

Sign Language Writing Acquisition – Technology for a Writing System

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Abstract

The Deaf use Sign Language for intellectual development, communication and other language dependent tasks, including the learning of the oral language in which they are immersed. However, Deaf children should no longer be expected to access academic learning using the oral language [1][4][6]. Rather they need to have access to a writing system in/for Sign Language. Writing systems (sequence of characters to represent a language) store and retrieve vital information for literature, science, knowledge creation, information dissemination, communication etc. SignWriting is a writing system deemed adequate to the spatial-visual nature of Sign Languages. However, the existing learning methodologies and computational technologies fail to help the Deaf (they lack usability, and/or are one-to-one translation from the oral language etc.). This article proposes a new, more natural approach: that of using screen and stylus, in context. It also presents a framework with which to develop tools for written literacy in Sign Language.

1. Introduction

Deaf people have the right to access the available human possibilities such as symbolic communication, social interaction, learning, etc. Sign Language, of visual-spatial manner, is the natural language of the Deaf, capable of providing complex linguistic functionalities [1] [4] [23][51].

Unfortunately, Deaf children who are born into non-Deaf families (90% of the cases) lack mother tongue acquisition [4]. This lack of early language acquisition causes dire consequences to the Deaf's intellectual development, citizenship and culture, according to [2]. According to [51], language is essential for quality education; it is necessary for children and adults to be able to use their own language to participate in the world around them, both orally and in written form. But most Deaf do not have that opportunity "simply because their language is not written down". The lack of a writing system is

a factor of marginalization. The use of a writing system interacts with other factors to: promote literacy for economic development; to aid in the learning of another language; to provide means for a wider communication of the culture values – thus leading to appreciation by others of the richness of the language; to give the option to use it in the electronic media [51].

The Deaf have difficulties to acquire a writing system, be it of the oral language, or of the Sign Language [4]. *SignWriting*, created by Sutton (based on her *DanceWriting* – an iconic method to "write" dance movements), is the most used writing system for Sign Language, and should be taught and used [3] [51]. Writing systems (sequence of characters to represent a language) serve as support for the modern, global society. Writing systems are used for literature, cultural preservation, information storage and retrieval, science, knowledge creation, communication among many other vital societal functions.

Family, social, technological and educational inadequacies prevent Deaf children to become competent readers and writers: in order to acquire the written language there needs to be a natural development of language, intelligence and an immersion of the learner in the social practice of the written language [4] [5].

According to [6], Deaf children should no longer be expected to access academic learning using the inaccessible majority (oral) language. Unfortunately, this goal is still elusive. Mostly, there are very few teaching methodologies and fewer computer systems that aim at providing the Deaf and their interlocutors with writing system support [4]. For example, the systems lack usability (mainly, they use an oral language paradigm, such as a one-to-one translation, among other problems).

Also, there is little written material in Sign Language, thus depriving the Deaf community of a major component of their culture. As an exception, the reader may find some material at [3].

The challenge to provide tools for learning and creating written Sign Language for Deaf children and their non-Deaf interlocutors is an urgent, clear call

for innovative approach, lest we are faced with an entire community with no written history. Memory dependent and non-memory dependent are two different manner of human existence: the latter being the basis for modern society.

The work in [7] presents a pedagogical architecture to inform design of tools for bilingual literacy for Deaf Children. Bilingual literacy, considered to be the most adequate choice for Deaf education [1] [4] [6] [10] [12], is the resulting process of appropriation and use of Sign Language as a mother tongue, for intellectual development, and the written modality of the oral language as a second language [1] [4].

This research proposes a framework with which to create tools for written literacy. Literacy differs from the simple act of reading and writing because it presupposes an understanding or an adequate use of such skills within the society in which the text is immersed [8].

Thus, this research is twofold: firstly, it proposes a literacy approach, in which learning is a process where the learner acquires the writing system in a context of use. Additionally, the framework informs design of tools with which such learning occurs within a new paradigm – that of using touch-screen technology and stylus, in a natural, more direct writing way. Simply put, the user would write the primitives of *SignWriting* into the tablet using the pen.

The remainder of this paper further describes the plight of the Deaf, and their need for Sign Language and a writing system; briefly discusses *SignWriting* as a writing system of choice; shows some inadequacies of related work and, then, presents a framework with which to develop tools for written literacy in Sign Language. A tool for teaching *SignWriting* was developed as per the framework. Initial results show the adequacy of the proposed approach.

