videos were produced, and after the end of the funding, still in 2019, three more videos were concluded.

The research developed within the project MathLibras at UFPel is still in process, and currently the team is composed by two Undergraduate research students with scholarships (one student from the Undergraduate course of Film and Audiovisual and one from the Undergraduate course in Languages – English/Portuguese Translation), a Master's student on Mathematics Education, a teacher from the area of Mathematics Education, a hearing teacher specialized in Libras and three Deaf teachers<sup>6</sup> that work teaching Libras (one of them holds a degree in Mathematics).

In 2020, due to the international pandemic scenario, the recording and editing processes of MathLibras videos were suspended, forcing the team to rethink ways to maintain the project, but with a different focus.

Thus, the project's current proposal is to evaluate the already produced videos, through the team's own scrutiny, by doing a detailed analysis of the videos available on the YouTube platform, taking into account three different parameters: (a) Linguistic, concerning the translation process Libras-Portuguese, focusing mainly on the use of classifiers and image description; (b) Mathematical, referring to linguistic, visual and algebraic representations; and c) Audiovisual Resources, analyzing the use of *Motion Graphics* for narrative contextualization.

It is important to point out that these elements are obviously complementary in the construction of the narrative presented in the videos, so they were selected as the analysis. The analyzed critical events (Powell et al., 2004) present these elements interconnectedly, and, sometimes, one stands out in relation to the others. The critical events analysis can help us to understand the interaction between the elements and the role they play in composing the narrative. This evaluation carried out by the team has the following goals: to qualify the videos

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<sup>6</sup> The three professors are tenured professors of Libras in public universities. One of them is pursuing a master's degree, the other two already have a master's degree, and one of them is pursuing a PhD.

to be produced in the future; to identify the intertwining of areas as well as the influence they act on each other; and to enable inferences for the restructuring of the project for the post-pandemic scenario.

Therefore, this article aims to present the analysis of significant elements that were identified by the production team regarding the constructed narrative of the video **Addition in Libras - Sum 5**<sup>7</sup>, considering the use of at least one of the three parameters: linguistic, mathematical and audiovisual resources.

Based on this objective, the group sought to answer questions such as: is the linguistic structure of the video appropriate for the narrative presented to Basic Education students? Is the mathematical concept easy for students to understand? Do the visual elements contribute to the acquisition of Libras and to the interpretation and resolution of the mathematical problem? Our hypothesis, as a research group, is that the narrative produced presents a complex strategy, which involves the three chosen parameters, throughout different scenes of the video.

### **Parameters**

Seeking to facilitate the understanding of the analysis proposed here, we will present the three basic parameters that the team has defined for the production of the videos, namely: (1) linguistic, (2) mathematical and (3) audiovisual resources. The choice of the three parameters was based on the fact that they are the basic ones from the construction of the script to the finalization of the edition, being complementary in the construction of the narrative presented.

### **Linguistic parameters**

The production of MathLibras video lessons goes through an intermodal translation process, that is, the translation occurs between language pairs of different modalities (Segala, 2010). Thus, Portuguese assumes the role of a second language (L2), in an oral-auditory modality (M2) for the Deaf, whose mother tongue (L1) is the sign language, that is, a visuospatial language (M1) (Mec, 2014).

According to Cruz (2016), the main difference between sign languages and oral languages lies in the modality. For the author, the articulators of sign languages and oral languages are different, since the oral languages have the tongue as the main articulator,

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<sup>7</sup> Video available at: [https://www.youtube.com/watch?v=s\\_Cb0Vky\\_Xc](https://www.youtube.com/watch?v=s_Cb0Vky_Xc). It is possible to activate English subtitles.

whereas sign languages have two independent articulators, but anatomically identical, which are the hands. Regarding this, the author points out that the signs could be broken down into parameters: handshape, location, movement, palm orientation and the production of non-manual expressions that can accompany the production of some signs.

Regarding the production analyzed here, we have access to the script in Portuguese (oral-auditory language) as the source text and the video lesson in Libras (visuospatial language) as the target text. This type of translation is between languages of different modalities, and thus:

[...] translation permeates the effects of modality and working with a signed language encompasses the mental representation of images that are proportionally formed as the sentences are elaborated and thus develops a spatial structure of signing, which is a cultural aspect of the language users, generating visual elements (Souza, 2018, p. 11).

Translating with this specific language pair generates multiple challenges when making references “[...] representing the naturalness of the collocations and ensuring the necessary fidelity of meaning” (Souza, 2018, p. 11-12). Carneiro (2016) points out that in sign languages, including Libras, there are linguistic resources capable of simultaneously transmitting a large amount of information using only one sign. By producing a sign, it is possible to extend its meaning and present characteristics of previous signs. Thus, it is possible to display pragmatic aspects of statements, in addition to reducing ambiguities through representations of the context (Kendon, 2000 apud Carneiro, 2016). Among the linguistic resources applied to signs are classifiers (CL) and imagetic descriptions (ID).

