Towards Gamification for Signed Languages

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ⓒ Catalina De La Rocha, 2015

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Abstract

This project created an educational game to support the Mexican Deaf community in teaching and learning the Mexican Sign Language (MSL) with their hearing family and friends. Visual elements understandable by both hearing and non-hearing players were used to bridge the gap between Signed Language and Written Language. The game uses SignWriting® and Augmented Reality to afford a convivial learning experience and to promote MSL in Mexico. A Design Thinking approach was used to empathically examine signals, trends and drivers, and gathering inputs from global experts. Integrating digital and tangible tools, a game was created using Augmented Reality to provide a three-dimensional experience of Sign Language. The app encourages players to create their own word collections that could potentially create a MSL crowd-sourced library. Combining gamification, SignWriting® and crowdsourcing, the tool can be easily customized across different countries in different Sign Languages.

Dedication

To: My tribe. To all who believed in me and stood

by my side, on the phone and/or on the other side of the

screen, showing me how love moves mountains. You have

inspired me in immeasurable ways and I will eternally be

grateful with God for surrounding me with an army of

kinds hearts, open arms and big smiles.

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1   Introduction

1.1   A Scenario

"Consider the astronaut, for example. When you think about it you realize he is in fact, severely disabled. He cannot walk properly unless he wears special boots to keep his feet on the ground in that weightless outer space environment. He can't feed himself unless he learns to coordinate his hand to mouth movements. He requires specially prepared food. Nobody talks about his bowel and bladder needs but it's difficult to imagine how he could possibly cope without some special kind of clever collecting device! The astronaut can't even sustain his body's need for oxygen. He requires "life support" systems for his very survival.

Yet, who would label an astronaut "disabled", "deficient", or in need of intensive medical attention? Society doesn't see his or her significant physical incapacities as "problems" that need to be fixed. Assumptions of helplessness, inability, incompetence, or needing to be "cared for" never exist. In fact, it's the opposite! Rigorous training and expectations to carry onerous responsibility in carrying out complex and demanding outer space tasks are the norm. Astronauts are "heroes".

It's the environment, the "moon" that is deemed to be the problem, never the astronauts' deficiencies. His or her environment is perceived as hostile, alien, incompatible with life and definitely not accommodating to the astronaut's physiological requirements. So, at enormous expense and billions of tax dollars, assistive devices are created to enable that astronaut's physical and physiological needs to be "accommodated" so he can function, stay alive and breathe in that unfriendly world.

And so, it would seem that meeting the needs of "disabled" earth bound humans, whose unique physical requirements make it difficult to live and function in an everyday world, depends largely on society's values and perception. A person's physical abilities often cannot be changed, but the attitudinal and physical environment in which they live certainly can."

Audrey King, 14 March 2006[1]

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[1] http://www.independentliving.org/column/king20060314.html.

1.2   Context and rationale

One of the eight Millennium Development Goals of UNESCO is to Achieve Universal Primary Education by 2015.[2] The incidence of illiteracy is particularly high amongst people who are hard of hearing. Three out of every ten persons with a hearing disability in Mexico are illiterate according to the 2010 General Census of Population and Housing by National Institute of Geography and Statistics (INEGI). But the main challenge starts with a natural and basic human right: communication, for which language – signed or spoken – is a primary tool.

Due to multiple variables such as cultural differences, discrimination based on disabilities, personal beliefs or economic situations, it is the hearing parents and tutors around the world that make the decision about their deaf children's communication channel and type of education. And more often than not, they underplay the importance of sign language and encourage the deaf children to adapt to spoken language. The World Federation of the Deaf (WFD) reports that

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[2] http://www.unesco.org/bsp/eng/mdg.htm.

about 70 million deaf people around the world use sign language as their first language or mother tongue. The WFD goes on to stress that, " In every effort to improve deaf people's human rights, the removal of linguistic barriers is of paramount importance. A deaf person must have the right to use sign language in any given situation."[3]

Sign language not only provides access to communication, but is also the key for inclusion of deaf and hard of hearing people in their communities and families. It creates identity for the Deaf Culture and allows signers to express themselves and learn naturally.

1.3   Problem

Some parents and tutors accept to enroll their deaf children in a sign language program, but face challenges to keep updated with the learning process as the children progress to acquire vocabulary and fluency. Although communication and exchange of ideas takes place among the family members, it is broken and develops many gaps. There is a felt need for accessible learning tools that teach sign language to

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[3] http://wfdeaf.org/human-rights/crpd/sign-language.

family members to bridge these gaps than the other way around. This major research project explores the problem in the Mexican context and reports possible solutions, including one prototype game.

1.4 Project Objectives

The following high-level objectives guided the project activities:

- Promote Sign Language as a native language for deaf people.
- Open the conversation among bilingual families through a convivial experience.
- Empower deaf children to teach sign language to their loved ones.
- Contribute to the development of accessible and interactive apps in the market for the Mexican Deaf community.

The project culminated in the identification of gamification and augmented reality as strategies for creating an accessible and engaging sign language learning experience.

1.5 Design Challenge

The design challenge undertaken by the project was to identify and use technologies that make learning accessible, engaging and bring out the true flavour of sign language. A web app was the platform of

choice. Gamification techniques were incorporated to enhance learner engagement. Augmented Reality, a powerful tool that enhances two-dimensional tangible materials, was used to connect signed, written and spoken languages through images to create material that shows sign language in its true three-dimensional form.

1.6 Target User Group

This project focused on school children who are deaf or hard of hearing who

- Learn sign language and are members of a bilingual family
- Learn sign language empirically at a sign language program outside of the regular schooling system while learning about different topics related to their age
- Constantly learn new concepts and words in sign language
- Some members of their family know sign language but the majority does not, resulting in broken communication between the children and other members of the family.

The first version of the game targeted families in Mexico and used Mexican Sign Language (MSL).

1.7   Approach and Methods

A Design Thinking approach to problem solving was used (Brown, 2008). Design Thinking encompasses the ability to combine empathy for the context of a problem, creativity in the generation of insights and solutions, and rationality to analyze and fit solutions to the context. The project adopted the five key steps of Design Thinking as defined by Stanford University's d.school (Stanford, 2012): Empathize-Define-Ideate-Prototype-Test and the six priorities:

- Be biased towards action

- Collaborate across boundaries

- Focus on human values

- Be mindful of the process

- Prototype towards a solution

- Show, don't tell

The activities were organized into three phases: Discovery of relevant information through empathic literature review, environmental scan and expert interviews followed by defining of design requirements; Design of several possible solutions through a process of ideation; and Implementation of the game through prototyping and testing.

Despite the differences in the education systems in North America, the challenges that the Deaf community face to have access to high quality education and freedom of communication are very similar.

Experts in Sign Language education and advocates of the Deaf community were identified and were asked to describe these challenges in their country's context. All the information provided is accessible to the public through the associations where they are involved therefore no Research Ethic Board's approval was necessary for this study.

1.8   Outcome

The proposed solution is a web app with a crowdsourced library where users can upload their own vocabulary in sign language and a "hybrid" tool that involves both technology and paper. Using Augmented Reality, the users will learn and practice MSL vocabulary with their families and friends downloaded from the crowdsourced libraries of sign language words.

1.9   Report outline

The next section elaborates on the implications of signing and language as effective communication tools. Section 3 sets the technology context while Sections 4 and 5 explore the users challenges and strategy options for the solution. Section 6 defines the design requirements chosen and describes the prototype developed. Section 7 discusses how the resulting game is a game-changer and the importance and implications of the game in meeting the project objectives. The final section summarizes the unique contribution made by the project and outlines the next steps in moving the ideas forward.

2   Sign Language and Deaf Culture

2.1   Understanding Sign Language

The World Federation of the Deaf defines Sign Language as "a visual language that uses a system of manual, facial and body movements as the means of communication."[4]

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[4] http://wfdeaf.org/our-work/focus-areas/sign-language

As the rest of the languages in the world, sign language varies from country to country enriched with the culture and context of each community, but has the unique characteristic of having similarities in gestures and structure that make it possible for signers from around the world to understand each other. This is recognized as International Sign which rather than being an universal language, is a communication system that is generally used in international events such as conferences and the Deaflympics.   However, Valerie Sutton explains that translating from one sign language to another is not a simple process as the same hand shape and movement can mean drastically different things and the same "meaning" in a spoken language can be signed in drastically different ways, as sign languages are as indigenous as any other language, they are not a magically "universal" language.