2. Sign Language, writing and reading

The lack of early Sign Language acquisition precludes the Deaf to acquire basic concepts of daily living [9]. Consequently, the Deaf do not learn to ask questions in order to clarify doubts. Thus, they do not start to form relations that alter their cognitive structures, combining, comparing, inferring, deducing and extrapolating old and new knowledge, in a mental process that is mediated by social experiences and language.

This lack of mother tongue acquisition is detrimental to the intellectual development of the

Deaf, with severe consequences: the inability to perform daily tasks for the development of intelligent action; the inability to learn and plan; the inability to overcome impulsive behavior; the dependency on concrete, visual situations; difficulties to control herself and to socialize, among others [10].

Additionally, the Deaf grows into a reality where there is little written material in Sign Language [3]. It is not enough to present the Deaf with concepts in the oral language, and expect them to create concepts in their own culture and natural language [6].

Such monolingual model has deprived the Deaf of higher achievements, when compared to their non-Deaf peers. The “interdependence theory” by [11] tells us that there is an interaction between the language of instruction and the type of competence the child has developed in her language prior to school. Additionally, for [12], the Deaf should be able to create their own knowledge. And to create their own knowledge in their own language, which includes the use of a writing system for Sign Language [51].

The problem of alphabetization is still subject of much investigation for writing systems for the oral languages. However, for Sign Languages, it has only recently entered the research agenda. Despite investigations on experiences of the Deaf learning to read and write, Deaf students continue to plateau at levels below non-Deaf students, according to [13]. For the Deaf, the widely used premise that she has already had contact with the letters does not apply. Deaf children have at their disposal all of the language acquisition devices, systems, capacities and mechanisms [14]. And in order to use all this potential, the Deaf child should be immersed in Sign Language as their mother tongue, so that they can also benefit from intellectual development [6].

To understand the benefits of the social use of the mother tongue, one needs only to observe that non-Deaf children learn to hear in her family circle: the start of language acquisition process that is social and interactional by nature. Such process starts the intellectual development of the child. Therefore, it is essential to realize that each and every child brings her own experiences that should be used in the process of literacy [15]. According to [16], in order to make use of such experience, educators must understand the manner in which the child not only learns the subject, but also how she appropriates its linguistics, social and cultural components: how does the process which creates meaning work?

The learning environment must make sense to the child, and should be so that she partakes in a collective construction of the daily text, that will eventually turn symbolic. Literacy occurs in the

interaction with mediation, and comprehension and context are to be found in the text. They are not on the mere fragmentation of the word, which, out of context, makes no sense. This brings us to the many possibilities in learning to read, as [17] tells us to use “sedimentation”, in its Vigotskian sense: human behavior is sedimentation of successive layers in which the new one builds on the previous one [18].

Before the letters, the first knowledge is of the word: the text and the context reflect the experiences the child has in the culture in which she is immersed. There follows a need to broaden the child’s vision of the world and her ability to feel, think and act on it. Writing systems are a form to represent language. What differs a drawing from a symbol from the writing system is the association of an utterance with the graphical form. For non-Deaf persons, this can be a word, for example. A drawing is a reference to things in the world about which one can make comments. When marks signify meaning, the reader/writer develops intentionality, a turning point in literacy. Deaf children have been observed rehearsing manually (fingerspelling) what they intend to write – a strong dependence on visual and kinesthetic strategies [19].

3. Importance of a writing system for Sign Languages

Eighty five per cent (85%) of the world population uses some sort of Writing System, which serves as support and basis for the modern, global society [20]. Writing systems serve many functions: they reproduce speech, thoughts, and abstract concepts among other language related events. They are more than “the painting of the voice” as Voltaire wanted: writing systems are a cultural representation of society, as used in literature; they are the utmost tool of human knowledge, necessary for science development; they play a major role in information dissemination in journalism; in many cultures, the calligraphy is an art.

As for the Deaf, writing systems are more objective and substantial than the linguistic communication: they allow for abstract notions; and they are rooted in the fundamental human need to store and retrieve information for communication with others over time and space [21]. Writing systems are used to organize our lives, record our dreams, discoveries and feelings [22]. Additionally, writing fulfills specific functions and meanings that require deliberate analytic actions capable of constructing an intentional structure: writing conveys

more than ideas: it represents our way of seeing, feeling and interpreting the world [23].

