# Glossary of computational terms as a stimulus to programming logic: a case study with deaf students

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*Abstract*—**This research full paper presents that Brazilian deaf community has conquered rights in the area of education, and in recent years, with the increase of the enrollment of deaf people in educational establishments, there is a need to elaborate new specific signs of LIBRAS for technical terms of specific courses in different areas. The objective of this work is develop a computational glossary of signals in LIBRAS with the reserved words of the SuperLOGO programming environments and the NXT robotics software. In addition, programming logic and geometry learning in deaf students will be stimulated. The work will be carried out in a bilingual high school, in the mathematics discipline. To validate the glossary and the development process of the students' knowledge will be used categories of pedagogical evaluation and content analysis. The use of these programming softwares combined with the glossary demonstrated the ability to build knowledge in programming logic and geometry that would be hampered by the language barrier. We conclude that the signs developed for the glossary enable the deaf to access complex terms of computing, providing the same possibilities of educational development as their fellow listeners.**

***Keywords—computational glossary, logic programming, deaf, SuperLOGO, Lego Mindstorms NXT***

## I. INTRODUCTION

In Brazil, according to IBGE[1], 9.7 million people have hearing impairment, representing 5.2% of the Brazilian population. Of this statistic, 2.0 million have severe hearing difficulties, being considered deaf. The deaf initiated their interactions with education after the recognition of the LIBRAS[2] as the second official Brazilian language through Law 10.436 [2]. The Decree-Law 5.626 [3] guarantees deaf students access to the regular school, with the inclusion of this language as a curricular discipline, in addition to the training of bilingual [3] education professionals, deaf instructors and interpreters of LIBRAS [4]. Another right acquired by the deaf was the enactment of Law 13.409 [5] which includes persons with disabilities in the quota system adopted by Brazilian federal universities and technical schools. These achievements allowed the expansion in the entry of the deaf into technical and higher level courses [4].

Those who reach the technical and higher level courses face the problem of disciplines that have complex terms, adequate to their specificities, making it difficult for the deaf students to understand. LIBRAS is a language in construction and the number of specific signs for technical terms of some professions is insufficient [6], and regarding the area of computing this scenario is not different.

Motivated to solve this problem, the work aims to elaborate new technical signals of computation together with teachers and interpreters of LIBRAS and to stimulate the logic of programming in deaf students. The work is structured as follows: In Section II are presented the related works, in section III is presented the methodology used in the experiments, section IV is performed the analysis of the results and final considerations in Section V.

## II. RELATED WORKS

A study on glossaries of technical terms of computation in sign languages, available on the internet was conducted. Among those surveyed, we highlight the ASL-STEM Forum [4], a collaborative American glossary which deaf students, teachers, interpreters, researchers and other interested parties can consult, discuss and upload new signs, contributing to the enrichment of technical terms of the language ASL [7]. It has a large collection of technical terms divided by areas of knowledge, including computing.

Another prominent international glossary is the Spread the Sign[5] website. It is a European project with the purpose of popularizing the sign languages of several countries. Although the main objective is to make sign languages accessible to deaf individuals, the intention is to make them available for everyone [8]. Spread the Sign is a glossary whose primary feature is to provide the same term in several different sign languages. The user can consult the signal by the section of interest or the desired national language of signals, being possible to switch between them at any moment simply by clicking on the flag of the country. It is an abundant glossary because it contains more than 300,000 signs, sum of all the signs of the collaborating countries.

The LIBRAS glossary of UFSC [9] is a prominent Brazilian glossary, as it provides the signs of technical terms in a differentiated way. It presents the signal video, description, variations and possible examples. It shows images of the hands configuration, location of gesture and

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[1] IBGE – Brazilian Institute of Geography and Statistics
[2] LIBRAS is the sign language used by the deaf in Brazil.
[3] Bilingual is the individual's ability to máster fluently the LIBRAS and the Portuguese language.
[4] ASL-STEM FORUM can be accessed by URL: https://aslstem.cs.washington.edu/
[5] Spread the Sign can be accessed by URL: http://spreadthesign.com/

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makes available the signal in signwriting[6]. In addition to the glossaries presented, others are considered relevant in this research, such as deaftec[7] and vlibras[8].

