iTecDeaf: glossary of technical terms in Libras with dynamic interface for deaf

Rafael Pinto Granada
PPGEC – FURG
Federal University of Rio Grande
Rio Grande, Brazil
rafaelgranada@furg.br

Regina Barwaldt
Center of Computer Sciences – C3
Federal University of Rio Grande
Rio Grande, Brazil
reginabarwaldt@furg.br

Maicon Douglas Lussanrriaga
Center of Computer Sciences – C3
Federal University of Rio Grande
Rio Grande, Brazil
dodoylele@gmail.com

Naraína Zerwes Gentil
Center of Computer Sciences – C3
Federal University of Rio Grande
Rio Grande, Brazil
narainagentil@furg.br

Tiago Fossati Otero
Center of Computer Sciences – C3
Federal University of Rio Grande
Rio Grande, Brazil
tiagofotero@gmail.com

***Abstract* — The deaf community has conquered rights in the area of education and with the entry of deaf people into universities, there is a need to develop new signs in Libras for technical terms in the various areas of knowledge. This paper aims to present iTecDeaf, a technical glossary with a dynamic and bilingual interface for the deaf, based on Vygotsky's theory that emphasized the use of signs and symbols for the cognitive development of the individual. It is characterized by the use of videos, animations in sign languages and fingerspelling in written form, providing relevant and easy-to-understand content for its users. In validation, the predictive evaluation was used to identify problems in the interface and in the design, carried out by 5 experts with knowledge about the deaf public in which a checklist of 10 questions was applied as an evaluative instrument. iTecDeaf showed a positive result of 86% and proved to be a learning mediator instrument that enables signs through a differentiated interface with the perspective of contributing to the academic activities of deaf students, interpreters and teachers.**

Keywords — technical glossaries, sign languages, deaf, interface, usability.

I. INTRODUCTION

In Brazil, according to the Brazilian Institute of Geography and Statistics (IBGE), 9.7 million Brazilians have hearing loss, representing 5.2% of the population, of which 344.000 are considered deaf. After the recognition of the Brazilian Sign Language (Libras), through Law 10.436[1], the right to expression in various spaces of society began to be guaranteed, as well as Law 13.409[2] , on the inclusion of disabled people in the quota system adopted by Brazilian universities.

When entering higher education, deaf people face several obstacles such as non-existent accessibility, inadequate university infrastructure and teaching methodology that does not favor them [1]. Furthermore, communication with hearing people presents some barriers, as they do not know sign languages (SL) or the visual experience of the deaf [2].

In addition to the aspects mentioned above, we highlight the courses that have technical terms, adequate to their specificities and that do not have translation into sign languages [3]. This affects the student in the classroom, because if there is no sign for a specific word, the interpreter finds it difficult to express its meaning to the deaf student because he does not have knowledge about the subject presented, in most cases [4].

Libras is a language under construction and the amount of technical signs for the areas of knowledge is still insufficient. Such smallness is justified by the difficulty in producing them, because it is a lengthy process that involves several stages for its development, such as elaboration, recording, validation of the signals and, mainly, the construction of the publication platform [5].

In this way, motivated by the admission of deaf students to the federal public institution where the authors work, the work aims to develop a glossary of technical signs in Libras with an interface suitable for the deaf.

II. THEORETICAL REFERENCE

A. Contextualizing the Deaf Subject

Deaf people are individuals with considerable absence or loss of hearing and, as a result, do not develop oral language naturally, despite not having any organic dysfunction that prevents them from speaking. However, this condition disfavors communication, their metacognitive skills, abstraction and learning [6].

As a result, it is clear that language is the main mediator of social relations and an essential element in the formation of the individual's character, its acquisition enables communication, the development of thought, construction of knowledge and learning [7].