The new intellectual technologies brought about by the computer should be better explored both as managers of memory, through recording of social enunciation, and through writing systems, that allows humanity, via writing, to keep a more permanent history, less dependent on individual memory [24]. Computers have the potential to alter roles between speech and writing, as they free writers from speech, thus allowing for innovation. The human being should acquire the writing system in the moment when she is instigated and directed towards written material, thus making writing a part of a context of functional use of the language, in which the language acquires a character of real meaning.

The Information and Communication Technologies bring new demands on the educational process: education must empower people to perceive critically the way they exist in the world, which is not a static reality, but a reality in process, in transformation – populated by people and their relations. There has to be a comprehension, by the children and their interlocutors of the social function of reading and writing [25]. Thus empowered, they become critical thinkers and problem-solvers, agents of change, capable to “read the word and write the world” and control their social future. It is important to have a critical knowledge of the language use in order to participate and achieve personal and social goals [26]. This should include the learning, also, of a systematic orthography for Sign Language. Notes, labels, videos are indications of such social function, with which the child should be accustomed, and to the extent that they serve to organize the world in her environment, even before they start to draw the “letters”.

Writing is a consequence of the fact that the person knows how to read. He who reads is able to write – readers acquire a writer’s code [27]. However, the opposite is not true. One of the skills for reading is to decode the writing system. The acquisition of the writer’s code is contingent on the fact that readers consider themselves to be a member of the writers. Hence, a writing system for Sign Language is in direct relation to the Deaf child’s thought process. Such view of the process is usually related to alphabetization: “[...] *condition nécessaire, bien que non suffisante, de la compréhension des textes [...]*”¹, a step that cannot be achieved without explicit instructions of the code/decode process [28]; a process that has positive

¹ “Necessary condition, although not sufficient, for the comprehension of texts”.

Writing systems are usually associated with the oral language and, as such, there is a misconception about the possibilities and gains of the use of a writing system by the Deaf, who use Sign Language. Sign Language is a complete linguistic system, of visual-spatial manner. Thus, Sign Language requires a writing system that is compatible to its nature (i.e. a writing system that is capable of mapping the visual-spatial properties of the language that it proposes to represent). There is no meaning in an alphabetization that is not accompanied by some form of shared cultural knowledge: one of the ways the Deaf have to pursue social inclusion and their basic rights and citizenship [1] [2] [4].

The use of an adequate writing system for Sign Language helps the Deaf to develop an internal structure akin to her natural language, in a process that increases the linguistic and cognitive skills; such use enhances identity and Deaf culture [1].

There are co-existing proposed writing systems for Sign Language, of which the following are some examples: Mimographie notation by Bébien [33]; Stokoe notation [34]; Hamburg Notation System – HamNoSys by Hanke [35]; D'Sign system by Jouison [36]; François Neve notation [37]; and *SignWriting* [4]; some are restricted to the Brazilian Sign Language, such as Elis [38] and SEL [39]. The

3. Writing system for Sign Languages

	Sign Writing	Stokoe	HamNoSys
what?		$E_0 E_0 z \sim$	$\sim \text{[face]} \text{[question mark]} \text{[hands]}$
quote		$\ddot{N} \ddot{N} \dot{a}$	$\sim \text{[face]} \text{[quote]} \text{[hands]} \text{[double underline]}$
three		$3^\perp$	$\text{[hand]} \text{[three]} \text{[double underline]}$
bears		$\text{[face]} \text{[hands]} \text{[double underline]}$	$\sim \text{[face]} \text{[hands]} \text{[double underline]}$
Goldilocks		$\text{[hand]} \text{[three]} \text{[double underline]}$	$\text{[hand]} \text{[three]} \text{[double underline]}$

SignWriting is universal (i.e., just like the Latin alphabet is used by many writing system, *SignWriting* is used by many different Sign Languages) [40]. *SignWriting* is based on a pictorial/ideographic representation system, whose organizing principle follows visual-spatial significant elements. It is a system conceived to be used by Deaf people in their daily tasks. It serves the same purposes as other writing systems from oral languages: take notes, read and write books and newspaper, learning at school, write contracts, do

research, create literature etc.), thus making it valuable in real practical use.