There is a difference between the terms sign language and signed language.[5] As explained by Joanne Cripps and Anita Small from the Canadian Cultural Society of the Deaf (CCSD), the words sign and

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[5] http://www.deafculturecentre.ca/Public/Default.aspx?I=569&n=Signed+language+vs+Sign+Language.

language are nouns that together refer to the wholeness of a language that is interconnected socially, culturally and educationally.

They clarify that the term signed language is linguistically correct, with "signed" playing the role of an adjective describing the modality of language but it could be misinterpreted so that it does not support the values of the Deaf community. The only context in which CCSC would use the term signed language is to describe signed languages versus spoken languages in which case the explicit purpose of the discussion was to refer to the modality of languages rather than referring to the languages themselves.

2.2   The Gap

American Sign Language (ASL) was forbidden from educational institutions for most of the twentieth century in an attempt to abolish it, even though deaf education had been signed in the previous century.

This philosophy is called oralism. This current of thought is surprisingly still in force around the world, fuelling an on going war against inclusive education and forcing the framework of normalcy, "which insists upon pushing individuals into standard bodies" (Bauman

and Murray 2014) and considers cochlear implants as an ideal device to extinguish the existence of a signing deaf community.

A report presented to UNICEF in 2013 by the Teaching Institute for Learning Languages states that "the failure to achieve an education level according to the intellectual abilities of deaf people [in Mexico], derives from the education system that has prevailed for the last centuries in the country."[6] The system prevents deaf people from acquiring an efficient language to communicate and therefore from obtaining basic education. The lack of inclusive and accessible education isolates deaf people in Mexico from the hearing community for which the majority of products and services are designed. Most importantly, it directly affects their right to live with dignity and freedom.
Despite the efforts from the Public Education Secretariat (SEP) to make schools accessible, it is still evident that teachers are not trained to accommodate deaf students who end up copying assignments for the mere attempt to pass the class without really understanding and learning the content.

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[6] http://www.unicef.org/mexico/spanish/mx_10P-Modelo_educativo_bilingue.pdf

The Statistics National Institute for Geography and Informatics
(INEGI) in Mexico[7] reports that there are 69,445,176 people with
hearing loss caused by illness, accident, aging or birth in the country.
José Muñoz from the Disability Department at the Integral Family
Development center in Aguascalientes, Mexico, affirms that this is an
approximation far from of the real quantity, because it is based on the
population who agreed to participate in the Census and that many
households lie about their deaf members out of shame and
discrimination. In addition, the 2010 census states that three out of ten
deaf people are illiterate, to which Muñoz argues that out the other seven
people, only 20% have full understanding of what they are reading and
writing.

    The root of the problem lies in the lack of understanding of a
Deaf person's needs. The belief that everyone should fit the same mold
to succeed prevents the individuals from reaching their full human
potential according to their abilities and skills. The argument would be
over if society understood the concept of biocultural diversity discussed

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[7] http://cuentame.inegi.org.mx/poblacion/discapacidad.aspx?tema=P

by Bauman and Murray (2014) "If greater biodiversity is an indicator of the health of an ecosystem, the correlation suggests that greater linguistic and cultural diversity is an indicator of the health of a social ecosystem. Every language contains a worldview, a particular perspective on what it means to be human."

They saw that when the academic discipline of deaf studies focused on the cultural and linguistic uniqueness of deaf people, this understanding of deaf people was enormously successful in spreading the use and awareness of sign language throughout many countries.

For them, the concept of normalcy was not only about the majorities but also about defining the margins at either end of the curve. Their biggest understanding is that "disabled people, falling outside the boundaries of the normal, can serve as a stimulus to creating new technologies and new ways of thinking." Further, anthropologists postulate that things are not invented to meet needs but needs are discovered after something has been invented. According to Rich

Donovan, CEO of Fifth Quadrant Analytics[8], "Designing for extreme environments leads to consumer innovation".

In the monograph "American Sign Language for everyone" [9] the authors Samuel J. Supalla, Anita R. Small and Joanne S. Cripps, dare to imagine a world where reverse inclusion is applied to the educational system. They invite the institutions to stop assuming that all students can hear, remove the bias toward spoken language and understand that the needs of deaf students exceed the capacity of what's offered under "special education".

The authors, Irene W. Leigh, Donna A. Morere and Caroline Kobek Pezzarossi, propose a new definition of hearing loss: "Dislodging the four-letter word deaf from its essentialist roots based in hearing loss and shift the paradigm to the point where the words hearing loss take on a different meaning. In this sense, 'hearing loss' refers to the loss that hearing people experience by not being open to the benefits, contributions, and advances that arise through deaf ways of being.

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[8] http://returnondisability.com.

[9] http://www.deafculturecentre.ca/Common/ResearchN/Items/11_DCC_Monograph_2013_FINAL.pdf

Classic effects of hearing loss are a lack of comfort with eye contact, an inability to use the body as means of communication, a long- standing misunderstanding of the nature of human language, and a tendency to maintain monolingualism throughout one's life. With ideological rehabilitation, the negative effects of hearing loss can be mitigated."

2.3   Sign Gains

In the book "Deaf Gain, raising the stakes for human diversity" Bauman and Murray (2014) discuss how Sign Language represents a "medium of literature that has qualities that have been sought after for centuries: increased visual forms of textuality as well as a return to oral, performance, and embodied texts." They acknowledge that understanding how to interpret visual data and become visually literate is becoming an imperative in education in this increasingly visual age.

Peter C. Hauser and Geo Kartheiser in their article, "Advantages of Learning a Signed Language" state that the cognitive advantages of learning a signed language were not documented until the late twentieth

century, partially because it was not until the 1960s that scholars began to accept signed languages as natural languages.

Their research shows that when signing, the brain utilizes parts that are not exercised to same extent by spoken languages. This is recognized as "sign gains".

The potential contributions of deaf people in visual learning are now beginning to be uncovered, thanks in part to a National Science Foundation (NSF) Science of Learning Center founded at Gallaudet University called Visual Language and Visual Learning. Schools should start considering learning from the way signers think, create and produce in a visual gestural medium.

Gesture is a key factor in increasing student retention (Cook, Mitchell & Glodin-Meadow, 2008). Different visual-manual interfaces, such as the iPhone and other gestural interfaces, have yet to take full advantage of the more sophisticated system of signed languages, a fact recognized by Microsoft, which has filed a patent exploring potential uses of sign language with its Kinect technology[10].

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[10] http://escapistmagazine.com/news/view/102637-Patent-shows-kinect-recognizing-sign-language.

Bauman and Murray (2004) mention that "because deaf children do not access the dominant spoken language, they are ripe to generate a language from the innate capacities with which we are all endowed. This is clearly a contribution from deaf communities that is long lasting and paradigm shifting. "

A person, who is not familiar with signed languages, might think that signs are made with the hands and arms only. Eye-tracking studies have found that fluent signers focus on the face when engaged in a conversation or perceiving signed language instead of following the hands (Agrafiotis et al., 2003; Emmorey, Thompson & Colvin, 2009; Muir & Richardson, 2005)

2.4   Deaf Culture

Dr. Bill Vicars explains how in Deaf culture, there is a difference [11] between deaf (with a lowercase "d") and Deaf (with an uppercase "D"). The former is a condition of partially or completely lacking the sense of hearing to the extent that one cannot understand speech for everyday

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[11] http://www.lifeprint.com/asl101/pages-layout/terminology.htm.

communication purposes. The latter refers to embracing the cultural norms, beliefs, and values of the Deaf Community. The term Deaf should be capitalized when it is used as a shortened reference to being a member of the Deaf Community. For example: "He is Deaf," means he is a member of the Deaf Community; while "He is deaf." means that he is lacking in the sense of hearing.

In the book Deaf Gain: raising the Stakes for Human Diversity, the editors chose to use the word deaf (lowercase) to refer predominantly to culturally deaf people but not necessarily excluding those who do not sign.

In this research the word Deaf (capitalized) will be used when referring people who use sign language and belong to the Deaf Community and deaf (lowercase) when referring to someone who cannot hear.

The Canadian Hearing Society defines culture as a way of life and learned ways of acting, feeling and thinking based on a group who share

common language, values, traditions, social norms, and identity in a society[12].

Deaf culture has each one of these criteria:

- Sign Language as a predominant visual language used by deaf people.

- Values in Deaf people include the importance of clear language and communication for all in terms of expression and appreciation.

- Preserving literature, Deaf heritage, Deaf literature and Deaf art are examples of what Deaf people value.

3   Visual Language

3.1   Alistair's Story

This is the story about a deaf boy with autism.

