Production of a guide in Brazilian Sign Language for chemical laboratory utensils

Produção de guia em Libras para utensílios de laboratório químico

Producción de una guía en lengua de señas para utensilios de laboratorio químico

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ABSTRACT
The inclusion of deaf people in the Brazilian educational system is guaranteed by the use of Brazilian Sign Language (Libras). It is important that the learning process of these students, especially when dealing with abstract concepts such as those related to Chemistry, is offered based on teaching tools that cover this language. The objective of this work was to develop a guide with signs in Libras, already existing in the literature, of chemistry laboratory materials as a didactic device aiming to promote inclusion and facilitate access to experimental chemistry teaching for deaf students. The work began with meetings to plan the preparation of the booklet and choose the most common materials in laboratory classes (analytical balance, volumetric flask, beaker, burette, Erlenmeyer flask, funnel, suction bulb, volumetric and graduated pipettes, beaker and glass clock) accompanied by searching for the corresponding sign in Libras. The guide was created considering the five Libras parameters: point of articulation, movement,
facial/body expression, configuration and orientation of the hands. Therefore, the material created constitutes a facilitator and important tool for interaction between teacher and student in laboratory classes, resulting in a more dynamic and efficient teaching and learning process for the target audience.

**Keywords:** didactic tool, inclusion, interaction, chemistry laboratory, sign language.

**RESUMO**
A inclusão dos surdos no sistema educacional brasileiro é garantida pela utilização da Língua Brasileira de Sinais (Libras). É relevante que o processo de aprendizagem desses alunos, sobretudo ao tratar de conceitos abstratos como os relacionados à Química, seja ofertado com base em ferramentas didáticas que contemplem essa língua. O objetivo deste trabalho foi elaborar um guia com os sinais em Libras, já existentes na literatura, de materiais do laboratório de Química como artifício didático visando promover a inclusão e facilitar o acesso ao ensino de Química experimental para os alunos surdos. O trabalho iniciou com reuniões para planejamento da elaboração do guia e escolha dos materiais mais usuais nas aulas de laboratório (balança analítica, balão volumétrico, béquer, bureta, erlenmeyer, funil, pera de sucção, pipetas volumétrica e graduada, proveta e vidro de relógio) acompanhado pela pesquisa do sinal em Libras correspondente. O guia foi construído considerando os cinco parâmetros da Libras: ponto de articulação, movimento, expressão facial/corporal, configuração e orientação das mãos. Diante disso, o material elaborado constitui uma facilitadora e importante ferramenta de interação entre professor-aluno nas aulas de laboratório, resultando em um processo de ensino e aprendizagem mais dinâmico e eficiente para o público-alvo.

**Palavras-chave:** ferramenta didática, inclusão, interação, laboratório de química, língua de sinais.

**RESUMEN**
La inclusión de las personas sordas en el sistema educativo brasileño está garantizada por el uso de la Lengua de Señales Brasileña (Libras). Es importante que el proceso de aprendizaje de estos estudiantes, especialmente cuando se trata de conceptos abstractos como los relacionados con la Química, se ofrezca en base a herramientas didácticas que abarquen este lenguaje. El objetivo de este trabajo fue desarrollar una guía con signos en Libras, ya existente en la literatura, de materiales de laboratorio de Química como dispositivo didáctico con el objetivo de promover la inclusión y facilitar el acceso a la enseñanza de la Química experimental de estudiantes sordos. El trabajo se inició con reuniones para planificar la elaboración del cuadernillo y elegir los materiales más habituales en las clases de laboratorio (balanza analítica, matraz aforado, vaso de precipitado, bureta, matraz Erlemeyer, embudo, pera de succión, pipetas aforadas y graduadas, vaso de precipitado y reloj de vidrio) acompañado de la búsqueda del signo correspondiente en Libras. La guía fue creada considerando los cinco parámetros de Libra: punto de articulación, movimiento, expresión facial/corporal, configuración y orientación de las manos. Por lo tanto, el material creado constituye un facilitador e importante herramienta para la interacción entre docente y alumno en las clases de laboratorio, resultando en un proceso de enseñanza y aprendizaje más dinámico y eficiente para el público objetivo.