In view of this, in his studies in defectology[3] , Vygotsky considered the deaf, despite the organic limitation imposed, as individuals who were able to perform activities inserted in society, even with the misunderstanding on the part of the people around them. He developed the theory of compensation for disability, in which the loss of a sense would be naturally compensated by another healthy organ, whose function and development are enhanced, expanding its capabilities and occupying the sick with no or a tiny part of their functions [8].

[1] Provides for the Brazilian Sign Language - Libras and other measures. Available at: http://www.planalto.gov.br/ccivil_03/leis/2002/L10436.htm

[2] Provides for vacancies for people with disabilities in higher education programs at federal educational institutions. Available at: https://www.planalto.gov.br/ccivil_03/_ato2015-2018/2016/lei/l13409.htm

[3] Defectology is an area dedicated to studying the process of qualitative development of people with disabilities, in this case, the deaf.

Based on this principle, Vygotsky demonstrated that the difficulties of the deaf occur because they cannot express themselves through oral language, because with the absence of hearing, another form of communication and interaction with the world provides the development of language and mental functions. This process is granted through sign language, which is perceived by sight and reproduced by hands, body and facial expressions. This language with the help of signs and symbols enables the ability of attention, memory and communication for the deaf, in the same way that orality is for the hearing. In addition, they provide the deaf with the primary functions for the mediation of learning practices and social coexistence, promoting the development of a language.

In this way, technical glossaries given as instruments composed of signs and symbols can help in cognitive development, in addition to providing and facilitating communication between deaf and hearing users, once interactive, in addition to assisting interpreters and teachers in their classroom activities.

B. Interfaces and Interaction

Human-Computer Interaction (HCI) is the area of knowledge that is intended for the study of communication between human beings and computer systems, involving information, computing, behavioral and social sciences [9]. It pays attention to the design, evaluation and implementation of computer systems and their related phenomena, that is, it aims to provide users with a better experience in their use.

The communication between system-user is called interaction and corresponds to the actions that occur between them, intermediated by an interface, a virtual component that allows the individual to connect to a given application [10]. The interface needs to be easy to understand, reliable and intuitive, using mechanisms to provide usability in the interaction with a computer system as established by Brazilian Standard NBR 9241-11[4]. Usability is the area of the HCI responsible for evaluating the quality of handling a product and refers to user satisfaction regarding the ease and efficiency of its use [11].

III. METHODOLOGICAL PROCEDURES

The methodological path developed during the preparation of this research is presented, in which the iTecDeaf[5] Glossary is introduced. The work has a quantitative-qualitative approach due to the need to understand the entirety of the phenomenon studied, its relationships and changes based on the reality of the target audience through organized, detailed analysis and complemented by quantitative treatments in order to enrich the discussions. end of the research [12]. As for the objectives, it is considered exploratory, as its purpose is to build, elucidate and modify concepts through a different perspective for subsequent studies [13].

A. iTecDeaf Glossary

At times, the presence of an interpreter in the classroom does not prevent the frustration that occurs with deaf students due to problems in understanding the content objects presented in the disciplines. This can occur for different reasons such as teachers who are not prepared for students with disabilities, lack of visual resources, use of methodologies aimed at listeners, use of technical terms in the classroom, among others.

Due to these situations, the author developed iTecDeaf, a glossary focused on signs for technical terms, which would act as a learning mediator instrument with an interface that prioritizes the deaf user, as it is based on their native language, but with support for the Portuguese language (PL), which establishes it as a bilingual environment. In agreement with [4], [14] and [15], the iTecDeaf glossary can be used to:

- Query technical signs of a certain area of knowledge in the classroom, favoring the understanding of concepts in Libras;
- Help interpreters in simultaneous translation in the classroom, as it avoids the excessive use of fingerspelling[6] for terms that do not have equivalent in signs;
- Facilitate technical conversation between deaf students, their peers and hearing teachers;
- Contribute to the scientific dissemination of technical terms in Libras.

Therefore, Fig. 1 presents iTecDeaf home page.