According to Carneiro (2016), classifiers can be described as signs composed of more than one morpheme – they are iconic structures in which each part is composed of a classifier morpheme that characterizes a group of referents. Some classifying morphemes are: "the handshape, the movement performed by the hand, the characteristic of the movement, the starting and ending point of the movement, and the palm orientation” (Carneiro, 2016, p.122). In sign languages, classifiers are associated with verbs of location and movement, not presenting “the primary function of classification” (Bernardino, 2012, p. 254), but rather of referents’ characterization.

For Campello (2008), imagetic descriptions can be understood as compositions that perform visual mediations between the image and its visual representation, enabling a more detailed and specific understanding of the elements that compose a narrative, adding visual characteristics that could aid “in the visual grammatical comprehension and translation” (Campello, 2008, p.152).

The ID are made up of transferences, which configure “the descriptive image relations in interpretive synthesis” (Campello, 2008, p. 21), and can be classified as: (a) size and shape transference (SST): transmits the size and/or the form of signs; (b) spatial transference (ST): characterizes the space where the signing occurs, it can represent different details from different points of view; (c) location transference (LT): it is related to the gravitational effect of the narrating process, considering the direction of the movements; (d) movement transference (MT): balances the visual aspect and can also give subjective characteristics to a sign, such as high-up signs as positive representations and lower-down signs as opposite and negative representations; (e) transference of incorporation (TI): it can encompass all other transferences, the difference is that the person signing uses his/her entire body to represent the aspects of a referent.

Thus, during the analysis, the term classifier (CL) will be used for situations in which only the handshape was changed to characterize the sign, and the term imagetic description (ID) for the use of the body beyond handshapes– given that both resources are used during the text narrative in Libras, aiming at a better visualization and understanding of the narration details.

### **Mathematical parameters**

The Mathematics teachings developed in the videos are based on the assumptions of Inclusive Mathematics Education, defended by *Working Group 13: Difference, Inclusion and Mathematics Education* (GT13), of the Brazilian Society of Mathematics Education (SBEM). In this case, the teaching of Mathematics for the Deaf has a socio-anthropological character, considering Deaf people as belonging to a minority linguistic group and as users of a language that presents a different modality.

The Mathematics video lessons produced in the MathLibras project present initial concepts to be developed in the first years of Elementary School with young children.

In the context of teaching Mathematics for Deaf children, it is necessary to consider that some students may present delays in the development of mathematical reasoning, not because of cognitive problems, but due to limited interactions before entering the school space, probably due to the scarce or non-existent access to information in Libras (Nunes *et al.*, 2013).

Therefore, the purpose of the videos produced within MathLibras is to present simple but yet visual mathematics processes associated to the children's daily issues, so that they can establish relationships and integrate meanings, as according to Nunes and Bryan (1997, p. 17), “children need to learn about math in order to understand the world around them”; and in this



context, learn Mathematics from their mother tongue, that is, Deaf children learning Mathematics in Libras.

Nunes and Bryan (1997, p. 31) present a discussion on the numeracy skills of children, and state that: “Having numeracy skills means thinking mathematically about situations. To think mathematically, we need to know the mathematical representation systems that we use as tools. These systems must make sense, that is, they must be related to the situations in which they can be used”.

To offer initial mathematical knowledge, MathLibras videos present a situation (story) with visual mathematical elements and, at the end, propose a mathematical challenge expressed in a question, which is initially solved by counting in Libras and then presenting the calculation algebraically.

One of the concepts explored is addition, one of Mathematics basic operations. "Understanding and using the operations depends on proposing problem situations that are meaningful to students." (Smole & Diniz, 2016, p. 23). In addition, “[...] by registering the way they solved the operation, the students make all their reasoning and the used procedures visible, also being able to compare their notes with those of other children” (Smole & Diniz, 2016, p. 25).

Based on this idea, a simple and basic mathematics is presented, introducing the Deaf student to mathematical calculation after viewing the story in its context.

### **Audiovisual Resources (Motion Graphics and audiovisual language)**

The main technical resource used in the MathLibras project is video, as it is the textual support that best suits Libras' visuospatial particularities. The videos' production consists of the following steps: preparation of the lesson script by teachers and students in the area of Mathematics Education; recordings of Deaf actors in studio using *chroma key*<sup>8</sup>; audio file production by a narrator; concluding with editing, animation, sound mixing and subtitling. The process respects the productive order commonly used in audiovisual productions, with some adaptations to the project's context.