Alistair's entire story has been about trying to gain access. He was born without hearing. Hearing loss as big as it could be. The doctors diagnosed him deaf, but it never occurred to them that he had something

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[12] http://www.chs.ca/deaf-culture-and-community.

else. He was different from any other deaf kid: extremely hyperactive and he didn't pick up sign language. Angela felt like a huge failure.

Every time they went out, he would make a scene. One day, his teacher planned a trip to the mall. Angela panicked but the teacher was confident about her method.

To go to the mall, the teacher prepared him 3 days before. She had realized that access to Alistair was information.

They showed him pictures of the experience: getting into the car, driving to the mall, arriving to the mall, browsing the stores, getting back in the car, arriving to the school and finally going back home. They repeated this sequence for 3 days. When the day arrived to go to the mall, he didn't go crazy running and touching everything. He knew what was going on, he had information and that gave him peace. By seeing the pictures, he could understand what was going to happen and be calm.

Angela soon understood that was the case for everything. They had a boat and despite the amazing experience that going on a boat was, it was always a nightmare. After the mall trip, she realized that it wasn't that he didn't enjoy the boat. He didn't hate the boat either. He just

didn't like not knowing where he was going, when were they leaving and if he'd return home after the trip.

His dad decided to apply the same method for this trip. He showed him a calendar of the day they were leaving, how long they were staying in the boat and when they would return. He showed pictures and drawings of the adventure. That day Alistair finally enjoyed sailing in the boat.

Information was his access to his life.

But still no sign language would come from him. Two people being diagnosed with the same disability, does not mean that they both need the same treatment or things.

An ASL interpreter found out that even though he didn't make eye contact, he had a peripheral sight and was actually seeing the gesturer through the corner of the eye. He also had a delay in language. Once, a woman pointed out that there was a train passing nearby, ten minutes later he replied in Sign Language: "I saw a train".

He was diagnosed with cancer. During his stay in the hospital, Sign language was his way to show he was happy. He met a woman who

knew ASL and began communicating with him. His access now was having another culturally deaf person sign to him.

The technology that helped him the most: a pencil. He used it to draw his wishes.

The family tried to use images as close to reality as possible.

Parents should notice the way their kids are communicating. Taking away the rule of written or spoken languages.

People accomplish more when nobody tells them they can't. Alistair did more with people who believed he could do more.

Alistair's story sets the ground to show how one size doesn't fit all and that every design solution has to have the flexibility to be customized to fulfill the user's needs. In this case, images were all he needed to communicate, not text, not signs, just images. Other researchers have found the power of communicating through images and their findings are described in the next section.

3.2   Signs and Meaning

Semiotics is the study how meanings are made. "Semiotically speaking people use signs to designate objects or ideas. Because a sign

represents something other than itself, we take the representation as the meaning of the sign."(Salen and Zimmerman 2004)

Charles Pierce proposed four concepts in his seminal work on semiotics (1991):

- A sign represents something other than itself.

- Signs are interpreted.

- Meaning results when a sign is interpreted.

- Context shapes interpretation.

The concepts are further clarified by Mick Underwood of Communication, Culture and Media Studies (CCMS)[13] who says, "Because there is no simple sign = thing equation between sign systems and reality, it is we who are the active makers of meanings." The concepts of sign language and deaf culture are explored in the next few paragraphs.

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[13] http://library.calvin.edu/content/resource_abstract/5539

Figure 1 The icons of a woman and a man side-by-side form the universal icon for bathroom.

In the ASL University website[14] Dr. Bill Vicars states that there are five fundamental components that when mixed and matched create words in sign language: Hand shape, movement, location, orientation, and non-manual markers (shoulder movements, head tilts, and facial expressions.) There are infinite combinations of these components with one or two hands and arms, which are given a meaning depending on the context where they are interpreted.

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[14] http://www.lifeprint.com/asl101/pages-signs/classifiers/classifiers-main.htm
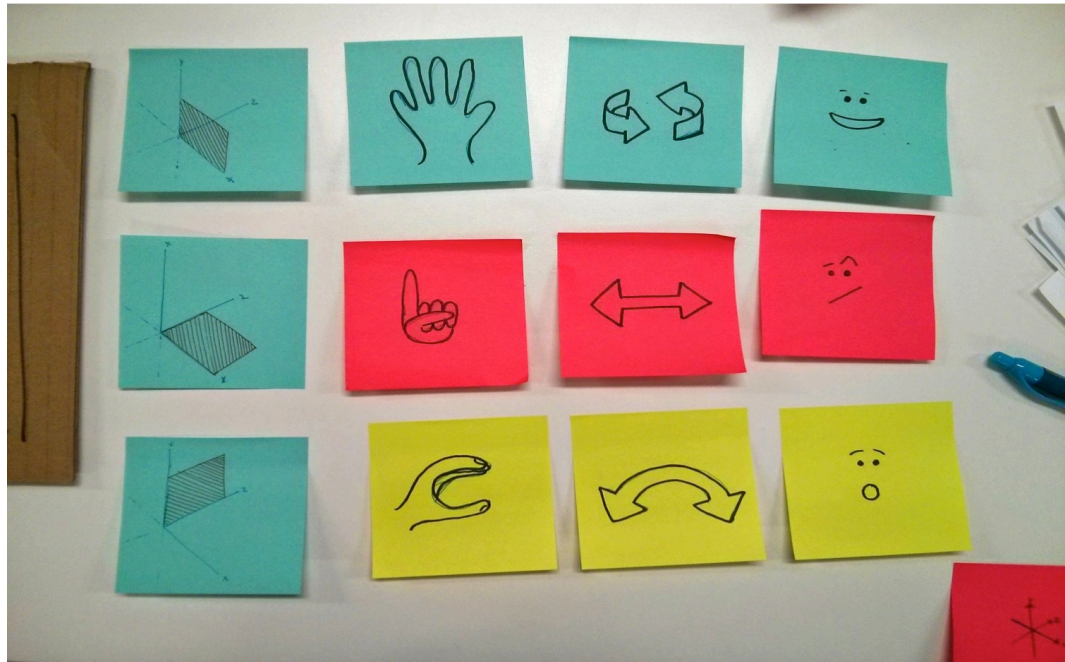
Figure 2 Fundamental elements of SL: hand shape, orientation, movement and non-manual markers

Hasbro's board game Scrabble is composed of a board with a grid and repeated chips with letters of the alphabet. The game starts with at least two players taking turns to create words with random letters that they withdraw from a pile and then place them on the grid (horizontally, vertically or diagonally). Each letter has a value, when a player gets rid of all the chips, the rest of the players count the letters and accumulate those points. The player with less points wins. This particular game has the characteristic that depending on the country that it is played, the

words will be interpreted in a different language. The same alphabet can be used across America and each country will create different words.

"Within the context of a game of Scrabble, words are reduced to sequences of letters – they literally do not have meaning as words. Rather, the letters are signs that have value as puzzle pieces that must be carefully arranged according to the rules of spelling." (Salen and Zimmerman, 2004)

The same theory is applied to sign language in this research raising the following questions: What if different sign language speakers are given the same set of chips? Can they create combinations that make words in their sign language? Can these combinations be crowdsourced?

3.3   Universal Language of Icons

The scripts such as Roman, as we know, are also visual signs. Mathieu Borysecivz defines written English as "a system built of 26 squiggly lines that communicate, illuminate, and educate."

However, there are other visual systems of representing language. Xu Bing's book "From Point to Point" is written entirely in a language of icons. His research was fueled by the challenge of producing a

universally accessible language, but in the end the creation of something

new was not necessary. He realized that by recollecting "existent

language that all of us already are already guilty of using on a daily basis",

a complete narrative could be composed out of logos, standardized

illustrations and emoticons that can be interpreted "regardless of cultural

background […] as long as one is thoroughly entangled in modern life."