## III. Methodology

The study on the glossaries of signs presented in the previous section evidenced the need to elaborate a computational glossary of technical terms in LIBRAS in the area of computing. This glossary will be used to stimulate logical reasoning in deaf students, thus, it was based on Vygotsky's principles, which studied defectology [9] and advocated the use of signs for intellectual development. For this, it was necessary to perform 4 steps.

1ª) Search for software in the literature that approached the programming logic and could be suitable for the deaf public. To contribute to the process of constructing the glossary, the researcher had the help of the project collaborator, a deaf and bilingual teacher.

Several programming environments such as Alice[10] and Scratch[11] were searched, however, in an attempt to take advantage of the experiences of the deaf collaborator, we opted for the SuperLOGO[12] environment. The Fig. 1 shows the interface of the chosen software.

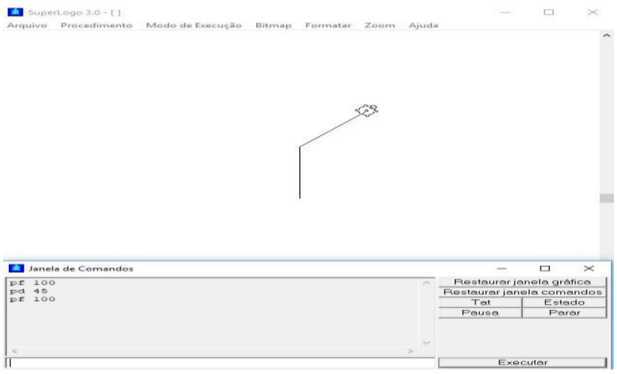


Fig 1. SuperLOGO interface

2ª) Choose the reserved words from the SuperLOGO environment to incorporate into the glossary. Of these, 21 were selected. The criterion used in choosing reserved words allowed the introduction of programming concepts and geometry for beginners.

3ª) Elaborate the signals for the glossary. This process of elaboration cannot be performed arbitrarily, the signals have a specific sequence of gestures, in order to facilitate and objectify the understanding of the information by the deaf public [10]. In order to elaborate each signal, the configuration of the hands, point of articulation, movement, arrangement and orientation of gestures and contact region were taken into consideration [6].

4ª) Develop the glossary interface. The glossary has been developed and can be accessed by the deaf community or interested public through a website[13]. For the first version, we developed a clear, simple and intuitive interface, adapted to the reality of the deaf, because in these individuals, communication is established through visual means unlike listeners that is conceived by oral and auditory [4]. The interface was defined in 3 menus, one for each category of signals, movement, tools and colors. The Fig. 2 shows the glossary interface:


Fig 2. Initial version of Glossary with SuperLOGO terms

Therefore, the glossary building process is presented in Fig. 3.

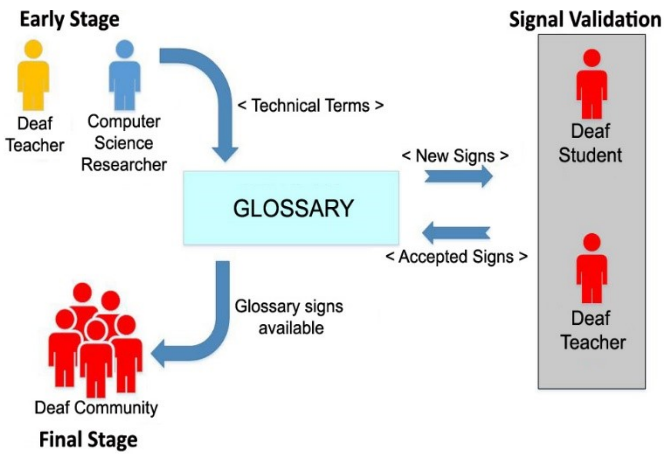


Fig 3. Glossary building process

In the Fig. 3, the early stage demonstrates the four steps described for the construction of the glossary, thus, a new stage arises, the validation. In order to approve the signals, acceptance by deaf individuals or specialists in LIBRAS is required [11]. After this process, the glossary was made available, corresponding to the final stage. The validation step will be presented in the next section.