Fig. 1. iTecDeaf Home Page

The signs inserted in iTecDeaf correspond to 3 areas of knowledge, such as Information Systems, Food Engineering and Chemistry, which can be seen in Fig. 1. Furthermore, iTecDeaf has the possibility to insert technical signs from other fields of knowledge by accessing the registration button located on the top bar of interface.

B. iTecDeaf Operation

The appearance of iTecDeaf is minimalist with no borders and shadows, soft colors in shades of blue, contrasting in relation to its visual elements, fonts of different sizes associated with each one of its functions and videos/animations that provide pleasant viewing.

The iTecDeaf interface is considered dynamic because it uses a resource called mouse-over, which is the effect applied to an icon, image or link and works as follows: when positioning the mouse pointer over these visual variables, they undergo transformations in their appearance such as changing color, image or starting a certain procedure.

Through Fig. 2 we demonstrate this functionality in different time intervals, in the first one with the mouse arrow on the thumbnail of the video "Camadas" and in the second moment with the video "Conexão". It is worth mentioning that

[4] Set of technical standards that define the concept of usability and the way to apply them in the implementation of interactive systems

[5] Available at the URL: https://itecdeaf-frontend.herokuapp.com

[6] Spelling a word or expression in sign languages

the positioning of the mouse pointer is what determines the beginning of the visualization of the vídeos.

Fig. 2. Mouse-over feature over the signs videos

The iTecDeaf was implemented so that these effects can be executed simultaneously providing a strong visual interaction with the user, minimizing the display of long texts in its interface.

In view of this, it presents a logical, linear and responsive layout to help users judge which content they require access to complete their tasks, that is, no prior knowledge or practice is required to use it spontaneously, exploring the defined usability concepts by [11]. For the implementation, it was necessary to research technologies that would make possible an interface with dynamic characteristics, as a result, we chose to use two different technologies, React[7] and Node.js[8].

Fig. 3 shows the functionality of iTecDeaf, in the sidebar, five subjects of the Information System program are defined, each one represented by a different icon. They are: algorithms, algebra, calculus, discrete mathematics and internet systems. For the user to select the course, just click on one of them, and its signs will appear simultaneously in the thumbnail area in the center of the interface. As explained earlier, when the mouse arrow is over a sign, its thumbnail will start animating, displaying the sign.

Fig. 3. Interface of iTecDeaf

However, if the user clicks on the selected sign, two videos will appear, the chosen sign and it's description, at the bottom of the interface, in larger size. Fig. 4 shows the sign for the term Elif from the Algorithms discipline of the Information Systems program.

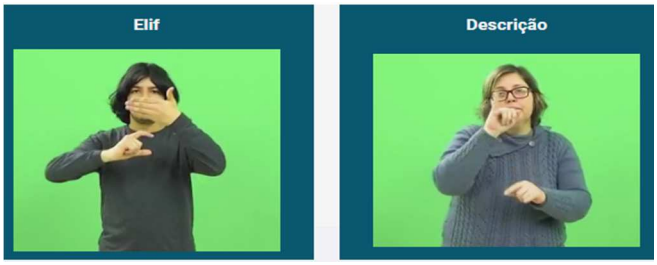

Fig. 4. Sign of the Term "Elif" (left) and it's description (right)

Simultaneously, in the lower right part of the interface, 4 items will appear as a complement, the name of the sign, the discipline in Portuguese and in fingerspelling. In the third item, the writing of the sign in signwriting[9] is displayed and, finally, its description in a succinct manner, as shown in Fig. 5.

Fig. 5. Complementary information for the term "Elif"

The iTecDeaf glossary is characterized by prioritizing the use of the native language of the deaf in its navigability because it uses the mouse-over feature and menus with simplified information in PL, advocating the use of videos and animations in SL, in addition to signwriting and use of fingerspelling in text form. The author was concerned with providing relevant content displayed dynamically, in addition to supporting cognitive aspects of learning through strategies for the development of educational interfaces proposed by [10]. Due to its dynamic interface, the iTecDeaf Glossary was designed for exclusive use on desktops and notebooks, not having a definitive version for mobile devices.