Concerning the audiovisual tools used in the videos, this article seeks to focus on those that are characteristically part of *Motion Graphics* and their role as supporters and complements

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<sup>8</sup> *Chroma key* is a technical feature for overlaying video images. The technique consists of recording videos using a solid color background, usually green or blue, and subsequently applying color cancellation and image overlay, using a specific software.

of the narrative progression and the production of a visuality linked to visual representations. However, before presenting a more detailed discussion, it is necessary to introduce what are *Motion Graphics* and which one of these tools the project uses.

*Motion Graphics* is understood as “a specific area of audiovisual creation that results from the junction of processes and languages of design, cinema and animation” (VELHO, 2008, p. 20), thus presenting some characteristics from the precursors of the area, such as sharing a few technical apparatus regarding appropriations and consequent adaptations of linguistic apparatus.

Therefore, *Motion Graphics* manages to encompass the most diverse linguistic experiments, presenting varied applications. According to Gonçalves (2018), *Motion* can be used in opening and closing vignettes for television channels and programs, information exhibition on television grid, infographic support for journalistic programs, commercial cards, appearing, also, as an aesthetic resource in video clips, video art and experimental videos and, finally, as an infographic support for institutional and educational videos, as used in the project described here.

Especially for MathLibras videos, the main visual resources that are used are part of the apparatus of tools and techniques that *Motion Graphics* presents. Among these tools there are the composition of animated scenarios, the animated characterization of important objects for the narrative (in addition to the interaction between the Deaf actors and these objects) and the insertion of the project's characters, Sara and Levi. All these elements are designed aesthetically with vibrant colors and simple *design* to promote identification and easy assimilation by children. Furthermore, there is the addition of typographical texts that emphasize fundamental issues of the classes, such as the mathematical operations. It is important to highlight that subtitles are inserted in order to offer the translation for viewers that are not fluent in Libras, such as family members and teachers, as well as for Deaf people that are not fluent in Portuguese and who would like to study the language using the videos.

An important addition to the videos are the sound effects that, altogether with music and narration, make up a soundscape that also considers hearing people as the target audience of the video classes, whether they are educators, caregivers or people interested in learning the language. In his work about the importance of sound in cinema, Carvalho (2005) seeks to classify the different types of sounds and their narrative functions. The sound effect, then, is presented in the role of figurative sound, being “the one that has predominance in the image/action record due to its need to constitute a sign and that refers to a 'concrete' object.”

(Carvalho, 2005, p. 5). Therefore, in addition to emphasizing visual resources, it gives meaning to the exposed concepts and streamlines the hearing viewer's audiovisual experience.

### Methodology

The methodological proposal of this text is to analyze selected scenes about critical events from the video lesson **Addition in Libras - Sum 5**, considering the use of at least one of the following parameters: linguistic, mathematical or audiovisual resources.

The video that we have analyzed presents the narrative of the girl Sara (one of the regular characters of MathLibras) who goes to an amusement park with her family and is not afraid of the park's rides. At the very beginning, the character eats popcorn and rides on the Ferris wheel twice. Afterwards, the character walks through the park and enjoys other rides, such as the roller coaster, the carousel, the bumper car and the ghost train, as well as winning a prize in a target shooting. Then, Sara decides to ride the Ferris wheel again and, at this time, she rides it three times.

The mathematical content covered in the video is addition, as can be seen from its title, and it poses the following challenge to its target audience: *how many times has Sara ridden the Ferris wheel?* The challenge in this question is to understand and maintain information about Sara's trajectory throughout the narrative, since there is no linearity in her Ferris wheel rides: each one occurs intercalated between the other activities in the park. At the end of the video, the mathematical sum required to complete the proposed challenge is presented, totalizing five Ferris wheel rides ( $2 + 3 = 5$ ).

For the analysis and treatment of data, we chose to use the analytical method proposed by Powell et al (2004) which, according to Powell and Silva (2015), has seven interactive and non-linear phases: 1) observing the data from video, that is, carefully watching the video several times; 2) describing the video data, in a direct, non-interpretative way and separating it according to time, meaning or situation; 3) identifying critical events, which are events that demonstrate “a significant or constant change in relation to a previous understanding” (Powell et al., 2004, p. 104); 4) transcribing critical events; 5) coding, a phase dedicated to the analysis and identification of the contents/themes of critical events; 6) creating a plot, when the organization of critical events is proposed, using the previous established codes; and 7) composing a narrative, observing of the entirety formed by the seven phases.

This video was planned for a specific audience: Deaf children from the early years of Elementary School. The scenes were selected by the group of researchers based on the identification of critical events throughout the video.

Subsequently, the results and the discussion will be presented. We have opted to present the discussions in the same section, and for each critical event highlighted (a selected scene) we present the theoretical discussion of the elements that compose it: linguistic, mathematical, and audiovisual resources, as previously mentioned.

For a better contextualization, images of the selected scenes will be presented, the parameter(s) involved will be identified, and the perspectives on how the group understands the critical event will be put forward.