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[6] Signwriting s a writing system for sign languages. For more information, access the URL: http://www.signwriting.org

[7] Deaftec ASL Dictionary can be accessed by URL: https://www.deaftec.org/resources/stem-signs/it

[8] VLIBRAS Toolkit can be accessed by URL: http://www.vlibras.gov.br/

[9] Defectology is the area dedicated to studying the process of qualitative development of people with disabilities.

[10] For more information about Alice, access the URL: https://www.alice.org/

[11] For more information about Scratch, access the URL: https://scratch.mit.edu/

[12] For more information about SuperLOGO, access the URL: http://projetologo.webs.com/slogo.html

[13] The computational glossary can be accessed by URL: http://200.132.77.56:3380/Glossario/Glossario.html

## A. *Glossary Validation*

The glossary was validated at a bilingual elementary school, participated in the experiment a LIBRAS interpreter, responsible for the pre-validation of the signals of the glossary, who also serves as director of the school, the mathematics teacher and six students between 14 and 25 years old. The subjects of the research had their identity preserved, being cited only by numbers:

- Subject 1 - 14 years old: Communicative, smart, confident and disciplined;
- Subject 2 - 15 years old: Shy, concentrated, intelligent and observant;
- Subject 3 - 14 years old: Dedicated and intelligent, but agitated, she has difficulty concentrating and insecurity in her abilities;
- Subject 4 - 15 years old: Shy, rarely interacts with others, organized, caring and questioning;
- Subject 5 - 22 years old: Light intellectual deficient. Dedicated, communicative and organized;
- Subject 6 - 25 years old: Deaf-blind and light intellectual deficient. Friendly, cheerful and observant.

The experiment was carried out by the researcher along with two undergraduate scholarships from the InfoEduc group, which totaled 11 weekly meetings of 1h: 30m. of duration. The researcher was responsible for teaching the lessons while a human sciences fellow had the function of documenting and observing what was happening in the classroom, giving pedagogical support to the experiment. The other fellow was responsible for the technical support and assisted the students when necessary. SuperLOGO is an easy-to-use, simple and flexible programming environment designed to stimulate the use of geometry [12]. Thus, the encounters occurred in the mathematics discipline with the presence of the teacher, who also acted as an interpreter.

## B. *SuperLOGO Experiment*

In the first encounter was introduced the SuperLOGO using the software commands, which allow us to move the turtle through the interface of the computer. Alongside this the computational glossary of technical terms served to consult the respective signs and the spelling of each command. We instruct students that the glossary should be used in conjunction with SuperLOGO. The Fig. 4 demonstrates how students performed the activities.

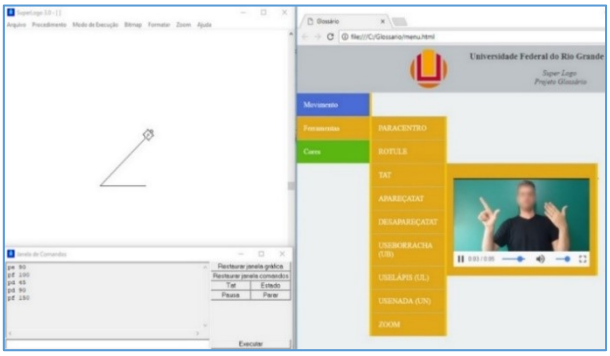


Fig 4. SuperLOGO and Glossary on the same screen

In the sequence, a new activity was suggested, the construction of an irregular closed polygon to exercise the concept of angles and to facilitate the understanding of the content of geometry. At that point, the math teacher explained to the students how they should proceed with the angles to construct polygons correctly. With this, the use of the basic commands has been completed and the "repita" command, repetition structure, is presented, which allows executing the same commands several times, a structure widely used in programming languages.

The next topic covered was the use of the "aprenda" command. This functionality allows the user to define new methods (commands) in the SuperLOGO through a procedure editor, allowing shortcuts for constructing certain figures. The syntax is similar to high-level programming languages, allowing students to have an introduction to what it would be to program [13].

The last content covered consisted of the colorization of the SuperLOGO and, thus, presented to the students how the color of the lines and geometric figures should be changed. In this programming environment, each color is represented by a certain number, so that whenever students use colors, they should consult their respective numbers in the glossary. The Fig. 5 shows the drawing of subject 2 using colors in the SuperLOGO.