He was inspired by the ability of airports to communicate

complex messages to travelers from a wide range of cultural and

linguistic backgrounds in an instant and accurate way, through a visual

system that everyone could understand despite the rush and chaos in the

environment.
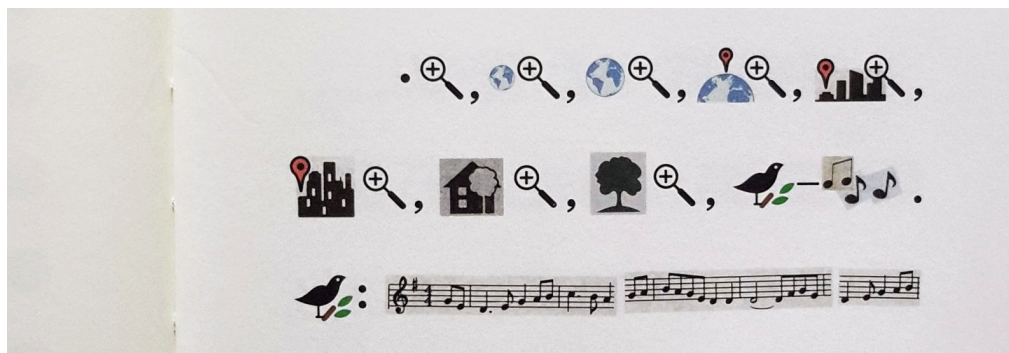
Figure 3 Excerpt from page 1 of Xu Bing's book "From point to Point"

3.4   Blissymbols

Charles K. Bliss (1897-1985) developed Blissymbols while he was a refugee at the Shanghai Ghetto and Sydney for the purpose of creating an intuitive language for international communication, inspired by Chinese characters.

Since the 1960s/1970s, Blissymbols have been a popular method to teach people with complex communication needs to communicate. It was first used to aid children with physical disabilities in 1971 at what now is the Bloorview MacMillan Centre in Canada.

The Blissymbol[15] method has been used in Canada, Sweden, and a few other countries. Practitioners of Blissymbolics (that is, speech and language therapists and users) maintain that some users who have learned to communicate with Blissymbolics find it easier to learn to read and write traditional orthography in the local spoken language than do users who did not know Blissymbolics.

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[15] http://www.blissymbolics.ca/about-bcic.

With over 5,000 graphic symbols, each symbol can be combined to form words create new symbols. They are easy to learn and allow people to easily express their ideas.

Figure 4 "I want to go to the cinema" in Blissymbolics[16]

3.5   SignWriting

SignWriting is used to read, write, learn, research, transcribe, share and read stories in Sign Language. It can preserve Sign Language Theater and bring signers together.

Valerie Sutton, creator of the system defines SignWriting as " a visually-designed alphabet - a series of symbols that writes "the pronunciation" of body movement"

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[16] https://en.wikipedia.org/wiki/Blissymbols#/media/File:Bliss_cinema.png

Sutton states that " SignWriting is not pictures or icons, but instead, it is a real writing system, written by hand or by computer" According to the SignWriting website it is " a writing system which uses visual symbols to represent the hand shapes, movements, and facial expressions of signed languages. It is an 'alphabet' - a list of symbols used to write any signed language in the world that can be compared to the Roman alphabet. In the same way, the symbols in the SignWriting alphabet are international and can be used to write American Sign Language, Danish Sign Language, Norwegian Sign Language, British Sign Language, Dutch Sign Language - any sign language you choose."

SignWriting[17] makes it possible to have books, newspapers, magazines, dictionaries, and literature written in signs. It can be used to teach signs and signed language grammar to beginning signers, or it can be used to teach other subjects, such as math, history, or English to skilled signers.

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[17] www.signwriting.org.

Lucinda O'Grady Batch[18] expresses her optimism about SignWriting in her work, 'SignWriting a Deaf Perspective' as, "Deaf Americans are one of the very few linguistic minorities that are unable to get books that teach English in their native language. I feel that we can use SignWriting in order to learn English. Deaf people will benefit greatly from books explaining English grammar and idioms in written ASL"

The SignWriting website not only provides lessons and material to learn the writing system, but it also offers the option to create SignWriting words through their free software called "SigMaker" and the words are made available through the software called "SignPuddle". There are currently 200 words for Mexican SignWriting which means that there is great opportunity for the Mexican Deaf Community to collaborate in the creation of the vocabulary.

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[18] http://signwriting.org/archive/docs1/sw0001-Deaf-Perspectives.pdf.

4 The Technology

4.1 Signals and Trends

4.1.1 *First sign language Refugees:*

At the 2011 conference cohosted by the World Federation of the Deaf and the European Union of the Deaf, a clear concern was echoed among presenters regarding the decrease in intergenerational transmission of their sing languages, putting them in danger of extinction.

"The opportunity for sign-language transmission in the schools has declined so precipitously that the world has now seen its first sign-language refugees." (Boye-Niemela, 2011)

4.1.2 *Paperless books:*

"More and more of the world's cultural and educational resources are being produced, distributed and accessed in digital form rather than on paper. Born-digital heritage available on-line, including electronic journals WWW pages or on-line databases are now part of the world's

cultural heritage. The demand to obtain knowledge is dictating more accessible delivery channels." [19]

4.1.3   *Inclusive ICT's for people with disabilities*

"A high level plenary session on "Making Empowerment a Reality – Accessibility for All" was organized by UNESCO on 27.05.2015, with governments, civil society and IT industry. The session provided space for open consultations and constructive dialogue in the area of access to information and knowledge using accessible and inclusive Information and Communication Technologies (ICTs) for inclusion of persons with disabilities and explored ways on how technological developments can contribute to their development and empowerment.[20]"

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[19]http://www.unesco.org/new/en/santiago/communication-information/memory-of-the-world-programme-preservation-of-documentary-heritage/memory-of-the-world-programme-objectives/

[20] http://www.unesco.org/new/en/communication-and-information/resources/news-and-in-focus-articles/all-news/news/wsis_forum_2015_making_empowerment_a_reality_accessibility_for_all/#.Vc_c1WTF_68

4.1.4 Crowdsourcing Languages

"Duolingo, the successful language-learning app, has announced the launch of an "incubator" that will allow any user to create new courses for different languages."[21]

It was created by crowdsourcing pioneer Luis von Ahn, PhD, and Severin Hacker, PhD. With over 80 million users, Duolingo has organically become the most popular way to learn languages online in only 2 years.

"We believe everyone should have access to education of the highest quality - for free."[22]

4.1.5 Re-Embodying Education

Digital technology has created a gap between the physical material where a sign is printed, hand written or painted and the context and signifying aspects of that sign, disembodying it from its material and loosing authenticity.

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[21] http://www.cnn.com/2013/10/15/tech/mobile/duolingo-incubator-language-teaching/

[22] https://www.duolingo.com/info

Analogisms are the result of pairing the benefits of digital

technology with the simplistic, organic feel of analogue to produce

interesting fusion products.

There are many advantages to digital media but the

personalization and authenticity are key to communication and that's

worth keeping. (Kashtan, 2013)

Signals: Products such as the Samsung Galaxy Note for

smartphones, Interactive Blackboards, tablets and video games are

incorporating handwriting features as input methods and they have a

positive response from the users who enjoy the kinesthetic sharing of

information.

4.1.6   Inverse Inclusion

Bauman and Murray (2004) Forsee that "traditional deaf

residential schools could become elite boarding schools. We can now

imagine replacing deaf education's dreary on remediating hearing loss

with a Deaf Gain- focused education that maximizes the visual-spatial-

kinetic nature of deaf ways of being and the use of sign language to

produce cosmopolitan, technologically savvy, yet collectivist global

citizens who live in a deep, intersubjective reciprocity with fellow citizens of the world. "

4.2   Affordable tablets

With wireless connectivity becoming more accessible in developing countries, Mexico ranks as the first country with more internet access through mobile devices and second country in Latin America in terms of digital population, according to ComScore's "2015 Mexico's Digital Future in Focus" analysis.[23] The study found that in 2015 Android dominated the Mexican market with 82.5% presence. ComScore reported that most Internet access in the country is accessed through open and public Wi-Fi network rather than a data plan.

These facts determine the feasibility of developing apps to augment the learning experience of deaf children that are accessible and within their reach. Nevertheless, this doesn't necessarily mean that the service is delivered in high quality. Despite these promising facts about

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[23] http://www.comscore.com/Insights/Presentations-and-Whitepapers/2015/2015-Mexico-Digital-Future-in-Focus

Internet access, Reporte Indigo classified Mexico as a narrowband country.[24]

Rumie is "a non-profit organization bringing free digital educational content to the world's underprivileged children. In a nutshell, large private donors who believe in our mission cover our operating costs, allowing public donors (you) to contribute to our campaigns knowing that 100% goes to educating children.[25]

The organization provides schools with low cost tablets curated with educational and recreational apps that run preferably without Internet connection. Children are able to use the apps relevant to their school level and when the teacher considers it appropriate, grants them a certain amount of "play time".

In an effort to deliver high quality education to underprivileged children, Rumie is currently working to curate an accessible tablet for deaf kids in Mexico with the principal researcher of this study.