**Palabras clave:** herramienta didáctica, inclusión, interacción, laboratorio de química, lengua de señas.
1 INTRODUCTION

Education for the deaf in Brazil began during the Second Empire, marked by the promulgation of Law 839, signed by D. Pedro II on September 26, 1857. This law established the National Institute for Deaf Mutes (INSM), later renamed the National Institute of Deaf Education (INES), headquartered in Rio de Janeiro (Reis e Silva, 2012). After the World Conference on Special Education in Salamanca, Spain, the movement for the integration of students with special needs into regular schools gained strength. The Salamanca Statement (BRAZIL, 1994) advocated for the inclusion of these students with support or assistance from the regular education system to prevent failure in inclusion.

In 1996, the Law of Guidelines and Bases of National Education (LBD, in Portuguese) (BRAZIL, 1996) was enacted, which determined that all students with special needs should preferably receive education in regular schools, with specialized services to assist them. Law 10,436, enacted on April 24, 2012, recognized Brazilian Sign Language (Libras) as a legal means of communication and expression. This language, of visual-motor nature and with its own grammatical structure, represents an important milestone for the deaf communities of Brazil (Ferreira et al., 2014).

Through Decree 5,626 of December 22, 2005, Law 10,436/02 was regulated, and Libras was included as a mandatory curriculum subject in teacher training courses, both at the high school and higher education levels, and in Speech Therapy courses, in public and private educational institutions (BRAZIL, 2005). This decree recognizes various courses as teacher training, including undergraduate courses in different areas of knowledge, high school normal courses, higher normal courses, Pedagogy courses, and Special Education courses.

A recent achievement for the deaf community was the enactment of Law No. 14,191 in August 2021, which aims to guarantee respect for the human, linguistic, cultural, and identity diversity of deaf, deaf-blind, and hearing-impaired people. This law inserted the Bilingual Education modality for the deaf in the LDB, providing for integrated teaching and research programs to offer bilingual and intercultural school education to deaf students (BRAZIL, 2021).

Despite the advances provided by legislation, offering quality inclusive education for deaf people remains a significant challenge. According to Benite (2011), in Chemistry education, deaf students may be at a disadvantage compared to their peers, as many chemical concepts
are acquired through hearing. However, as noted by Dizeu and Caporali (2005), deaf individuals have the same learning conditions as hearing individuals, but language development occurs through the gesture-visual channel, as opposed to the oral-auditory channel.

Science aims to explain nature, and it is through experiments that students gain a more scientific understanding of the transformations that occur in it (Farias, Basaglia; Zimmermann 2009). However, Marin et al. (2018) emphasize that many students have difficulty with experimental activities because they are not familiar with the glassware and equipment used for practical activities. Therefore, it is important to produce materials that assist in the presentation of these materials, especially those that are more commonly used in laboratory classes.

In this context, it is necessary to rethink pedagogical practices to favor the acquisition of such concepts by deaf students. Lima and Almeida (2013) highlight the importance of developing and using materials with visual resources in the experimental teaching of Chemistry for this audience. Therefore, it is essential to develop inclusive pedagogical strategies capable of promoting access to and understanding of Chemical concepts.

Given this scenario, the present study aimed to construct a guide in Libras with the main laboratory equipment and glassware for Chemistry, aiming to promote inclusion and facilitate access to experimental Chemistry teaching for deaf students.

2 METHODOLOGY

The study is of a qualitative participatory nature with an expository and inclusive focus on experimental Chemistry teaching for deaf students at the Federal Institute of Bahia - Guanambi campus. According to Brandão (1984), this type of study includes the researcher as an integral component of the elaborated object. Therefore, the participatory qualitative methodology with an expository focus involves not only the active immersion of researchers in the study context and interaction with participants but also the clear and understandable presentation of research results in an accessible and useful way for interested audiences.

The research was conducted between February and May 2021. During this period, due to the Covid-19 pandemic, caused by the novel coronavirus (Sars-Cov-2), isolation measures were adopted by the WHO (World Health Organization), including the closure of educational environments. For this reason, all activities of the work were conducted remotely.
The methodological development involved three stages, as presented in Figure 1.

Figure 1. Fluxogram of the methodology used.