C. Usability evaluation of the iTecDeaf Glossary

To guide the evaluation of iTecDeaf, the DECIDE Framework was used, an aggregate of methods and concepts organized to conduct the evaluation planning of a system [9]. It consists of 6 steps: i. determine the objectives of the evaluation; ii. explore the issues to be addressed; iii. choose the type of paradigm; iv. identify elements to be addressed by the evaluation; v. decide on the ethical issues involved and, finally, vi. interpret, evaluate and display the data.

Initially, the evaluation objectives were defined, which were to analyze the iTecDeaf Glossary, verify if its interface and design meet the expectations of the deaf public, guaranteeing quality of use, adequate navigability and accessibility at a satisfactory level.

The second stage refers to the questions that will emerge about the evaluation to be carried out, that is, what information

[7] JavaScript library used to design user interfaces for websites

[8] JavaScript execution environment that requires few computational resources, being fast in processing your applications

[9] Writing system for reproducing signs in sign languages. Available at: http://www.signwriting.org

will be collected during its execution, what will be identified, investigated or improved. Some of these questions are:

- Is iTecDeaf an attractive digital artifact?
- Is your interface suitable for the target audience?
- Will resources such as mouse-over, SL animations and handwriting be well accepted by the deaf?

In the third step, we must consider some pertinent aspects that will help in this process, such as the technical team involved, time availability, feasibility of the equipment that will be used and the data analysis method. Based on these factors, predictive evaluation was chosen to analyze iTecDeaf, because it is necessary to identify or predict possible design problems in the interface from a technical level to make the glossary available to deaf users, free of errors or inconsistencies.

In the next step, two fundamental elements were defined for the evaluation process, the definition of the execution environment and the choice of evaluators. The procedure was carried out through the Internet, with the participation of 5 specialists, masters degrees in Computer Engineering, with experience in the area of Computer Education and possessing previous knowledge about the deaf public, in the same way used by [16].

The elements to be evaluated in iTecDeaf were defined in a checklist of questions, elaborated from the adaptation of the heuristics of [11] and [17]. The evaluators had their identity preserved, being cited only by numbers as shown in Table I.

TABLE I. GLOSSARY EVALUATORS

Avaliators	*Occupation*
1	Tutor Sead[10] Furg - Data Science Post-graduate Program
2	IFRS[11] High Education Professor – Computer Program
3	PROITI[12] Furg Information Technology technician
4	PROITI Furg - Information Technology analyst
5	Sead Furg Administrative Technician in Education

In the fifth stage, the ethical aspects involved in the evaluation must be considered and, therefore, the anonymity of the evaluators and the confidentiality of the data produced and analyzed were guaranteed. It is worth mentioning that in the predictive assessment, the participation of end users is unnecessary, that is, there was no presence of deaf individuals. As a result, the Informed Consent document was not used.

The last step refers to the execution of the evaluation itself, that is, the analysis of the iTecDeaf Glossary by the specialists, the collection of data, interpretation of the results and their display. To carry out this process, the evaluators accessed the glossary and answered the checklist, made available by the author through a link to Google Forms.

The collection instrument consisted of a total of 10 questions, in which the evaluator had to choose between the options Yes or No, with mandatory justification. The analysis and discussion of these data will be presented in detail in the next section.

IV. ANALYSIS ON THE USABILITY OF THE ITECDEAF GLOSSARY

The analysis of the results was conducted through the full reading of the evaluators' answers in the checklist of questions presented in the previous section, in which the interpretation of the data was carried out according to the requirements of the DECIDE Framework. The checklist questions and the analysis on the evaluators' answers will be displayed as below:

Question 1: Is the information presented in the iTecDeaf interface organized to avoid user cognitive overload?

iTecDeaf is organized by knowledge areas, using lateral groupings and presentation of content in a carousel, which made the interface intuitive and allowed for an agile and consistent navigation that did not present noise or overload in the display of contents. In addition, the use of videos and animations in SL favor the understanding of the deaf, as written language and sign languages have different structure and syntax, which can lead these users not to assimilate the content presented in the interfaces immediately [18] . In this way, it can be seen that iTecDeaf employs visual and textual elements in order to minimize the users' memory load when using it, as explained in the work of [19].