## **Results and discussion**

As presented in Powell et al. (2004), critical events can be chosen because they represent moments when a constant was maintained or was changed, which can result in the confirmation or refutation of research hypotheses. Subsequently we will present the descriptions and analyses of four critical events selected from the video **Addition in Libras – Sum 5**.

The selected critical events were: 1) bag of popcorn; 2) carousel; 3) ghost train and 4) Ferris wheel. The selection of these events was based on the understanding of the group that they would provide the analysis of the required elements, namely, linguistic structure, mathematical concept and visual elements. It is noteworthy that other analyzes can be made from the video, both with other events and with other parameters.

### **Popcorn bag and one-handed signing**

At one minute and seventeen seconds (00:01:17), the Deaf actor uses a classifier for the verb 'to walk', indicating that Sara would be heading somewhere. The classifier indicates a girl's walk. It is noticed that the Deaf actor embodied the character Sara, becoming a narrator-character. In Libras, the narrative requires the use of character features incorporation (Garrutti-Lourenço et al., 2017), mainly through the use of body and facial expressions, each occupying mentally defined spaces. Sara is faced with a queue to buy popcorn. At one minute and twenty-one seconds (00: 01: 21), the Deaf actor indicates that someone hands Sara a package of popcorn of considerable size, using a classifier to highlight the size of the bag of popcorn with both palms facing toward the center, half open. When Sara picks up what would be the bag, in the space in front of her face, the animation of a popcorn bag appears (*fade in*), as shown in Figure 1.



Figure 1.

*Critical event "popcorn bag" (Video Addition in Libras – Sum 5, 2019)*

Afterwards, the Deaf actor puts the bag of popcorn in one of his arms. To do this, he makes a circumference with his arm, creating an inferential space filled by the bag of popcorn, and starts eating with the other hand. Sara watches the Ferris wheel, and signs with her free hand (the hand that she is eating popcorn with). The Deaf actor continues to sign with only one hand, as the other one is occupied with the bag of popcorn, as shown in Figure 2.



Figure 2.

*Signing with and without the popcorn bag (Video Addition in Libras – Sum 5, 2019)*

The signer, personified as Sara, looks at the Ferris wheel and says to himself: “*I'm not afraid!*”, then talks to the audience and asks, using the third person singular pronoun: “*Are you afraid?*”. Then, the Deaf actor continues to eat popcorn, until one minute and thirty-six seconds (01:36:00), when he returns to the role of narrator-observer, without the popcorn bag in his arm (Figure 2).

**Carousel**

We have selected the critical event “Carousel” (00:02:30 – 00:02:42) because it contributes to the analysis of the hypothesis related to the use of classifiers followed by

imagetic description, in order to add details, characteristics and specificities about each ride in the amusement park presented in the video lesson. Furthermore, the analysis of this event also supports the understanding of the presence and relationship of animation along with linguistic aspects.

At two minutes and thirty seconds (00:02:30), the animation (*Motion Graphics*) of a carousel appears (*fade in*) in the background, as shown in Figure 3. The Deaf actor enumerates the ride, showing that it is the third one and, with a neutral facial expression, performs the sign “horse” with his right hand. Keeping the handshape, he rests it on the left hand, which is lying down, in a “B” handshape, and with the palm facing right. Afterwards, the right hand performs a circular movement with the index finger raised, while the left hand is at rest next to the Deaf actor's body.

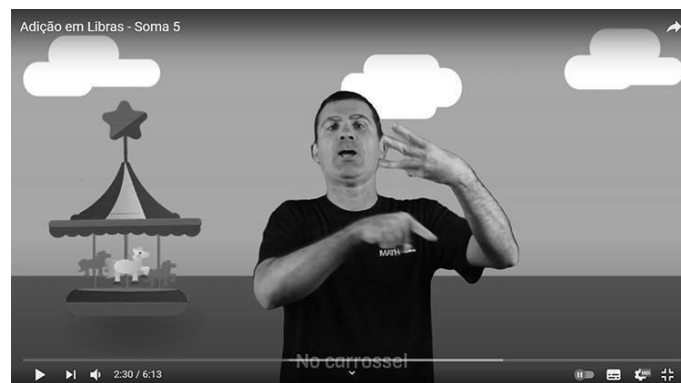


Figure 3.

*Critical Event "carousel" (Video Addition in Libras – Sum 5, 2019)*

At two minutes and thirty-four seconds (00: 02: 34), the carousel image disappears (*fade out*). Then, the Deaf actor keeps one hand over the other in an “S” handshape. Afterwards, smiling openly, his body performs up and down movements, flexing the knees; meanwhile, his right hand is open, waving in various directions, and his left hand remains in the previous position.