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[24] http://www.reporteindigo.com/reporte/mexico/mexico-un-pais-de-banda-estrecha
[25] http://www.rumie.org/

With 16 GB of space to fill with educational apps, they have only found 524 MB of material to add, due to the fact that most free apps in Spanish are not accessible, therefore useless for these kids.

4.3   Existing Apps in the Market

"Dear Industry,

What if the greatest book ever written was not available to everyone? What if we neglected to translate the text into multiple languages, never made large print versions, never made an audio book, or didn't take the time to make a braille edition? Quite simply, millions of people would never be able to read "The Greatest Book in the Universe, EVER!" Accessibility isn't about changing the content of the book; it's about changing the delivery. While there is no way to make the book available to absolutely everyone, we can make as many versions available as possible to make sure that ALMOST everyone can enjoy it. And did making these different versions of the book take anything away from the original? Did we lose something in the translation? Absolutely not. Now apply the same logic to video games (…)

Chris Taylor, Director of Industry Enrichment (EEDAR)" (Barlet & Spohn, 2015)

As of July 2015, users around the world had access to a variety of 1.6 million apps for Android and 1.5 million apps for Apple devices. (Statista 2015)

Despite the myriad of options to choose from, deaf users face a great challenge to find accessible apps for entertainment, education and communication purposes.

An accessible app can't rely on the fact that the user knows how to read and write or on audible messages and alerts. The ideal app has a signed language interpretation of all the menus, instructions and details.

The Canadian Cultural Society of the Deaf (CCSD) in collaboration with marblemedia Inc. Have created DeafPlanet.com, which has an option to fingerspell the navigation menu and buttons. The website comes in English/ASL and French/QSL.

Being the first website and TV show in American Sign Language, Deaf Planet's goal is not only to teach sign language but to allow sign gesturers to watch the character's adventures and navigate through the

interactive and educational site in an inclusive environment without any communication barriers.

What would the ideal tablet for a deaf user look like? Android's Play store has several apps that allow users to translate text into sign language animations and even voice into sign language animations. Apps like Signing Savvy in ASL provide a Sign of the day video to keep learning new words daily for free and for a monthly membership take quizzes, create word lists, print signs and build phrases.

Still most of the apps for sign language found in the app stores are just providing dictionaries and spelling and grammar games. Looking at the Language Skill levels stated by the Common European Framework of Reference for Languages (CEFRL). Most of these apps stay in the Basic category that only provides tools to memorize words and concepts and do not require a user to be fluent in sign language to use the app.

These extraordinary apps are available for free (some with a freemium option) for Android devices.

- SpreadSigns

- SigningSavvy (ASL videos dictionary)

- International Signs (dictionary)

- ASL American Sign Language (flashcard dictionary)

- Kitsord (Guatemala) (Learn and test with videos)

- Lengua de signos (3d animation dictionary in Spanish Sign

  Language)

- Hand talk (Brazilian SL voice and text to sign) animation

- ProDeaf (Brazilian SL) animation

- Mimix (ASL) animation

- Signslator (SSL) video

In search for the "Ideal Tablet Content" a scan through the Google Play store was made to see which apps were available for a school aged deaf child in Mexico. Taking in consideration accessibility, engagement, use and age these free apps were chosen:

Dictionary	Spelling	Storytelling	Math	Geography	Entertainment
Dimelo	Learn to Spell	Te Cuento	Multiplication Monkeys	Geography Learning	Quiver
Singslator	Palabra Correcta	I Spy with Lola			
	4 Pics 1 Missing				

Table 1 Ideal Tablet Content

4.4 Assistive Technology Analysis

4.4.1 *Gesture Recognition*

The initial idea was to use gesture recognition technology for a game that could recognize the movement of the hands when signaling S.L.

A group of students from the Technology Institute of Superior Education of Monterrey in Chihuahua Mexico explored the use of Microsoft' Kinect technology. They created a program that allows the user to create a library of signs by recognizing the skeletal movements of the hands.

Once the library is created, a person can sign a word and the computer will show the written form and will play the spoken word.

The project funding ended and the software was left at the stage of a library/dictionary that if developed further, it could be used to learn and practice vocabulary.

At the start of this research this project was explored for an opportunity to collaborate and continue with the UI/UX design of this project.

Due to the large amount of man-hours and storage space required to create a library with all MSL words, this option is feasible for a desktop computer with large RAM and Memory Space. The Kinect device is essential for the program to function. It has a retail price of $149.99 USD (2015).

Leap Motion describes its sensor as "technology that senses how you naturally move your hands, so you can reach into the world beyond the screen" At a price of $79.99 USD in 2015. As they state in their website "We're just getting started" Leap motion is an extraordinary company that has provided technology that will allow Sign Language Recognition and the development of great apps around this. The fact that they are a new company means that the development of these resources is just starting and there is still a long path of trial and error to get to an accurate recognition of S.L.

Two companies Baby Taxi and MotionSavvy are working of developing software for Leap Motion to translate Sign Language into Text and voice to allow the conversation between a hearing and a deaf person in their native languages.

Motion Savvy is launching their software in Fall 2015 with two

products. UNI Basic is PC/Mac software for $99 USD plus a $20 USD

monthly membership and UNI Pro is a tablet with a Leap Motion device

+ the software for $799 USD plus a $20 USD monthly membership.

The software will include 2000 signs in ASL with the option to create

and upload your own signs.

For the purpose of this project, the option to develop material for

this technology will be considered for future steps.

The intention is not to create a dictionary but an interactive app

that pushes the users to set their own goals to learn new words and to

encourage them to teach Sign Language to their beloved ones.   The goal

is to address the issue of learning Sign Language first, and it is more

feasible that families have access to a low cost tablet ($50 USD) rather

than any of these devices for the moment.

4.4.2   *Augmented Reality*

Augmented Reality (AR) plays the role of connecting graphic and

kinesthetic language by using a 3D layer that allows the players to

understand the position, orientation and movement of the hand more

deeply. This plays a crucial role in the engagement of the kids thanks to

the interactivity that the use of the tablet provides. It merges the tangible and digital world without loosing any of the benefits from each one.

It makes it impossible to stay passive and just observe because it requires the player to move its upper body to use the tablet to unveil the secret hidden in the AR marker.

AR has the advantage that it can be used with almost any device with a third party app installed. Most of these apps are free and offer access to AR Libraries that can be uploaded and updated by users around the world.

4.4.3 Text based Solutions

As described on the website[26] "Inform is a design system for interactive fiction based on natural language. It is a radical reinvention of the way interactive fiction is designed, guided by contemporary work in semantics and by the practical experience of some of the world's best-known writers of IF."

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[26] http://inform7.com/

Being a text-based HTML experience, screen readers are able to access the content without any barriers making it accessible for low vision and visually impaired users. For the Deaf community, these types of tools are accessible only with a high level of literacy that allows the reader to fully understand the content.

5 Designing a Game

5.1 Gamification or Game?

When the problem of this research was found in the communication challenges that deaf children have with their hearing members and friends, thinking about a game-based solution was the obvious answer. But it is important to remember that this is not only about learning Sign Language, the desired goal of this research is to design a tool that will serve 1) as an advocate for Mexican Sign Language as a first language 2) to reverse the role of adult–child teaching and learning and 3) as an item for Deaf identity. The "empowerment" aspect is crucial to differentiate the solution from any other existing app, tool or game for Sign Language.

Gamification is a new concept that has been characterizing several successful apps such as Foursquare and Nike +. In his book "Gamify: how gamification motivates people to do extraordinary things" Brian Burke (2014) provides a methodology to increase productivity, engagement, develop skills and change behaviors. Gamification, he claims, "can improve lives".

Gartner defines gamification as "the use of game mechanics and experience design to digitally engage and motivate people to achieve their goals."

Burke highlights these key points to understand the terminology:

- Gamification is not about making activities look like a game.

- It is not always about reward programs.

- If the product has no advantages over the alternatives, Gamification won't help you.

He states that engagement is emotional and transactional and that to achieve emotional engagement these intrinsic motivators should be integrated in the solution:

Autonomy - the desire to direct our own lives.

Mastery - the urge to make progress and get better at something that matters.

Purpose - the yearning to do what we do in service of something larger than ourselves.

To achieve autonomy "players are given the opportunity to discover and learn using different paths. Sometimes they are just given goals, tools rules and a space to play without being directed on the next steps to take"

Burke remarks that gamification is not necessarily about being fun. It is more centered on the science of motivation and the use of digital engagement to extend motivation behind the limits of the physical world.