Question 2: Do you consider that all the information presented in the visual elements (text, videos, icons, animations) of the interface are relevant?

The elements presented in written form are instructive, short and objective while the icons and images are clear, perceptible and significant. The videos and animations that contemplate the target audience's native language stand out, which can enhance the attention, motivation and learning of these individuals, as it was based on signs and symbols, elements defined by Vygotsky that help in the development of human knowledge. iTecDeaf interacts in a comprehensive way with users, displaying relevant language, without using specific terms according to [20].

Question 3: The layout of controls and visual elements are presented in a standardized way on glossary pages?

iTecDeaf is a specialized page, with a well-defined purpose, the visual blocks are displayed in predictable places, that is, at no time will users be surprised by an interface item being displayed in another place than expected. On the other hand, evaluator 4 highlighted another important point, the thumbnails of the signs do not have a defined order and they could be organized alphabetically.

Question 4: Is finding a specific sign in iTecDeaf without search engines a relatively simple operation?

The Evaluators 1 and 4 mentioned that iTecDeaf has an attractive interface that allows them to locate terms easily and without relying exclusively on search engines.

[10] Department of Distance Learning (SEAD) of FURG. For more information, access the URL: http://sead.furg.br

[11] Federal Institute of Education, Science and Technology - Rio Grande do Sul. For more information, go to a URL: https://ifrs.edu.br/

[12] Institute of Innovation and Information Technology. It can be accessed at: https://proiti.furg.br/

The glossary is organized into areas of knowledge and the subjects help in the search for a technical term, however, evaluators 2, 3 and 5 consider it necessary to develop an agile search engine because an increase in the number of signs to be inserted is imminent. in iTecDeaf during its use and the search for a certain technical term can become difficult.

Question 5: When interacting with iTecDeaf, were there any errors or warnings?

iTecDeaf was developed with the aim of presenting content in an organized, minimalist and accessible way with a well-designed interface advocating error prevention according to the guidelines of [19], as well as the usability principles of Nielsen [11].

Thus, when using iTecDeaf, the evaluators did not witness any errors or abnormal behavior that compromised its functioning. However, evaluator 4 considered a warning of a website under construction as a warning when accessing the technical terms pertaining to Food Engineering because there were still no signs posted for this area of knowledge.

Pergunta 6 Question 6: Can the user perform their activities efficiently and simply?

The interface is friendly, easy to navigate and interact; It's spacing is well used and helps to maintain the perception of the main blocks such as the menu, the sign thumbnails area and other informative elements. The interface was designed to make it minimalist with a high level of pregnancy, that is, with a simple, balanced and homogeneous visual organization, easy to interpret and understand [21]. However, evaluator 1 points out that a deaf user in the learning process may find it difficult to look for or understand terms that are in the English language because normally they don't master it.

Question 7: Do you consider the use of thumbnails with animations a facilitator for the preview of signs?

The evaluators considered the use of thumbnails with animations made possible through the mouse-over, a differential mechanism of the project and an innovation in the presentation of signs in technical glossaries. This feature facilitates the visual perception of the deaf because it allows the acquisition of information by reducing the amount of interaction clicks, providing direct and understandable answers. Consequently, its use minimizes the memory load needed to assimilate certain information [19].

Question 8: Are the videos of the signals in an adequate resolution?

The videos presented satisfactory resolution because it is possible to clearly perceive the interpreters' hands, as well as the movement of the fingers and facial expressions. The framing of the videos and animations made it possible to follow the trajectory of the performer's body and upper limbs during the signaling, which proved to be expressive and not exaggerated, reducing the likelihood of communication noise as explained by [20]. It is noticeable that videos do not need to have a professional quality to be useful, they just need to be correctly inserted in the interface and that they are informative, collaborating with users' learning [10].