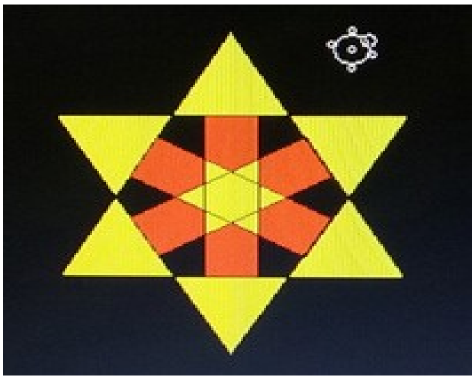

Fig 5. Drawing of a star

For the final activity of the experiment the subjects were asked to take photographs of historical buildings or bring images of ancient monuments. Thus, each subject chose an image according to their preference. After the exercise the subjects a SuperLOGO and glossary evaluation questionnaire. Fig. 6 shows the comparison between the original photograph and the drawing drawn by subject 1 on the right.

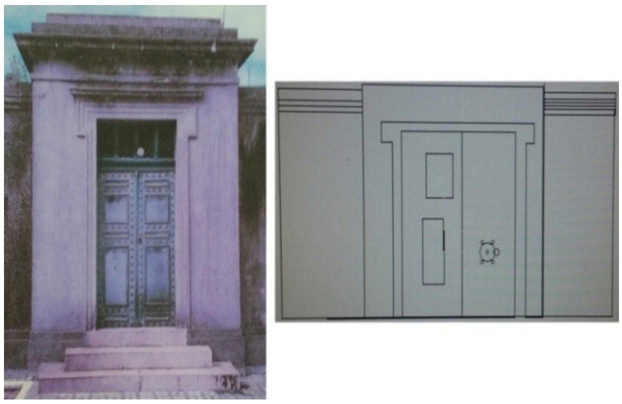

Fig 6. The original photograph and drawing of the subject

In this section the methodology with the SuperLOGO was demonstrated, so, in the sequence will be presented the second experiment of this research.

### *C. Lego Mindstorms Experiment*

The second part of the project was to improve logical reasoning skills and thus Lego Mindstorms NXT[14] was used. Its use provides the development of logic, curiosity and spatial reasoning [14]. In this way, [15] applied programming logic concepts using Lego Mindstorms NXT for deaf and other students, and states that, because it is simple and attractive, it favors communication and interaction between them. The deaf communicates essentially through their visual experience perceiving the world in this way [16] and, therefore, the main reason for using Lego Mindstorms NXT in this research is the possibility of concretely projecting the abstract concepts of programming, facilitating the understanding of deaf students.

For the second part of the project it was necessary to elaborate new signals for the technical terms of the Lego Mindstorms NXT and programming in general because it uses a more structured syntax than the SuperLOGO, in addition to using different commands.

This new version had a significant change, each technical term has two videos, the first one is the signal itself and the second is its description. This format is the same used in the LIBRAS glossary of UFSC [9]. The glossary of Lego Mindstorms NXT is shown in Fig. 7.


Fig 7. Lego Mindstorms NXT Glossary

The activities with the Lego Mindstorms NXT occurred in the same school as the SuperLOGO experiment, but with the absence of subjects 5 and 6. In these activities a different working method was used, mentioned by [17], which considers 4 principles for teaching of students with deafness, presented below:

- Encourage student activity;
- Organize tasks in small groups;
- Use visual communication procedures;
- Provide various tasks to students.

The presentation of the NXT was performed, where were shown the basic commands for robot movement whose format is a vehicle with mats. Each command was explained separately as well as its functions, allowing the subjects to visualize the robot's functionality. They worked the same way as the previous experiment, with the programming environment and the glossary side-by-side.

In the sequence, the research exposed the subjects as the NXT performs the curves, a process that requires the perception of which of the robot's engines must be turned on or off and the amount of time necessary to be parameterized in the commands to perform this action

In the following tasks, the subjects programmed the robots to travel in pre-defined circuits, in which the concepts of geometry, variables, sensors, condition structures and acceleration and deceleration procedures were explored. Three of these circuits are shown in Fig. 8.