Gamification has the characteristic that it digitally connects users that are doing the same tasks and pursuing similar goals. By creating a competitive environment it allows advantages in scale, time, distance, connectedness, cost. In Burke's words " The more the merrier, the larger and more diverse the crowd is the more likely they will find innovative solutions."

His key is to trigger baby steps to help people change behaviors. By repeating behaviors, they become habits and develop change overtime.

By applying this thinking to the solution for this research, the child would be able to curate the vocabulary and activities in the app according to the goals he wants to achieve. The app will track progress, compare it with other players and keep the child motivated.

Deaf children would start to use Sign Language more often with their families by being provided with the play space and the opportunity to create the objectives, rules, rewards around that topic.

5.2   Accessibility Guidelines

Basic guidelines to follow in the design of the app where retrieved from the online Game Accessibility Guidelines website[27] and the following where considered the most relevant to the project. A full list can be found in Appendix A.

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[27] http://gameaccessibilityguidelines.com/

- Provide details of accessibility features on packaging and/or website

- Offer a wide choice of difficulty levels

- Include some people with impairments amongst play-testing participants

- Ensure interactive elements / virtual controls are large and well spaced, particularly on small or touch screens

- Use simple clear language

- Provide a choice of text colour, low/high contrast choice as a minimum

- Ensure no essential information is conveyed by a colour alone

- Ensure no essential information is conveyed by audio alone, reinforce with text / visuals

5.3   Inclusive Design Questions

Can we satisfy everybody in the Mexican Deaf community? In the Global Deaf community?

Which is the best seamless and fun implementation?

How can public engagement related to education be achieved?

Do technical difficulties challenge accessibility?

Are we considering not only users but also their families, caregiver's and

friends?

How can a person feel relevant to the bigger problem?

Is the idea thinking about the community?

How can Reverse Inclusion eliminate the assumption that everyone must

learn to read and write?

To do:

Test with real people as often as soon as possible.

Think about Transformation. Not reform, not improvement.

Allow greater capacity for spontaneity, capacity for reframing, and sense

making.

6   Designing to Sign

6.1   Personas

6.1.1   *Sebastián*

He is a nine-year-old boy who lives in Aguascalientes, Mexico. He

is the only deaf member of his family. The family recently agreed to take

him to Mexican Sign Language lessons. He doesn't know how to read or

write. His mother is also learning MSL. He would love to have a conversation with his dad. He communicates through basic gestures to point, affirm and deny but mostly he just follows what his mom shows him to do without much understanding.

6.1.2 Maria

She is 12 years old. She is the only deaf member of her family. She was oralised and knows how to read lips. Basic reading and writing. She is very introverted. She is currently in 5th grade. Her teacher lets her copy all the assignments from her classmates and passes her. Loves to paint and draw. Her family doesn't want her to learn Sign Language because they believe it will prevent her from trying to speak and be integrated in the regular school system.

6.1.3 José

8 years old. He is deaf. Both of his parents are deaf and know Mexican Sign Language. He plays soccer with other deaf kids. His cousins don't know sign language; it would be so much easier to play videogames with them if they knew.

6.1.4 Pablo

He is 15 years old He is a hearing boy. His mother is deaf but doesn't know Sign Language. He would like to learn SL with her to bond and give her the opportunity to meet other Deaf women from the Deaf community. His grandparents were too ashamed of her disability that they never sent her to school, taught her sign language (so nobody could see she was deaf)

6.1.5 Anna

She is 18 years old. Deaf. She went to regular schools and learned to read and write. She doesn't speak and barely reads lips. When she was 12 her mom enrolled her to a basketball team with other deaf girls with many doubts in her mind because she didn't want her to learn Sign language, afraid that she would not want to go to regular school anymore. Eventually her fears disappeared when she saw how much Anna changed. Anna started opening up and asking so many questions about everything. She became interested in more sports and did very well in school. Sign language gave her the tools to discover and understand the world around her.

6.2 Game Ideas

Based on the insights gathered from the expert interviews and the literature review, the following ideas were proposed for the solution. The first one was chosen to be prototyped and in an iterative process a second version was proposed.

6.2.1 Version 1

The first prototype consists of an Augmented Reality Game called "¡Enseña la Seña!" (Translation from Spanish: Teach the Sign!) This concept was co-created with three graphic design students from the Universidad Autonoma de Mexico (UNAM) under the supervision of Leilani Medina.

The game is played with two decks of cards and a tablet with Internet connection. In order to play the game the Augmented Reality app "Aurasma" must be installed and the game aura must be followed.

The "Players" deck is divided among the players. Each card has a word in MSL represented by an image and it's Spanish written form. For this prototype the topic of the deck is "Days of the week".

Figure 5 Cards from the game "Enseña la Seña"

The game begins when the moderator places a random card from his deck in the middle of the table, with the AR marker facing up. The players will scan the card to reveal a 3D animation of the corresponding sign in the screen. Players have to browse through their cards to find the matching card and to the sign to the moderator.

Figure 6 Cards from both decks of the game

If the sign is correct, that player will have won that round and collect that card, but if the sign is incorrect, another player will have the opportunity to do the sign correctly and steal the card. The game is over when the moderator deck is divided among the players. The player to have more cards wins.

Figure 7 Icons of two players. The second player has collected all of the cards.

Figure 8 Packaging of the game

This is a modular game that can be complemented with different "theme" decks that could eventually lead to phrases and sentences. For example, the next theme could include verbs: "Yesterday + Run". Then adjectives: "Yesterday + Ran + Fast".

However, a few design challenges arose during the process of creating the prototype. The main one consists in the fact that creating a library with all the MSL words with 3D animations is a huge investment of time, money and space. While there are several apps in the market

with this feature, this project has currently no resources to hire a 3D designer and an interpreter to create such library.

The target users of this game are bilingual families, that is to say that at least one of the members knows MSL. That person has knowledge of the MSL vocabulary and signs, therefore it is redundant to have the answers in a 3D animation when that person can sign them in real life.

Still the question of which was the game play existed, until the team learned about SignWriting. It has 96 icons that represent all the hand shapes required to sign any word in any Sign Language in the world.

Although SignWriting requires some training to be able to read and write it, it is very intuitive due to its icon-based signs. For somebody who has learned Sign Language, these signs are familiar icons that allow an effortless interpretation of the word.

Based on this rationale a second version of the game was proposed.

6.2.2   Version 2

The game is composed of two decks of cards, one with an AR marker on one side made with the hand shapes in SignWriting and another one with images of words.

The moderator will have the SignWriting icons deck and the other deck will be distributed among the players.

The moderator will then place a card in the center of the table and participants will scan the card with the tablet. The AR app will reveal the complete SignWriting form of a random word that belongs to the family of that hand shape and the Spanish written form.   Players have to browse through their cards to find the matching card and sign it to the moderator.

If the sign is correct, that player will have won that round and collect that card but if the sign is incorrect, another player will have the opportunity to do the sign correctly and steal the card. The game is over when the moderator deck is divided among the players. The player to have more cards wins.

The interesting aspect about this version is that it is supported by a web app that will encourage signers from all the Mexican Deaf

Community to contribute to the crowdsourced library using a version of the SignBank Maker[28] to add the Mexican SignWriting, an image and the meaning in text. The library allows players to download and print more cards and keeps the app updated with all the new categories with words of interest to the community.

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[28] http://www.signbank.org/signmaker/#?ui=es&dictionary=mfs
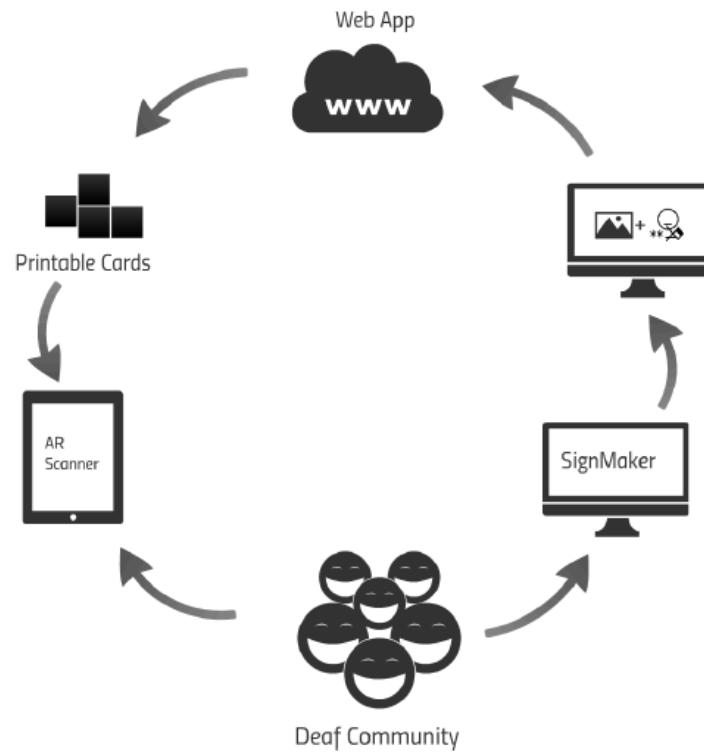
6.3 The Solution

Figure 9 App Architecture Cycle: Deaf Community, SignMaker, Web App, Printable Cards, AR Scanner.