Question 9: Do animations and videos have proper loading times?

The evaluators ran some tests with different internet speed settings and in all respects the signs loaded quickly as most were approximately 200 KB in size. In addition to these settings, iTecDeaf was tested in some browsers and the loading time of signals and animations remained fast and satisfactory.

In this way, the glossary has an interface with numerous visual elements and in constant movement without delays in the display of videos and animations, demonstrating consistency and quality of use [9], [11].

Question 10: Do you think it is important to use signwriting in the description of signs?

Experts consider signwriting a complementary resource for the interaction of deaf users in iTecDeaf because it favors understanding in the reading of technical signs. It is a way of writing that preserves its three-dimensional characteristics, helping to improve communication, stimulating creativity and the cognitive development of the deaf [22].

The evaluation of the usability of iTecDeaf occurred in a predictive way, made possible by a checklist of 10 questions, carried out by 5 specialists in the area of Information Technology in Education. Therefore, the glossary obtained 43 positive responses, guaranteeing a value of 86% of approval, as shown in Fig. 6.

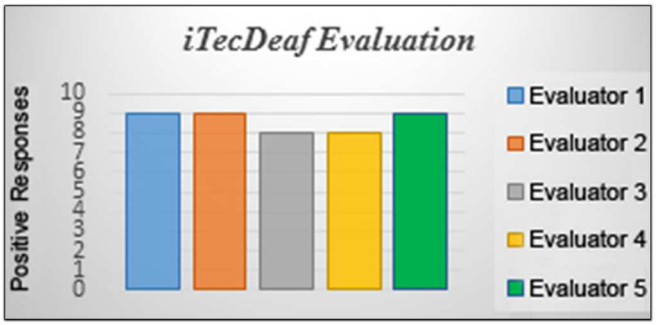

Fig.6. Positive responses from evaluators

The iTecDeaf presented a positive value in the evaluation, as it presents content in Libras through thumbnails with animations that replace text menus, fingerspelling in written form and signwriting in order to avoid the cognitive overload of its users. In addition, it provides its visual elements in a standardized way in a minimalist format and videos of signals in adequate resolution and timely loading.

V. FINAL CONSIDERATIONS

When deaf people enter technical and higher education institutions, they face several obstacles, in which the subjects that have technical terms, adequate to their specificities, and that do not have a Libras translation stand out.

As a result, it became necessary to build iTecDeaf, a glossary of signs for technical terms, learning mediator instrument with an interface built to prioritize the deaf user, as it is based on their native language, but with LP support, which establishes it as a bilingual environment. In view of this, iTecDeaf presented a dynamic interface with a consistent and standardized appearance with the use of mouse-over, videos, animations in LS, signwriting, fingerspelling in its written form. Such elements provide relevant content, support for the cognitive aspects of learning and usability suitable for the target audience.

Predictive evaluation was chosen to identify or predict possible design problems in the interface, navigation and user

satisfaction from a technical level. It was carried out through 5 specialists in the area guided by a checklist of questions that reached 86% of positive responses, in addition to suggestions for improvements.

We can consider iTecDeaf as a digital artifact that facilitates learning, built with a dynamic interface based on Vygotsky's principles and usability to provide access to signs of technical terms, which can help deaf students, interpreters, teachers in their academic activities. Regarding future work, it is intended to carry out accessibility tests in iTecDeaf and classroom assessments with deaf students.

REFERENCES

[1] L. Marconcin et al, "O olhar do surdo: traduzindo as barreiras no ensino superior," Revista Eletrônica do Curso de Pedagogia das Faculdades OPET, Ensaios Pedagógicos, pp. 12, 2013

[2] K. MACK et al, "Social App Accessibility for Deaf Signers". ACM Hum-Comput. Interact, vol. 4, article 125, 2020.