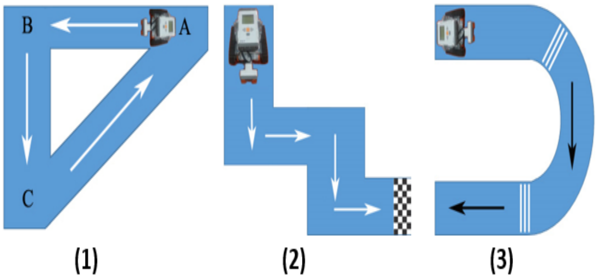


Fig 8. Some of the circuits used in the activities

In order to verify if the subjects built knowledge about the contents covered in Lego Mindstorms NXT, a multidisciplinary activity on traffic education was proposed. Thus, a circuit was elaborated which subjects should leave point 1 and choose the best route for the parking lots represented by points 2 and 3. In the route, they must respect the direction of the streets, the traffic signs, diverting of holes and not invading the lawn and the buildings. Fig. 9 shows the circuit illustration.


Fig 9. Circuit illustration

The previous figure demonstrated the circuit illustration for the final NXT activity, but it was necessary to build it in the real world. In this way, the researcher reproduced the idea through tapes and printed drawings applying them to the floor of a computer lab. Fig. 10 shows the physical circuit of the activity.

[14]For more information, go to the URL: https://www.lego.com

Fig 10. Circuit represented on the floor of a computer lab

After the presentation of the methodology of the experiments, the analysis of the results and discussion will be shown in the following section.

## IV. ANALYSIS OF RESULTS AND DISCUSSION

The pedagogical evaluation was based on content analysis [18] that defines a cluster of methodological instruments used in varied discourses, that is, it is a research technique that interprets the subject's thinking through content expressed in texts [19]. To obtain data, the intensive direct observation method was used, as [20] is a type of study that uses the senses (seeing and hearing) in obtaining certain aspects of reality, as well as examining facts or phenomena. In addition, questionnaires and interviews were used.

The analysis of the data was conducted as follows: organization and digitalization of the information documented in the classroom, transcription of the interview with the mathematics teacher, reading the answers of the questionnaires. In addition to these activities, in order to define the categories of evaluation, a mind map of the class reports was generated in digital format with Sobek Mining[15]. The mind map of the reports is shown in Fig. 11.

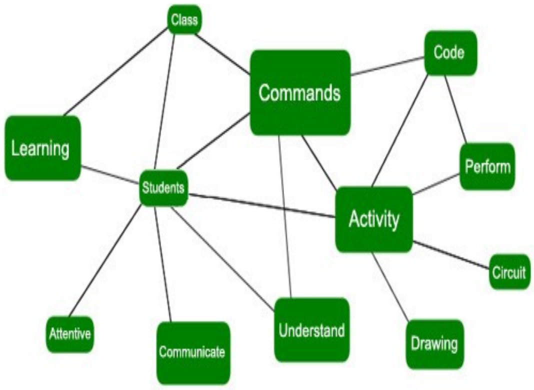


Fig 11. Mind map of activity reports

With the systematics presented, four categories of evaluation emerged: knowledge, understanding, attention and interaction. The first two made it possible to analyze the students' learning, while the "attention" category allowed to evaluate the degree of interest and curiosity, while the "interaction" allowed the analysis of the communication and the relationship between the subjects. The categories knowledge and understanding can be found in Bloom's taxonomy [21] and attention category, in the ARCS interactive motivational model [22]. The categories used can be observed in Fig. 12:

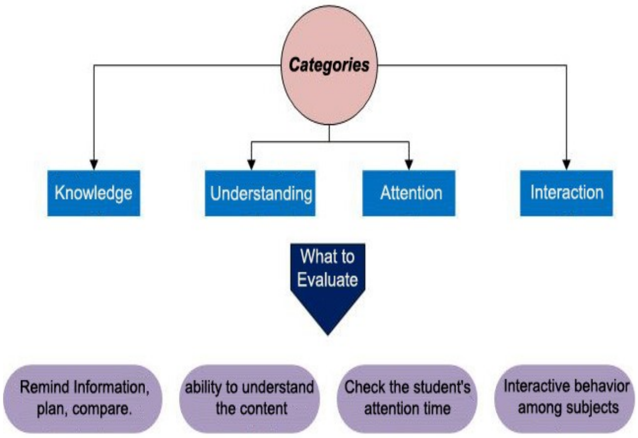


Fig 12. Structure of the evaluation categories

The pedagogical evaluation of the subjects allowed to verify how they develop the logical reasoning through programming softwares with the aid of a glossary of signs of technical terms. Thus, it was shown how the subjects behaved before the proposed activities, what were their limitations and abilities.