The described critical event could be divided into two moments (Figure 4). In both moments the Deaf actor chooses to use different linguistic resources to describe the ride. In the first moment (left part of Figure 4), the sign “Carousel” is performed using only handshapes related to the composition and functioning of the ride. However – after the carousel image *fades out* –, in the second moment of the critical event (right part of Figure 4), the Deaf actor changes his signing, making reference to the act of riding the carousel, demonstrating the action performed by the character Sara.



Figure 4.

*First and second part of the critical event "Carousel" (Video Addition in Libras – Sum 5, 2019)*

Thus, in the first part, when signing “carousel”, the handshape characterizes and represents the objects that compose it (horses) and the action required to ride it (verb “to ride”), as shown on the left part of Figure 4. In addition to that, there is also the representation of the referent's circular movements, shown in Figure 5. Thus, since classifiers are iconic structures connected to handshapes and that characterize referents, it is possible to conclude that at the first moment of the critical event, this resource is used.

Another issue that also contributes to the understanding of the use of CL is the fact that at this first moment the facial and body expressions of the Deaf actor remain neutral, leaving only the hand movements in evidence, a process that can also be identified in Figure 5.

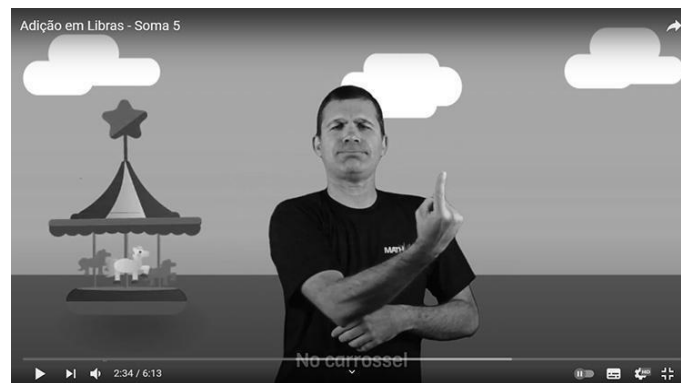


Figure 5.

*Facial expression and circular movement (CL) of the critical event “Carousel” (Video Addition in Libras – Sum 5, 2019)*

At the end of the signing with the use of classifiers, the Deaf actor changes his narrative strategy, and starts to use imagetic descriptions, specifically for the use of incorporation transference - which encompasses in itself all other types of transferences. Therefore, he uses his entire body to represent aspects of the referent, and in this case, to represent the character

Sara riding on the carousel and waving to the people around her, taking the signing beyond the mechanical movements produced by the ride.

Furthermore, when performing this transference of incorporation, the facial expressions of the Deaf actor are no longer neutral, and he finds himself smiling intensely to express the joy of the child character. Both the transference of incorporation and the changes in the linguistic parameter are shown in Figure 6.



Figure 6.

*Transference of incorporation (ID) and facial expression in the critical event "Carousel"  
(Video Addition in Libras – Sum 5, 2019)*

During the analysis of the critical event "Carousel", it was possible to observe that the use of classifiers is followed by the use of imagetic description, and the order that these resources were used caused an influence in the process of *fade in* and *fade out* background images of the carousel. While there is the mechanical and compositional description of the ride using CL, the carousel image *fades in* and remains until the end of the critical event first part, being *faded out* when the Deaf actor resorts to the use of imagetic description. Therefore, the joint action of two analysis parameters selected for this work were found: the linguistic and the use of audiovisual resources – both were highlighted in the same event.

The next critical event that will be described and analyzed is the ghost train ride. This event occurs shortly after the critical event "carousel", according to the chronological order of the video lesson.

### **Ghost train**

The critical event "Ghost train" (00:02:44–00:02:47) starts with the enumeration, which shows that it corresponds to the fourth ride in the list. At two minutes and forty-five seconds (00:02:45), the image of a train with ghost images around it *fades in* – at the same time, the



Deaf actor is with his arms raised, his palms facing forward and his fingers bent; his eyes are wide open, as is his mouth (Figure 7, left side), representing a ghost. Then, with a neutral facial expression, he places both hands forward, at the height of his chest, with both palms facing each other and with the middle and ring fingers of each hand in contact, he performs an opening movement, moving the hands away in opposite directions and forward. The image of the ghost train disappears. The Deaf actor smiles and his hands seem to hold a cart iron bar in front of him, his body moves from left to right simultaneously, his gaze goes in different directions, while his facial expression is of fear (Figure 7, right side). Finally, the Deaf actor once again raises his arms, puts his palms forward, with his fingers curled, his eyes and mouth wide open, and leans his body back and forth.