The proposed solution involves the Deaf Community in both the

learning and the creation of the interactive material using the Web App.
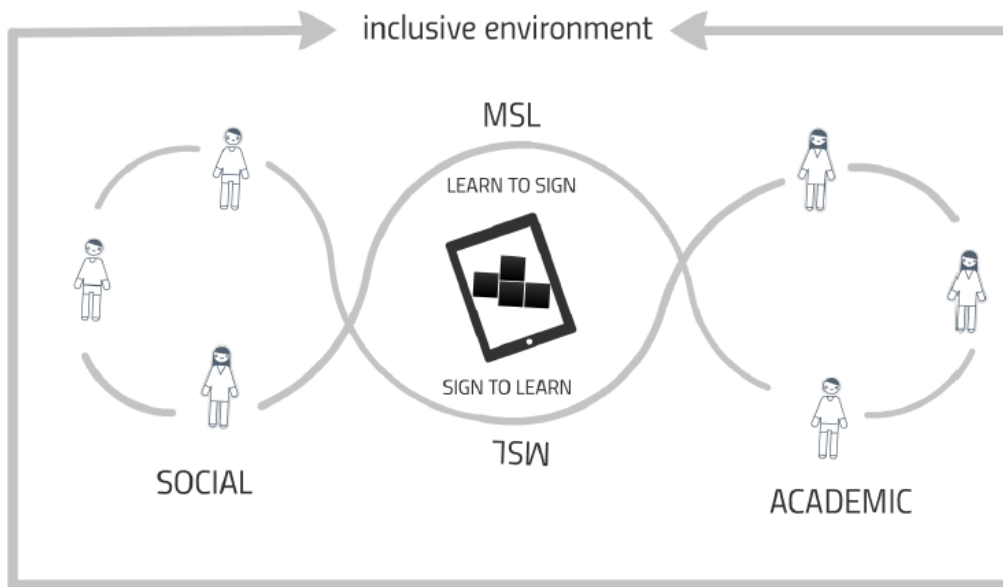
Figure 10 Inclusive Environment

The learning of Sign Language does not come directly from the cards, but from the conversation around the use of the cards. The game creates an inclusive environment that is lead by the Deaf members of the group.

7 A Game Changing Game

7.1 Why

This project was created to develop accessible and interactive tools that will empower Deaf children to learn and teach Mexican Sign Language with their bilingual families and friends. With the idea that the gap between Signed Language and Written Language can be bridged

with the aid of visual elements that both hearing and non-hearing members can understand, a game was designed using SignWriting® and Augmented Reality to bring families and/or groups together for a convivial learning experience and as an advocacy game to promote Mexican Sign Language (MSL) in Mexico.

Design Thinking and Interviews were conducted with Sign Language instructors and advocates from different countries in North America to learn from their expertise working with families with deaf or hard of hearing members and their communication challenges inside and outside the classroom.

The proposed solution integrates digital and tangible tools that engage the users in the learning experience. Augmented Reality allows the game to have a three-dimensional representation of Sign Language and the app encourages the players to create their own word collections that could potentially create a MSL crowdsourced library.

The main focus of this project is to create tools to support the Mexican Deaf community and contribute to the creation of tools and resources to fulfill the deep need for accessible and inclusive education. Nevertheless, the combination of gamification, SignWriting® and

crowdsourcing are the base components for a tool that can be easily customized across different countries in different Sign Languages.

When I was pitching my product idea at a business incubator back in 2012 in Mexico, the investors wanted to know the size of the market to evaluate if the product could be sustainable and profitable. A market of 300,000 potential users, to their eyes, was not worth the risk. One of them, straight out of Silicon Valley, advised me to come up with another idea that would create a lot of profit so that then I could designate 10% of the earnings to a charitable organization that could provide this type of products to people with disabilities. Others suggested to find a way that "everyone" could use the app to learn sign language regardless of their hearing level.

Designing for inclusion goes beyond the normalcy of western consumption. It is about understanding the essential role that we as individuals have in our community. The importance of diversity in order for the system to function properly and the responsibility that we have to make sure that our neighbour is living with dignity and peace.

Creating opportunities for the Mexican Deaf community has become so important to me because I can't understand how education

and communication are not accessible just because there are not enough people with the same need to create sufficient demand.

Aware of all the challenges and barriers to overcome I've tried to design a solution that provides an alternative to waiting for the government to take accessibility for education seriously and that starts from the ones who will benefit the most: Deaf children. By providing the kids with a tool to keep learning Sign Language and teach it to their loved ones, this bottom-up approach will create a behavioural change in how they see their education.

Underprivileged communities in Mexico are used to extend their hands and receive a soothing patch from the government and charities to cover their needs. I believe that by empowering the Deaf children to build combinations of words, new rules and create libraries they will understand that they have control over their education and that they are part of a bigger picture involving thousands of Deaf persons around the world.

This product will only provide the necessary tools to access that platform of possibilities. It is just a small seed in a river of discrimination, poverty, closed doors and many obstacles more, but

some of the most beautiful water lilies grow in these adverse circumstances.

8 Conclusions

8.1 Contributions

This work is a grain of sand that sums up to the effort of several educators, researchers, designers and active members of the Deaf community in Mexico. The proposed solution takes into consideration the accessibility challenges that developing countries face and the resources available to overcome them. By designing a cross-platform free web-app that can be used in low cost tablets, the Deaf community will have access to the first game for MSL using SignWriting. At the same time, it will open the opportunity for the crowdsourced library to grow from the current 200 signs in MSL and will make it available to the Global Deaf community. The possibilities are infinite.

8.2 Future Work

The next steps for this work is to play-test the prototypes with deaf children and their families in Mexico and build the web app to crowd source the MSL library and potentially include other languages.

The crowdsourced SignWriting database has worked in the U.S., but it is

important to know if the Mexican community responds in a positive way

to the invitation to create the MSW library.

There is also the need to explore the option of an offline version that

just needs to synchronize the content once in a while due to the fact that

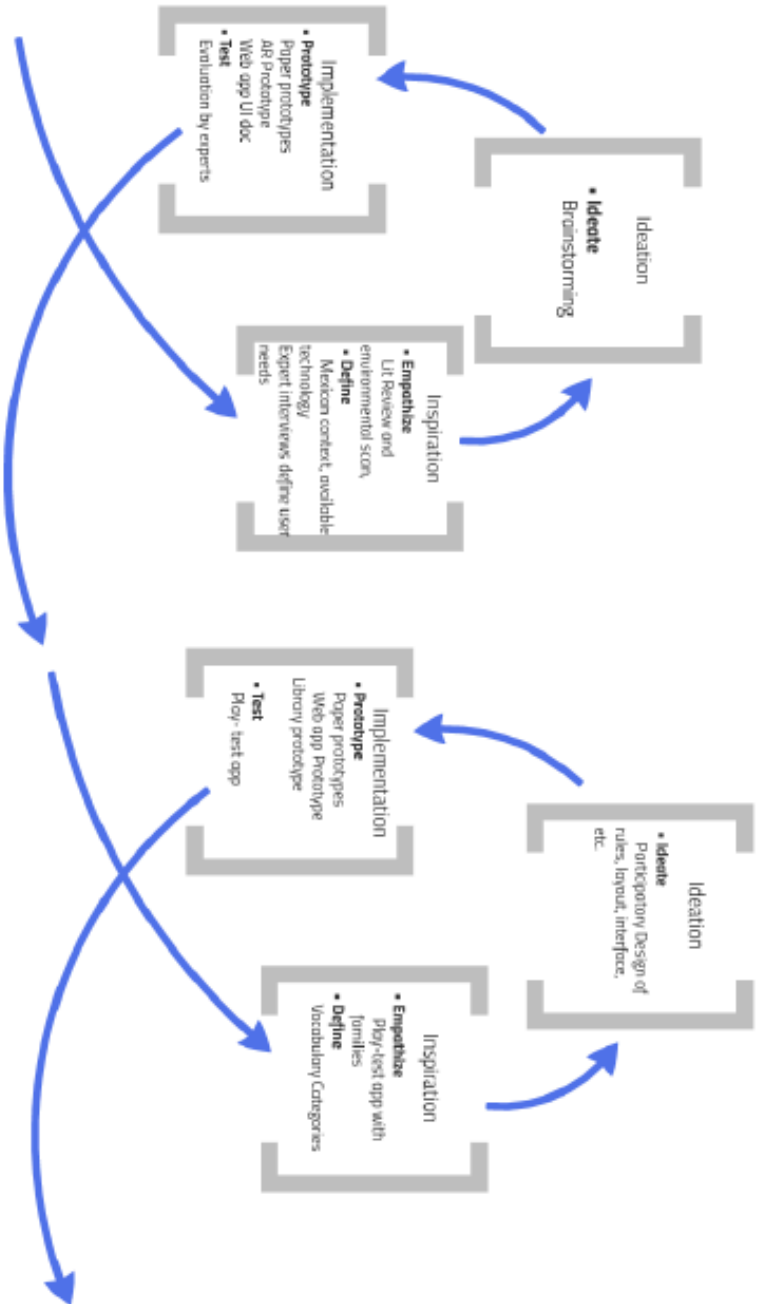Internet connection in Mexico still has several gaps in speed and quality.