### A. *Pedagogical Evaluation of SuperLOGO experiment*

In this subsection will be presented in Fig. 13 the incidences of the categories in relation to the subjects during the 11 encounters of the experiment, indicating the frequency that they appeared in the activities.

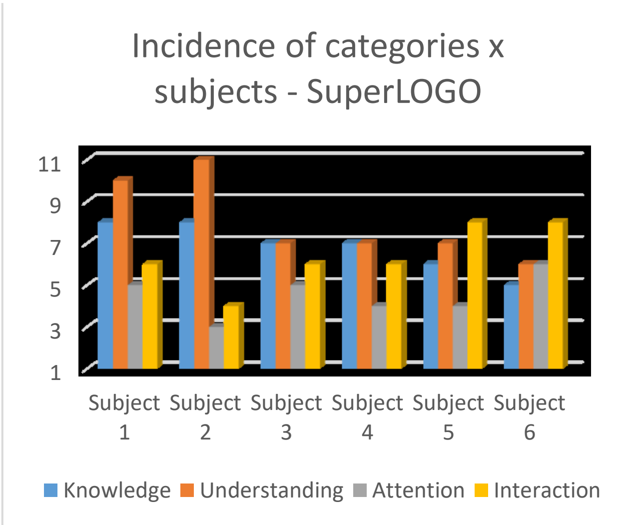


Fig 13. Incidence of categories - SuperLOGO

Subjects 1 and 2 presented the highest values in the category because they demonstrated knowledge construction when performing the tasks and the use of the glossary, as well as continuous use of commands that require logical reasoning such as "repita" and "aprenda". Both subjects obtained the

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[15] For more information about Sobek Mining, access the URL: http://sobek.ufrgs.br/

same value also for the comprehension category because they tried to understand what had been given in the class, being questioning and in need of learning.

The subject 2 obtained a low value in the attention category, since in all the meetings did not present variation in this item, he remained regularly attentive in the explanations about the contents approached. He presented low value in the interaction category because he is shy and rarely communicated with classmates.

Subjects 3 and 4 presented similar values in almost all categories. They constructed knowledge about the contents, but they were dispersed and their drawings had no planning, besides presenting some difficulties in the "repita" and "aprenda" commands, which characterized the amount of incidences in the understanding category. Subject 4, because he was shy, presented an index with reasonable value in the interaction category because he communicated sporadically with subjects 1 and 3.

Finally, subjects 5 and 6 presented difficulties in all aspects, were unable to develop any of the activities without help, showing difficulty in create the drawings and understand the contents covered. According to [23], such limitations are caused by the restricted level of some mental functions, severe communication problems, in which the difficulties of developing oral messages and reception are highlighted. This can be explained by the incidence of multideficiencies in both students of them, the social interaction through the speech with other people and the access to the information that is disposed to him. However, they obtained a high level of incidence in the interaction category because subjects often communicated with each other, even individual tasks, in mutual assistance.

In general, all the subjects presented in several situations, difficulties in mentally designing what should be built in the software, so that the drawing was done, because they present problems of abstraction. According to [24], the language is divided into gestual, verbal and written and as the deaf does not present oral language, this can cause difficulties in their development and learning, because their thinking is based on concrete experiences. Thus, the analysis of the SuperLOGO results was presented, in the sequence, the Lego Mindstorms NXT evaluation will be demonstrated.

## B. *Pedagogical Evaluation of SuperLOGO experiment*

For the pedagogical evaluation of the subjects in the Lego Mindstorms NXT experiment, the incidence of the categories in the activities performed is presented in Fig. 14.