SignWriting has only recently entered the scientific agenda [23]. Although still incipient, the evidence on the advantages that the incorporation of such writing system would enhance accessibility and social inclusion of the Deaf are undeniable. The current literature point to, at least, two main advantages related to the political and social recognition of the Deaf community and its natural language (in our case, the Brazilian Sign Language (BSL)).

The incorporation of the writing system of the Sign Language (i.e. *SignWriting*) into the political-pedagogical projects developed in a bilingual context for the Deaf represent a paramount contribution to the dissemination of the BSL and of the Deaf culture. Additionally, such incorporation constitutes a mediating tool for Bilingual Literacy of the Deaf, based on visual semiosis. Bilingual literacy, considered by [1] [4] [23] to be more adequate for Deaf education, is the movement that claims the use of, at least two languages. Literacy is the resulting process of social practices of the use of the written form as a symbolic system and as a technology, in specific context, for specific goals, to be acquired by the Deaf via a functional use of the language, where language assumes a character of real meaning [1:131].

From the point of view of the linguistic political planning, the use of the semiotic writing system legitimates the representation of the Deaf culture, as well as the identity ties, given the important role that the dissemination of a writing system takes on the standardization, lexical enhancement and overall literary and artistic accumulation [1]. In such political and social scenario, a more natural use and dissemination of *SignWriting* provided by informational tools creates the opportunity for a greater balance in power relations between the BSL and the oral language (Portuguese, in our case) due to historical role of writing systems in maintaining alive the memory of the language, by incorporation and recording of the collection of human knowledge.

From the pedagogical point of view, the current discussion is related to the specificities of the alphabetization of the Deaf, and how the *SignWriting* should constitute a mediating element in the appropriation of the alphabetic writing system of the oral language [4] [15]. The learning of the oral language by the Deaf works with the premise that meaning attribution in writing follows from visual and symbolic processes, in which the use of Sign Language takes on a pivotal role. The written form of the second language can be achieved because the

development of writing is independent from the oral language, given that it is a different system, both in structure and behavior [18].

However, to realize such premise, there is a need for methodological process that differs from the ones used in teaching the oral language as the mother language. The current methods do not scaffold the learning by the Deaf, and it takes approximately nine (9) years to alphabetize a Deaf child [24]. These latter processes rely on the relations between phoneme and graphemes made by the native speakers. The Deaf cannot achieve such relation of the sound and its written form.

Some studies about the specificities of the literacy process of the Deaf [1] [4] [5] use the Sign Language as a mediating symbolism in the learning of the written text to enable the insertion of the Deaf in literacy practices. The direct visual aspect of *SignWriting* contributes to the development of what Vigotsky calls the complex superior psychological functions (e.g. memory, abstraction, generalization, meta-language etc. [18]) of the Deaf children, in a manner that increases literacy.

Existing editors are detrimental to the teaching and use of *SignWriting*. Consider, if you will, a scenario where a Deaf is watching a class, and wants to take her own notes: such simple task would be time and effort consuming. The present research proposes a more natural way to enter text in *SignWriting*: hand-written character in a touch-screen device, with the use of a stylus.

4. *SignWriting*: a choice of a writing system for Sign Languages

[34] and others have identified several parameters of the Sign Languages, such as Hand Configuration, Contact (Location), Palm of Hand Orientation, Global and Local Movement and Non-Manual Expressions. Linguists use such phonological parameters to describe a sign in Sign Language. And several computational models have been created to represent them [26]. Devised by [3] in the mid-70's, *SignWriting* has been the most universally accepted and used writing system for Sign Languages around the world [15] [23]. The reader can find learning materials for *SignWriting* in [3] [23].

According to International *SignWriting* Alphabet (ISWA) [41], there are 30 pictorial symbol groups. Each group contains 639 basic pictorial symbols. It is possible for each basic symbol to have 96 variations (up to 6 different fills and 16 rotations). Such combinations yield a total of 35,023 valid symbols. These numbers have increased with the ISWA 2010.

A much longer time is therefore needed to select and combine symbols to input a single sign than to type a word. The few existing editors for *SignWriting* are not complete; they lack usability resources; they are not in SL (i.e. they are in the oral language), they use specific, sophisticated software interaction (e.g. many levels of a menu to find a primitive) etc., all of which render them difficult to use, and they exclude the context of natural writing by the Deaf.