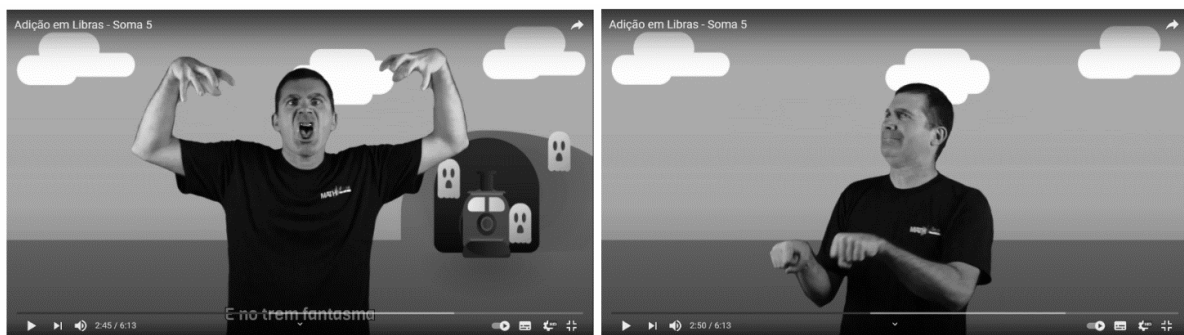


Figure 7.

*Ghost representation and holding the cart iron bar (Video Addition in Libras – Sum 5, 2019)*

The described event initially presents the use of classifiers to characterize the ghost train, aided by the ride's image in the background. As can be seen in Figure 8, iconicity is present to characterize the referent, in this case, the external part of the ride and its characteristic entrance gate. Furthermore, this classifier appears in the scene accompanied by the animated appearance (*fade in*) of the ghost train image, which plays the role of both a visual aid for viewers that may be unfamiliar with the presented word as well as being part of the video imagetic and narrative composition.



Figure 8.

*Opening of the ghost train entrance gate (Video Addition in Libras – Sum 5, 2019)*

Then, the ghost train image disappears, after fulfilling its function as a symbol and thus giving more space on screen for the Deaf actor to change his narrative strategy, thus using imagetic description by incorporation transference, in which he uses the entirety of his body to represent the character Sara riding it, moving the body in irregular directions due to the way the ride's cart moves. The use of ID is also highlighted by the facial expressions of the Deaf actor, which are intense and describe the feelings of dread and fear generated by the ghost train, observed in Figure 9.



Figure 9.

*Fear in the ghost train (Video Addition in Libras – Sum 5, 2019)*

In addition to the imagetic description and the ride's image, sound effects of the train tracks and a witch's laughter are used. These sounds fulfill one of the three levels of sound effect comprehension proposed by Carvalho (2005), in which the sound has a direct connection with its source. Concerning this specific critical event, the word *ghost train* is presented by the Deaf actor and receives visual reinforcement from the image, that corroborates for the assimilation of meaning and its importance within the narrative. Moreover, the sounds typically produced by train tracks and the strident laughter that make up the representation of witches in the Western imagination enhance this symbol and provide another layer for the apprehension of the word presented. In this case, “this sound effect affirms the visual image as believable and represents its object in the most complete and realistic way” (Carvalho, 2005, p. 10). When presented together, the visual resources, the language parameters, and the sound effects, act as a support of one of the main pillars of the video's structure, which is storytelling – and highlights that the analysis parameters can be presented simultaneously.

**Ferris wheel**

The episodes with the Ferris wheel appear in two moments of the video, so we chose to select these critical events (00:01:25-00:02:04 and 00:03:27-00:03:50) because they contribute to the mathematical analysis of the story, since this ride refers to the challenge proposed at the end of the video lesson, in addition to the presentation of linguistic and audiovisual elements in these scenes. Due to the challenge being presented in the sequence, we have decided to firstly describe the two episodes and afterwards the other highlighted events.

The Deaf actor starts by using the classifier "big wheel" with only one hand, and the handshape representing the number "5" in a circular motion, since in his other hand he still has the popcorn bag, and in this moment the Ferris wheel image appears (*fade in*) in the background (00:01:27). Soon after this, he expands the movement using an ID, because as he looks up, he sees the Ferris wheel, relating this movement to the object's height. At one minute and thirty-five seconds (00: 01: 35) there is an ellipse<sup>9</sup> and the popcorn bag fades out, releasing the Deaf actor's hands for signing. The narrator, when telling the story, states that the Ferris wheel is Sara's favorite ride, and that she rides it twice as soon as she arrives at the park. The Deaf actor signs as Sara enters the ride, using a complete circular movement twice with his hand, representing one ride on it. The counting (of number of rides) is carried out from the "sparkling" of the Ferris wheel (00:01:54 and 00:01:59), as shown in Figure 10, in which the Ferris wheel appears a little bigger, touching the clouds, that is, the visual element directly contributes to the mathematical element.