2.1 BIBLIOGRAPHIC SURVEY

The first systematic action was carried out through a bibliographic mapping, specifically in scientific articles involving the study's theme and in reference dictionaries of the language. Signs were selected from scientific articles such as "GLOSSARY OF GLASSWARE: SUPPORT MATERIAL FOR TEACHING STUDENTS WITH DISABILITIES" from the Federal University of Rio Grande do Norte (FURG) (Teixeira et al., 2017), "GLOSSARY IN LIBRAS FOR CHEMISTRY LAB GLASSWARE" from the Federal Institute of Goiás, Itumbiara campus (Silva et al., 2018), and "EXPERIMENTAL CHEMISTRY SIGNS IN LIBRAS: Building Communication Between Teachers and Deaf Students" from the Federal University of Maranhão (UFMA) (Lages et al., 2018), as well as from two of the main existing Libras dictionaries: the Digital Dictionary of Brazilian Sign Language version 3.0 from 2011, available on the National Institute of Deaf Education (INES) website, and the Trilingual Illustrated Encyclopedic Dictionary of Brazilian Sign Language (Capovilla; Raphael, 2018).
Based on the bibliographic information, the equipment and glassware that were part of the guide were selected: analytical balance, volumetric flask, beaker, burette, Erlenmeyer flask, funnel, suction bulb, volumetric and graduated pipettes, graduated cylinder, and watch glass.

2.2 PLANNING

Virtual meetings were held via the Google Meet platform to develop the planning regarding the construction of the didactic tool. Chemistry teachers, Libras interpreters, and students from the Bachelor's Degree in Chemistry at the Federal Institute of Bahia - Guanambi Campus participated in the meetings.

2.3 ACTIVE CONSTRUCTION

The active development of the guide involved step-by-step photographic documentation with descriptions of the execution stages of each sign for the presentation of the guide, focusing on the execution of the Libras sign for each laboratory glassware, observing the 5 linguistic parameters as recommended by Quadros and Karnopp (2004), namely: point of articulation (PA), hand configuration (HC), movement (M), hand orientation (HO), and non-manual signals (NMS).

According to experts in the structural study of Libras such as Capovilla et al. (2013) and Brito (2015), the LA comprises the region where the sign will be executed, with the main ones being: head, hand, trunk, or neutral space (away from the body). For Pereira (2010), the HC consists of the hand configuration that determines the sign. According to INES (2017), there are seventy-nine (79) identified HCs to date (Figure 2).
The M is related to the characteristics of hand movement during sign execution. It is subdivided into other aspects such as frequency (with or without repetition), manner (calm, fast), direction (from top to bottom, forward), and type (straight, circular) (Ferreira et al., 1990). The HO is based on the position to which the palm of the hand is pointing, and the ENM on body movement (trunk and head) and facial expressions (Ferreira, 2010).

After the guide was developed, the teaching material was presented to Chemistry teachers, sign language interpreters, deaf and blind students, as well as to students of the Chemistry Teaching degree at the Federal Institute of Bahia - Guanambi Campus.

Next, the material was made available for access through the following link: https://1drv.ms/b/s!Ao4MyEYX_BGkCyq8vU4X955ag2W?e=yB61JS.
3 RESULTS AND DISCUSSION

The guide was developed taking into account the signs found in the bibliographies. It demonstrates how the signs are performed, as well as the glassware to which they refer (shown in Table 1).

Table 1. Signs for chemistry laboratory glassware and equipment.