SignWriting preserves the tridimensional characteristics of the Sign Language as it contemplates several representations for the phonological parameters, such as: Hand position and orientation; Types of Contacts; Hand Configuration; Finger Movements; Arm Movements and Pointing; Non-Manual Expression; Facial Expressions; Location of Symbols in the Head; Head Movement; Gaze orientation; Body Movement; Movement Dynamics, among others. Figure 2 shows a picture of a Hand Configuration in three orientations and its representation in *SignWriting*:

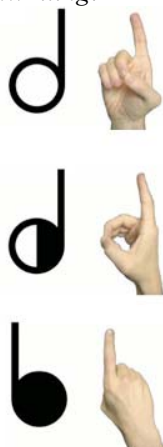


Figure 2. Hand Configuration and the corresponding *SignWriting*.

Figure 2 shows the basic *SignWriting* primitives for a hand configuration in three different orientations. Some of the symbols used by *SignWriting* are very iconic, which allows for a rapid association with the actual sign. The graphemes are presented simultaneously and sequentially, that best suit the nature of the Sign Language – a considerable difference when compared to other writing systems, which present the graphemes in linear form, in a pattern that follows the logic of the alphabetic writing of the oral languages.

5. Related work

Albeit the several positive aspects related to accessibility and inclusion that the systematization

and dissemination of a writing system in Sign Language would bring to the Deaf community, there are very few publications and educational methods, and the informational tools in *SignWriting* are precarious [23].

As for the educational materials, the site www.signwriting.org presents the reader with timely information about teaching *SignWriting*. It also provides links to various projects around the world in which the writing system is successfully used.

However, most of the material is descriptive of the system itself – its components, divisions, primitives, rules and other aspects of *SignWriting*. While these aspects are all important, little pedagogical material geared towards Deaf children and their interlocutors is presented.

Additionally, the materials used are mostly in paper. The use of computers, while present in the form of the use of *SignWriting* computer text editors, is marginal to the actual process: it does not take the pivotal role like the one proposed in this research.

The editors for *SignWriting* can be thus classified: First we have the “drag and drop” paradigm [42] [43] in which the user is presented with a series of menus she must navigate to find the desired *SignWriting* primitive, drag it to the “writing” area, and repeat the navigation process until she finds all the primitives she wants (out of at least 35,000 primitives). Then, she is left with the task of trying to place the primitives on the correct location in an attempt to form the desired sign, with little to no usability and accessibility support.

Some editors require the user to wear cumbersome accessories, such as gloves, sensors etc [49]. Others [44] are one-to-one translation from the oral language: this requires the Deaf to have extensive knowledge of the oral language (which is often not the case). Additionally, Sign Language is a completely different language, not dependent on the oral language, which makes such translation not viable. This approach allows for the writing of only the words that are present in the editor’s database (e.g. COFFEE may be in the database, but, if CAFETERIA isn’t already stored in the editor, then the user won’t be able to generate the *SignWriting*). Lastly, there are highly computational mark-up languages (SWML) [45], not adequate for general use. They would be more adequate for an actual translator: but that still will be more suited for non-Deaf people, who would be required to know before hand the entry to such translator (usually, the oral language, or some sort of video recognition). Unfortunately, to our knowledge, there isn’t work on handwritten *SignWriting* available.

6. Learning *SignWriting*: a framework

A writing system for Sign Language is in direct relation to the Deaf child's thought process [46] [47]. Such approach borrows from Goodman and Goodman's theory of a "whole-language" understanding of literacy as a process and as a valued social behavior [32].

[7] presents a pedagogical architecture to help members of the Deaf community and developers to inform design of tools for bilingual literacy. The created tool incorporates iconic elements in Sign Language, which are represented by an animation. Then, it presents the user with videos containing "spontaneous" and "scientific" concepts both in Libras and in written Portuguese. Spontaneous knowledge are those required in the daily, concrete experience. Scientific knowledge are more abstract, not mandated by the concrete only, more rational, acquired by explanation, related to previous knowledge and concepts.