[3] F. MARTINS, "Terminologia da Libras: Coleta e registro de Sinais-termo da área da psicologia. Doctoral Thesis in Psychology, University Federal of Santa Catarina, Florianópolis, 2018.

[4] R. GRANADA, R. Barwaldt, and D. Espíndola, "Glossary of computational terms as a stimulus to programming logic: a case study with deaf students.", *IEEE Frontiers in Education Conference (FIE)*. IEEE, 2018.

[5] R. GRANADA et al, "Computational glossary in Libras: an experience in undergraduate program of Information Systems." , *IEEE Frontiers in Education Conference (FIE)*. IEEE, 2019.

[6] C. BISOL and T. SPERB, "Discursos sobre a surdez: deficiência, diferença, singularidade e construção de sentido", Psicologia: Teoria e Pesquisa, v. 26, n. 1, 2010, pp. 07–13.

[7] L. VYGOTSKY, A Construção do Pensamento e Linguagem. Ed. Fontes, 2nd ed, 2009.

[8] L. VYGOTSKY, Obras Escogidas, T5 – Fundamentos de la Defectologia. Ed. Antônio Machado, 1st ed, 2012.

[9] J. PREECE, H. SHARP and Y. ROGERS, Interaction design: beyond human-computer interaction. New Jersey: John Wiley & Sons, 4th Edition, 2015.

[10] D. PETERS, Interface Design for Learning: Design Strategies for Learning Experiences. Indianapolis: New Riders Publishing, 1ª Edition, 2013.

[11] J. NIELSEN, Usability Engineering. Burlington: Morgan Kaufmann, 1st ed, 1994.

[12] M. MINAYO, "Pesquisa social: teoria, método e criatividade. Petrópolis: Ed. Vozes, 34th ed, 2014.

[13] A. GIL, Como elaborar projetos de pesquisa. São Paulo: Atlas, 7th ed, 2019.

[14] V. MALACARNE and V. OLIVEIRA, "A contribuição dos sinalários para a divulgação científica em Libras". Ensino em Re-vista, Uberlândia, v.25, n.2, 2018, pp. 289-305.

[15] C. MCKEOWN and J. MCKEOWN, "Accessibility in Online Courses: Understanding the Deaf Learner. TechTrends", v. 63, 2019, pp. 506–513.

[16] I. SAKIS and G. BERNARDI, "Rede Social de Aprendizagem Colaborativa para Surdos e Deficientes Auditivos". Revista RENOTE - Novas Tecnologias na Educação, v. 18, n. 1, 2020.

[17] A. YERATZIOTIS and P. ZAPHIRIS, "A heuristic evaluation for deaf web user experience. International Journal of Human–Computer Interaction", v. 34, n. 3, 2018, p. 195-217.

[18] C. PELAYO et al, "Codice: Assisting Vocabulary Learning for Students with Deafness". In: Proceedings of the 7th Mexican Conference on HCI, Mexico, 2018, pp. 1-4.

[19] R. PRESSMAN, Software Engineering: a Practitioner's Approach. Porto Alegre: Amgh Editora, 8th ed, 2016.

[20] C. FLOR, "Recomendações para a criação de pistas proximais de navegação em websites voltadas para surdos pré-linguísticos", Doctoral Thesis in Engineering and Knowledge Management, University Federal of Santa Catarina, 2016.

[21] E. CHROMIEC and M. BECCARI, "Representação Gráfica: uma abordagem crítica sobre as teorias de representação e percepção de Gombrich e Arnheim no contexto do design gráfico", InfoDesign-Revista Brasileira de Design da Informação, v. 16, n. 1, 2019, pp. 1-15.

[22] G. SILVA-OLIVEIRA et al, "O signwriting como proposta de registro escrito do sinal-nome/pessoa em libras", South American Journal of Basic Education, Technical and Technological - SAJEBTT, v. 7, n. 2, 2020, p. 661-672.