<table>
<thead>
<tr>
<th>VOLUMETRIC FLASK</th>
<th>PARAMETERS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hand Configuration: 56 and “S”</td>
<td></td>
</tr>
<tr>
<td>Point of Articulation: neutral space</td>
<td></td>
</tr>
<tr>
<td>Hand Orientation: up</td>
<td></td>
</tr>
<tr>
<td>Movement: up</td>
<td></td>
</tr>
<tr>
<td>Facial/body expression: wither the cheeks</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>BEAKER</th>
<th>PARAMETERS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hand Configuration: “C” and 56</td>
<td></td>
</tr>
<tr>
<td>Point of Articulation: neutral space</td>
<td></td>
</tr>
<tr>
<td>Hand Orientation: up</td>
<td></td>
</tr>
<tr>
<td>Movement: upwards</td>
<td></td>
</tr>
<tr>
<td>Facial/body expression: neutral</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>BURETTE</th>
<th>PARAMETERS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hand Configuration: 26 and “Y”</td>
<td></td>
</tr>
<tr>
<td>Point of Articulation: neutral space</td>
<td></td>
</tr>
<tr>
<td>Hand Orientation: left and right</td>
<td></td>
</tr>
<tr>
<td>Movement: rotary (represent opening and closing the tap at the bottom)</td>
<td></td>
</tr>
<tr>
<td>Facial/body expression: neutral</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Erlenmeyer</th>
<th>PARAMETERS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hand Configuration: &quot;O&quot; and 56</td>
<td></td>
</tr>
<tr>
<td>Point of Articulation: neutral space</td>
<td></td>
</tr>
<tr>
<td>Hand Orientation: upwards</td>
<td></td>
</tr>
<tr>
<td>Movement: circular (hand in &quot;O&quot; configuration)</td>
<td></td>
</tr>
<tr>
<td>Facial/Body Expression: neutral</td>
<td></td>
</tr>
<tr>
<td>Instrument</td>
<td>Parameters</td>
</tr>
<tr>
<td>------------------------------------</td>
<td>----------------------------------------------------------------------------</td>
</tr>
</tbody>
</table>
| Pisset or dosing bottle            | **Hand Configuration:** "C" and "X"  
                             **Point of Articulation:** neutral space  
                             **Hand Orientation:** forward/downward  
                             **Movement:** No movement  
                             **Facial/Body Expression:** Neutral |
| Wristwatch glass                   | **Hand Configuration:** "S" and "V"  
                             **Point of Articulation:** back of the hand  
                             **Hand Orientation:** upward and downward  
                             **Movement:** repetitive on the back, up and down  
                             **Facial/Body Expression:** Neutral |
| Test tube                          | **Hand Configuration:** 56 and "O"  
                             **Point of Articulation:** neutral space  
                             **Hand Orientation:** upward  
                             **Movement:** from bottom to top  
                             **Facial/Body Expression:** cheeks sagging |
| Funnel                             | **Hand Configuration:** 18 and 17  
                             **Point of Articulation:** neutral space  
                             **Hand Orientation:** Left/right  
                             **Movement:** from top to bottom  
                             **Facial/Body Expression:** neutral |
| Volumetric pipette                 | **Hand Configuration:** "B" and "Y"  
                             **Point of Articulation:** neutral space  
                             **Hand Orientation:** towards the body/to the right  
                             **Movement:** upwards and forwards  
                             **Facial/Body Expression:** sucking in the cheeks |
The development of a guide on laboratory glassware in Chemistry in Libras is a promising strategy to promote inclusion and access to education for deaf students. As Costa (2014) emphasizes, there is a strong need for the production and dissemination of specific materials for science education, especially in Chemistry. Therefore, the material constitutes a promising tool to facilitate the understanding of practical classes in the discipline, capable of promoting greater interaction and participation of students in the teaching-learning process.

Based on the studies of Fernandes et al. (2019), it is believed that the signs and visual interpretations present in the material enable deaf students to more effectively follow the explanations in the classroom, understanding the functioning and correct use of laboratory glassware. Moreover, this approach can contribute to making them feel more included and valued in the educational environment. Therefore, it is understood that the Libras guide can provide greater accessibility and understanding of the contents related to laboratory glassware in Chemistry.
Furthermore, it is important to mention that materials such as the guide can be useful as support for teachers during Chemistry classes. According to research such as Fernandes et al. (2019) and Andrade et al. (2020), teachers face difficulties in explaining concepts related to glassware due to the lack of materials that offer a visual and practical representation of terms and procedures, which can hinder the educational process of deaf students. Therefore, the produced guide can positively impact the interaction and communication between deaf students and teachers, promoting a better development of more inclusive and collaborative interpersonal relationships in the school environment.

4 CONCLUSIONS

Knowledge of laboratory glassware is essential for the teaching and learning process of scientific concepts in Chemistry classes, and the Libras (Brazilian Sign Language) Guide provides assistance to the teacher's work with deaf students in the laboratory, significantly enhancing the communication dynamics between teacher and student, thus making the teaching and learning process more dynamic. The Laboratory Glassware Guide in Libras can be used as a didactic tool for students and teachers; however, the continued creation and adaptation of materials for teaching Chemistry to deaf students are necessary.
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