The proposed framework extends the pedagogical architecture to include *SignWriting* so that the designed tool presents the Deaf child with a relation of the uttered sign to its written form. The use of the designed tool brings with it all the knowledge it already contains about a chosen real-life experience. Additionally, users of the tool will have already had the chance to learn (or at least be exposed to) such knowledge:

1 – The system is an extension of the original system designed as per the pedagogical architecture [7], adapted to run on a device that provides touch-screen and stylus. It presents a social environment from the daily life of the Deaf. In this example, a city park, with 13 elements whose Sign Language signs are iconic (tree, bird, butterfly, arbust, rain, clouds, sun, worm, grass, duck, fish, bicycle an sunglasses). Figure 3 shows the initial screen.

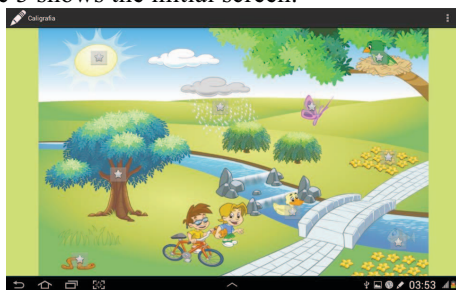


Figure 3 – Initial screen

2 – Its initial behavior replicates that of the original system for literacy [7]: after selection of an element, the illustration showing the iconic Sign Language sign is presented, followed by a video with some knowledge, both in Libras and written Portuguese. Figure 4 shows an example of the video, with the

Sign Language utterance and the written Portuguese "The butterfly flies".



Figure 4 – Video and knowledge

3 – The next step then gets the signs from the video – signs that already have been presented to the users – and show the *SignWriting* representation. Figure 4 shows the *SignWriting* for butterfly.

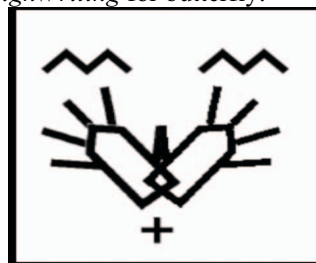


Figure 5 – Butterfly in *SignWriting*

4 – Each sign is then broken down in its primitives. Each primitive is presented to the student with images both of the sign (mostly, a picture of a hand configuration) and the *SignWriting* primitive. Figure 6 presents the hand configuration and the *SignWriting* primitive:



Figure 6 – Hand configuration and *SignWriting*

5 – The user is provided with screen space with which to practice the primitives – think of a non-traditional "calligraphy" system. Figure 7 shows the practice screen for the hand configuration.

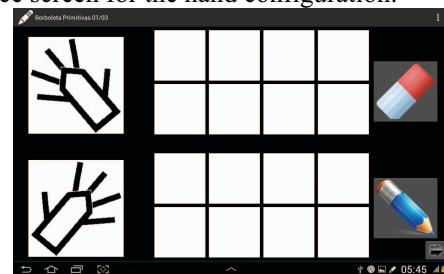


Figure 7 – Practicing the *SignWriting*

6 – After the practice of each primitive, the system presents the entire sign again, so that the student can now write it in full. Figure 8 shows the complete sign.

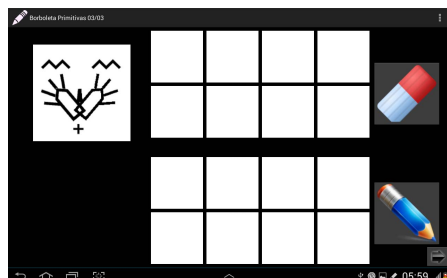


Figure 8 – Sign Language Butterfly

7 – The system goes back to the initial environment, to start a new interaction.

7. Case Study: writing *SignWriting*

How do Deaf people experience learning to write using *SignWriting*, a writing system for Sign Language? This research question leads to a naturalistic paradigm, qualitative in nature, where the interaction of sets of unique experiences, including those of the researchers, produce results that inform understanding, as opposed to variables that need to be controlled [48] [50]. Additionally, a community-based action research took place, in which participants collaborated in the process. Participants were 4 teachers and 16 Deaf students of a specialized school for the Deaf in the metropolitan area of the State Capital. The students were 7 to 8 years of age, with two years of schooling. The researchers acted as facilitators to the process of using the system. Students were from non-Deaf families, and their experience with Sign Language was that from the school – beginners.

The students had no formal knowledge of *SignWriting*. Neither did the teachers. This allowed for the learning process to occur simultaneously for both teachers and students. The sessions were in groups, each teacher working with 4 students, for 30 minutes, once a week, for 6 weeks.