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<sup>9</sup> The ellipse is a narrative resource widely used in literature, cinema and audiovisual as a whole. It consists of the deliberate omission of information and events, allowing the reader/spectator to fill in the narrative gaps. In the specific case of audiovisual, the ellipse tends to appear in the form of temporal leaps, attributing to the spectator the function of assimilating on their own the actions that were implied.

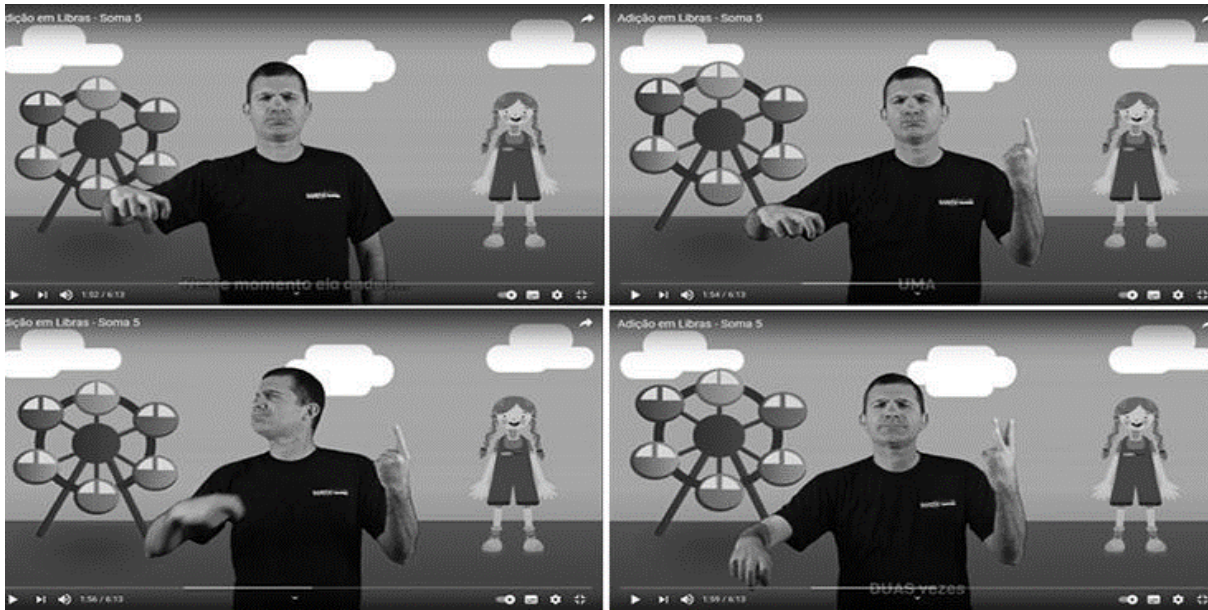


Figure 10.

*Ferris wheel “sparkling” twice (Video Addition in Libras – Sum 5, 2019)*

It is possible to observe in Figure 10 that the Deaf actor signs “1” and “2” with his hand, accomplishing the count. In this specific moment, it is possible to establish a relationship between the counting in Libras and the counting that may be performed by a hearing person, since the numbers 1 and 2 in Libras and the gestures of Brazilian culture that identify the units 1 and 2 are identical. At two minutes and four seconds (00:02:04), the Ferris wheel image disappears (*fade out*) and the narrator continues the story.

After going on other rides, Sara returns to the Ferris wheel, and the ride's image appears in the background (00:03:32). She rides it three more times (00:03:37, 00:03:42, 00:03:47), which are represented with the “sparkling” of the ride at each count, following the same idea presented in Figure 10. The Deaf actor signs “1”, “2” and “3”. At three minutes and fifty seconds (00:03:50), the Ferris wheel image disappears, and the narrator proposes the mathematical challenge.

In this story, the proposed challenge is: *how many times did Sara ride the Ferris wheel?* (00:03:52-00:04:01). The narrator continues to recall Sara's first moment in this ride, counting: 1, 2 (Figure 11). It is noteworthy that the Ferris wheel image (00:04:13) appears again in the background, in order to visually contribute to the counting process, that is, again the interaction between the visual and the mathematical.



Figure 11.

*First time on the Ferris wheel (Video Addition in Libras – Sum 5, 2019)*

The Deaf actor uses one of his hands to keep a sign of number 2 (00:04:18), using Heitkoetter and Xavier’s (2020) proposal called the buoy structure. According to the authors, by citing the production of Liddell (2003), when performing signs that are analogous to real buoys, the non-dominant hand “keeps floating in the air”, that is, it is suspended in the signing space during the production of other signs by the dominant hand. Subsequently, the Deaf actor presents the sign for *plus* in Libras, which is an iconic sign (+): in Libras, the signs that present some feature in common with the referred object are called iconic signs (Frydrych, 2012). At this point, it is possible to state that Libras, as an idiom, and Mathematics, as a language, are sharing the same representation.