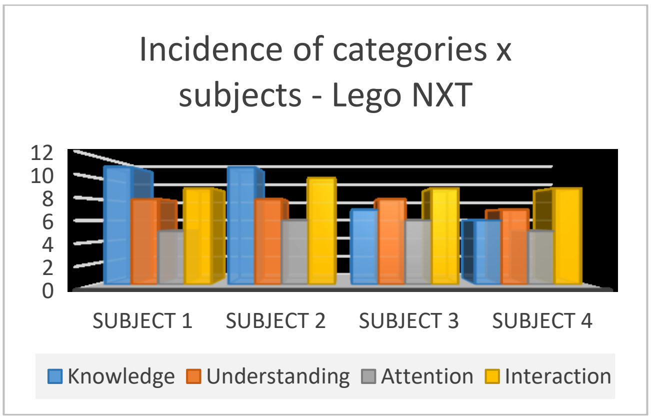


Fig 14. Incidence of categories - Lego NXT

In the knowledge category, subjects 1 and 2 presented a high index of incidences because they developed the activities correctly in practically all the contents approached. Thus, in the comprehension category, these subjects presented the same value of incidences because they evidenced assimilation in the contents covered and similar difficulties. However, in the attention category, the group presented low incidences because it exhibited different behaviors. Subjects 1 and 2 were concentrated in the activities while subjects 3 and 4 were found to be dispersed. In the interaction category, all subjects had a high incidence value because they frequently communicated with each other, with the researcher and the LIBRAS interpreter, either in the exercises or in the discussions about the contents.

During the activities, the subjects presented difficulties in some aspects. First, in the definition of parameters of the commands because they required numerical reasoning. This type of situation may occur because the deaf people have the least developed numerical reasoning, that is, they may present difficulties in stablishing links between numerical codes [25].

Difficulties were also observed in the understanding of variables, since in them there is a change in values and the subjects could not assimilate this variation. This may occur because the deaf are individuals who during their childhood have suffered significant delays in the progress of their metacognitive abilities, that is, their ability to understand the information that is demonstrated to them and their assimilation [26]. On the other hand, they demonstrated knowledge construction when carrying out the tasks proposed, mainly in traffic education activity, which programmed the NXT robot in an elaborate circuit with several rules.

# V. FINAL CONSIDERATIONS

This paper presented how the experiments to stimulate the logic of programming in deaf students occurred, using a computational glossary of technical computing terms in LIBRAS. Some related works relevant to the searched subject were presented, which evidenced the need to construct the glossary and the elaboration of the technical signals of computation. Two validation experiments were carried out to stimulate programming logic in a bilingual school. The use of a technical glossary with reserved words from SuperLOGO and Lego NXT provided to subjects knowledge building about the basic concepts of programming and geometry. Such experiments may afford to deaf people access to computer courses and prospects of attending a higher education course in this area.

As a way of evaluating the subjects, 4 categories were established that made possible the analysis of behavior in the activities to build knowledge. In it, their abilities, restrictions and difficulties were emphasized. Although the subjects evaluated constituted a heterogeneous group, with autonomy, they constructed their learning individually and collectively through the presented activities

# REFERENCES


[1] IBGE. Censo Demográfico 2010: Características gerais da população, religião e pessoas com deficiência. Available at: http://www.ibge.gov.br/home/estatistica/populacao/censo2010/caracteristicas_religiao_deficiencia/caracteristicas_religiao_deficiencia_tab_xls.shtm. Accessed on April 24, 2018.

[2] Brasil. Lei 10.436, de 24 de abril de 2002. Dispõe sobre a Língua Brasileira de Sinais - Libras e dá outras providências. Diário Oficial da União. Brasília, DF, 25 abr. 2002. Available at: http://www.planalto.gov.br/ccivil_03/leis/2002/L10436.htm. Accessed on April 22, 2018.

[3] Brasil. Decreto 5.626, de 22 de dezembro de 2005. Regulamenta a Lei no 10.436, de 24 de abril de 2002, que dispõe sobre a Língua Brasileira de Sinais - Libras, e o art. 18 da Lei no 10.098, de 19 de dezembro de 2000. Available at: http://www.planalto.gov.br/ccivil_03/_ato2004-2006/2005/decreto/d5626. htm. Accessed on April 22, 2018.

[4] D. F. Pereira and E. N. Silva. Teclibras: Um Protótipo Web de apresentação de Termos de Informática em Libras. Revista Fórum. No. 33. 2016.