Additionally, there was a meeting with the parents, who were instructed about the importance of the acquisition of the writing system. The parents were invited to take part on the experiments, in order to learn, and become users. Some of the pro *SignWriting* comments made by the parents were: a writing systems enhances the value of the Sign Language; it helps when I need to leave a note to my child; It is easier to use instead of video. Some of the con *SignWriting* comments were: It is not necessary, because there is video; it is very difficult to learn; it

has a lot of primitives; it takes time away from learning Portuguese.

The researchers collected instances of experiences from the participants, as per the procedure adopted by [48]: *Response* - positive or negative (e.g. “beautiful”, “difficult”, etc.). *Motivation* - interest and willingness to do more. *Reflection* - process of expressing an opinion (symbol accuracy, sign examples). *Assertion* - appropriation of the system

Experiences: some observations and utterances:

Response: both teachers and students responded very positively to the system: “it is beautiful”, “it is fun”. The students were very excited about the use of the tablet with the touch-screen and the stylus: “better than in a paper”.

Motivation: The students seemed to perceive it as a game, more so than an educational tool: “can I play again?”, “can I take it home to play in my computer?”, “when is the next time we will play?”.

Reflection: There was a discussion whether the sign for tree was with the palm of the hand facing up or down. Hand configurations for both duck and bird depicted a lateral view, and the students and teachers thought that it should depict a back view. A lot of discussion occurred as to the actual format of the primitives: that was a flaw from the system. In order to fit the primitive into the screen, it was enhanced, thus making the lines appear to be large stripes.

Assertion: The system allowed for practice of primitives of a given sign, and then, the complete sign. Teachers and students kept asking for additional signs, and for the entire sentence. This is also a choice of the system, which should be corrected for later versions.

Accounts:

The teachers perceived the introduction of a writing system of the Sign language as a very positive opportunity for them to prepare classes, and for the students to take notes. Although this is a rather simple use of *SignWriting*, it is clearly a practical one, with immediate application.

The teachers expressed a frustration with the overall slow pace of learning by the students, mostly due, according to them, to the lack of language exposure at home: “they don’t have with whom to interact, practice”. The teachers pointed that parents vary on the degree to which they accept and act on the child’s condition. Notably, most parents are not fluent in Sign Language, thus making it difficult to help the child with her homework. This was reinforced by the claim that most students didn’t do homework, and that they stayed later in school in order to finish their tasks.

All agreed that the proposed tool, due to its use of iconicity, and written Portuguese, provided them with

rich material with which to work. The context and knowledge that the tool presented before the actual *SignWriting* helped them and the students to understand the written system. This was true for the children too, as they reflected on the symbols, trying to find other signs where they would be used.

The teachers said that the tool was important to get the parents engaged in learning Sign Language, with two outcomes: increasing the importance of the language for the children, and allowing for better communication and understanding among them.

Most students thought that the written Portuguese was the writing system for their Sign Language. The research provided them with an understanding of the separation of both languages. And empowered them to relate the way they think to the way they are now able to write. Many ideas and variations were discussed, because they now felt free to express their thoughts. This was an important moment to convey to the students that their writing system also have rules that must be learned and obeyed.

8. Discussions

The need for a writing system is undeniable. Contrary to common belief, Sign Languages do have writing System. *SignWriting* is the most successful and used writing system for Sign Language. However, there is a lack of methods and computational tools for teaching the Deaf how to write in their own language.

The problem of alphabetization is still open for Sign Language literacy. This research proposes a pedagogical methodology based on the social importance of literacy. Additionally, it presents a new use of existing computational tools: that of a tablet, with touch-screen and stylus, so that the user can write directly on the screen – instead of the cumbersome existing text editors.

Students and teachers accepted and embraced the proposed technology. It is our sincere understanding that this research advances the state of the art.

This research could have been done with a larger audience, over a longer period of time. The parents should have been active participants. The system should be tested for other groups: age, level of proficiency in Sign Language and in *SignWriting*, non-Deaf, learners of Sign Language as a second language etc. The system should be more structure in its presentation of the writing system. Studies should be made to generalize the proposed technology into a theory of acquisition of written Sign Language. These and other research questions are already being conducted, and shall be the focus of future work.

9. References

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