Subsequently, the Deaf actor continues counting. In his left hand, he keeps the sign for number “2”, referring to Sara’s first ride on the Ferris wheel, which, in the addition process, is referring to the first portion’s calculation. In this case, the non-dominant hand of the Deaf actor “keeps the number” and the dominant hand inserts new quantities that are added to the one in the non-dominant hand. Then, the other three rides are added one by one, adding the number of the right hand into the left hand, as can be seen in Figure 12. At this point, it is possible to observe the perseverative capacity of the buoys, which Heitkoetter and Xavier (2020) highlight as one of the striking differences between sign languages and spoken languages. According to the authors, due to the acoustic nature of words, they do not physically integrate meaning after they are emitted. Thus, the lexical items of spoken languages cannot be touched or manipulated, as it is possible with signs, in this case, with the buoys.



Figure 12.

*Adding the number 3 to the number 2 (Video Addition in Libras – Sum 5, 2019)*

At the end, the Deaf actor asks the target audience for the result and congratulates whoever reached the result (number 5), which was evidenced in his left hand (00:04:14 - 00:04:37).

Considering the need to teach Deaf children the mathematical language, the representation of this calculation from the mathematical symbols is presented below, using the digits (00:04:40 - 00:04:53), as shown in Figure 13.



Figure 13.

*Calculation  $2 + 3 = 5$  using mathematical symbology (Video Addition in Libras – Sum 5, 2019)*

In the presented calculation, the digits 2, 3 and 5 are used, as well as the signs of “plus” and “equal”. The calculus is presented vertically, because the proposal is to show to the little ones the mathematical symbols that can be used in this representation, and not exactly to teach the mathematical algorithm of addition (horizontal operations). Mathematics is approached when teaching children in the 1st year of Elementary School, with children presenting the average age of 6 years old, focusing on the basic conceptual understanding of this operation, corroborating the ideas of Nunes and Bryant (1997).

This understanding of addition and, consequently, subtraction, can be understood from problem solving (Nunes & Bryant, 1997). MathLibras videos bring forward this proposal: short stories that will generate a challenge, a (simple) problem to be solved, seeking to simultaneously understand the mathematical ideas/concepts taught in the natural language of Deaf people, that is, Libras.

### **Final remarks**

Teaching Mathematics to Deaf children is a challenge, especially when it is conducted in Libras. In the case of MathLibras, as a teaching material, the videos were designed for the Deaf audience and total linguistic liberty was given to the Deaf actor to recompose the script in Libras. Therefore, it is possible to perceive in the videos the ubiquity of the mathematical proposal, the audiovisual resources, and the narrative structure to the target audience.

In this sense, the video was not the production of a sign language translation of a didactic material produced for hearing children. The video was an original production in Libras, for Brazilian Deaf children, following the proposition of Nogueira and Zanquetta (2013, p. 39, our translation): “the school should not be limited to just 'translating', into sign language,

methodologies, strategies and procedures of the common school, but it must continue to be concerned with organizing activities that provide a qualitative leap in the thinking of the Deaf”.

When analyzing the selected critical events, a pattern in the narrative strategy used by the Deaf actor was evidenced. In the critical events, it was possible to observe the use of classifiers followed by imagetic descriptions to describe the rides and actions performed in the amusement park. Thus, at first there was a more mechanical description of rides, with changes only in handshapes – characterizing the use of CL.

Subsequently, the description is related to the incorporation of the character going on different rides, in addition to showing the emotions experienced in the process through facial expressions – characterizing the use of ID (through incorporation transference). The way in which the Deaf actor used linguistic resources to describe the rides in the amusement park, combined with audiovisual resources (use of *Motion Graphic*) helps to make them understandable even to members of the target audience who, by chance, are not familiar with these rides.

As discussed at the beginning of the text, it was known that the analyzed parameters (linguistic, mathematical, and audiovisual resources) would not individually compose the narrative. However, the analysis of critical events revealed that there is a greater inseparability than we have initially imagined. Thus, it is possible to infer that teamwork in the production of the script, in rehearsals and the discussions on linguistic and animation solutions have contributed to the production of the video.

It is possible to conclude, therefore, that the selected critical events do not refer only to mathematical issues, but to a complex narrative strategy developed as a whole between the three parameters analyzed, found in many moments in the video: the mathematical utterance is linked, inextricably, to linguistic strategies and audiovisual solutions to make the narrative comprehensible.

These inferences and conclusions are important to guide the team regarding the production of new scripts and videos, both concerning the Deaf actor performance and the role of audiovisual resources.

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### **Authors' contribution**

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Author 2 - Project Coordinator, active participation in data analysis, writing and reviewing the final text.

Author 3 – Undergraduate research student (scholarship holder) of the project, data collection, data analysis and text writing.

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### **Conflict of interest statement**

The authors declare that there is no conflict of interest.

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