[5] Brasil. Lei nº 13.409, de 28 de dezembro de 2016. Available at: http://www.planalto.gov.br/ccivil_03/_ato2015-2018/2016/lei/L13409.htm. Accessed on April 21, 2018.

[6] I. M. Silva, and B. P. Santana. Libras e Ensino Técnico: A necessidade de novos sinais. VII Jornada de Iniciação Científica - PIVIC Mackenzie/Mack Pesquisa, 2011.

[7] A. C. Cavender et al. Asl-stem forum: enabling sign language to grow through online collaboration. In: Proceedings of the SIGCHI Conference on Human Factors in Computing Systems. ACM. p. 2075-2078, 2010.

[8] Hilzensauer, Marlene; Krammer, Klaudia. A Multilingual Dictionary for Sign Languages: Spread The Sign. This volume, 2015.

[9] UFSC. Glossário Letras Libras. Available at: http://glossario.libras.ufsc.br. Accessed on April 21. 2018.

[10] R. P. Granada et al. Estratégia digital como meio de inclusão para surdos na computação. In: Anais. Mostra de Produção Universitária, Rio Grande. 2017.

[11] J. S. Aragão *et al*. Um estudo da validade de conteúdo de sinais, sintomas e doenças/agravos em saúde expressos em LIBRAS, Revista Latino-Americana de Enfermagem, v. 23, n. 6, p. 1014–1023, 2015.

[12] M. S. Motta. Contribuições do Superlogo ao ensino de geometria. Colabor@-A Revista Digital da CVA-RICESU, v. 6, n. 21, 2010.

[13] R. P. Granada et al. Incentivo à lógica de programação para surdos utilizando um elucidário computacional. In: Anais do XIV Congresso Brasileiro de Ensino Superior a Distãncia, Rio Grande. 2017.

[14] I. V. Ely and D. A. Almeida. Robótica pedagógica criativa: um aprendizado itinerante, Revista Extensão em Foco, v. 3 n. 1, p. 7-19, 2015.

[15] C. Conchinha, S. G. Silva and J. C. Freitas. La robótica educativa em contexto inclusivo. Ubicuo social: Aprendizage con TIC. 2015.

[16] M. D. Nascimento, et al. A comparative study of deaf and non-deaf students' performance when using a Visual Java Debugger, *in:* Frontiers in Education (FIE), Indianapolis, Indiana. IEEE, 2017.

[17] M. de L. Deus. Surdez: linguagem, comunicação e aprendizagem do aluno com surdez na sala de aula comum. Revista Anápolis Digital. Vol.3, n.1, 2012.

[18] L. Bardin. Análise do discurso. Lisboa: Edições, v. 70. 1977.

[19] R.C. Caregnato and R. Mutti, R. Pesquisa qualitativa: análise de discurso vrsus análise de conteúdo, Texto contexto enferm, v. 15, n. 4, p. 679–84, 2006.

[20] E. M. Lakatos and M. de A. Marconi. Metodologia do trabalho científico. 4 ed. São Paulo: Atlas.1992.

[21] A. P. Ferraz,and R.V. Belhot. Taxonomia de Bloom: revisão teórica e apresentação das adequações do instrumento para definição de objetivos instrucionais. Gest. Prod., São Carlos, v. 17, n. 2, p. 421-431, 2010.

[22] J. Keller. Motivational Design for Learning and Performance: The ARCS Model Approach. Springer. 2009.

[23] C. Nunes. Alunos com multideficiência e com surdocegueira congénita. Organização da resposta educativa. Direcção-Geral de Inovação e de Desenvolvimento Curricular. Direção de Serviços da Educação Especial e do Apoio Sócio–Educativo. Lisboa, 2008.

[24] L. S. Vygotsky. A Construção do Pensamento e Linguagem. Martins Fontes. 1ª Edição. 2001.

[25] J.K. Monteiro and C.A. Galecki. Avaliação do raciocínio abstrato, numérico e espacial em adolescentes surdos. Sistema de informacion científica. Aletheia, n.21 p. 93-99, 2005.

[26] C. Bisol, and T. M. Sperb. Discursos sobre a surdez: deficiência, diferença, singularidade e construção de sentido, Psicologia: Teoria e Pesquisa, v. 26, n. 1, p. 7, 2010.