Implementation
- **Prototype**
  Paper prototypes
  AR Prototype
  Web app UI doc
- **Test**
  Evaluation by experts

Ideation
- **Ideate**
  Brainstorming

Inspiration
- **Empathize**
  Lit Review and environmental scan,
- **Define**
  Mexican context, available technology
  Expert interviews define user needs

Implementation
- **Prototype**
  Paper prototypes
  Web app Prototype
  Library prototype
- **Test**
  Play- test app

Ideation
- **Ideate**
  Participatory Design of rules, layout, interface, etc.

Inspiration
- **Empathize**
  Play-test app with families
- **Define**
  Vocabulary Categories

Figure 11 Design Iteration Process for Future Steps

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10 Appendices

10.1 Appendix A : Game Accessibility Guidelines

"The following game accessibility guidelines are an award winning guidance, examples and advice on why and how to cater for gamers with disabilities and other impairments. The guidelines are an umbrella set for all genres and mechanics. " (Ellis et al., 2012)

10.1.1 General

Basic

- Provide details of accessibility features on packaging and/or website
- Offer a wide choice of difficulty levels
- Ensure that all settings are saved/remembered

Intermediate

- Allow difficulty level to be altered during gameplay, either through settings or adaptive difficulty
- Include some people with impairments amongst play-testing participants

- Offer a means to bypass gameplay elements that aren't part of the core mechanic, via settings or in-game skip option

- Include assist modes such as auto-aim and assisted steering

- Provide a manual save feature

- Provide an autosave feature

- Allow a preference to be set for playing online multiplayer with/without others who are using accessibility features that could give a competitive advantage

Advanced

- Include every relevant category of impairment (motor, cognitive etc) amongst play-testing participants, in representative numbers based on age / demographic of target audience

- Allow gameplay to be fine-tuned by exposing as many variables as possible

- Allow settings to be saved to different profiles, at either game or platform level

10.1.2 Motor

(Control / mobility)

Basic

- Allow controls to be remapped / reconfigured

- Ensure that all areas of the user interface can be accessed using
  the same input method as the gameplay

- Include an option to adjust the sensitivity of controls

- Ensure controls are as simple as possible, or provide a simpler
  alternative

- Ensure interactive elements / virtual controls are large and
  well spaced, particularly on small or touch screens

Intermediate

- Support more than one input device

- Make interactive elements that require accuracy (eg.
  cursor/touch controlled menu options) stationary

- Ensure that multiple simultaneous actions (eg. click/drag or
  swipe) are not required, and included only as a supplementary
  / alternative input method

- Ensure that all key actions can be carried out by digital controls (pad / keys / presses), with more complex input (eg. analogue, speech, gesture) not required, and included only as supplementary / alternative input methods

- Include an option to adjust the game speed

- Avoid repeated inputs (button-mashing/quick time events)

- If producing a PC game, support windowed mode for compatibility with overlaid virtual keyboards

- Avoid / provide alternatives to requiring buttons to be held down

- Allow interfaces to be rearranged

- Allow interfaces to be resized

Advanced

- Allow play in both portrait and landscape

- Do not make precise timing essential to gameplay – offer alternatives, actions that can be carried out while paused, or a skip mechanism

- Include a cool-down period (post acceptance delay) of 0.5
  seconds between inputs

- Provide very simple control schemes that are compatible with
  assistive technology devices, such as switch or eye tracking

10.1.3 Cognitive

(Thought / memory / processing information)

Basic

- Allow the game to be started without the need to navigate
  through multiple levels of menus

- Use an easily readable default font size

- Use simple clear language

- Use simple clear text formatting

- Include tutorials

- Allow players to progress through text prompts at their own
  pace

- Avoid flickering images and repetitive patterns

Intermediate

- Include contextual in-game help/guidance/tips

- Indicate / allow reminder of current objectives during gameplay

- Indicate / allow reminder of controls during gameplay

- Include a means of practicing without failure, such as a practice level or sandbox mode

- Employ a simple, clear narrative structure

- If using a long overarching narrative, provide summaries of progress

- Ensure no essential information (especially instructions) is conveyed by text alone, reinforce with visuals and/or speech

- Give a clear indication that interactive elements are interactive

- Provide an option to turn off / hide background movement

- Support voice chat as well as text for multiplayer games

- Provide gameplay thumbnails with game saves

- Provide separate volume controls or mutes for effects, speech and background/music

- Ensure sound / music choices for each key objects / events are distinct from each other

- Include an option to adjust the game speed

- Provide a choice of text colour, low/high contrast choice as a
  minimum

Advanced

- Provide pre-recorded voiceovers for all text, including menus
  and installers

- Avoid any sudden unexpected movement or events

- Allow all narrative and instructions to be replayed

- Use symbol-based chat (smileys etc)

- Provide an option to turn off / hide all non interactive
  elements

10.1.4 Vision

Basic

- Ensure no essential information is conveyed by a colour alone

- If the game uses field of view (3D engine only), set an
  appropriate default for expected viewing environment

- Use an easily readable default font size

- Use simple clear text formatting

- Provide high contrast between text and background

- Ensure interactive elements / virtual controls are large and well spaced, particularly on small or touch screens

Intermediate

- If the game uses field of view (3D engine only), allow a means for it to be adjusted

- Avoid (or provide option to disable) any difference between controller movement and camera movement, such as weapon/walk bobbing or mouse smoothing

- Use surround sound

- Provide an option to turn off / hide background animation

- Ensure screen reader support for mobile devices

- Provide an option to adjust contrast

- Ensure sound / music choices for key objects / events are distinct from each other

- Provide a choice of cursor / crosshair colours / designs

- Give a clear indication that interactive elements are interactive

- Ensure manual / website are provided in a screenreader friendly format

- Provide separate volume controls or mutes for effects, speech and background/music

- Avoid placing essential temporary information outside the player's eye-line

- Allow interfaces to be resized

Advanced

- Allow the font size to be adjusted

- Provide a pingable sonar-style audio map

- Provide pre-recorded voiceovers for all text, including menus and installers

- Provide a voiced GPS

- Allow easy orientation to / movement along compass points

- Ensure that all key actions can be carried out by digital controls (pads / keys / presses), with more complex input (eg. analogue, gesture) not required, and included only as supplementary / alternative input methods

- Ensure screen reader support, including menus & installers

- Use distinct sound / music design for all objects and events

- Simulate binaural recording

10.1.5 Hearing

Basic

- Provide separate volume controls or mutes for effects, speech and background / music

- Ensure no essential information is conveyed by audio alone, reinforce with text / visuals

- If any subtitles / captions are provided, use an easily readable default font size, simple clear text formatting and provide high contrast between text and background

Intermediate

- Keep background noise to minimum during speech

- Provide a text alternative for all speech (subtitles / captions)

- Allow text alternatives to be displayed before any sound is played

- Provide a text description of narratively / atmospherically significant background noises

- Provide a visual indication of who is currently speaking

- Support text chat as well as voice for multiplayer

- Provide visual means of communicating in multiplayer

- Allow a preference to be set for playing online multiplayer with players who will only play with / are willing to play without voice chat

- Ensure that all important supplementary information (eg. the direction you are being shot from) conveyed by audio is replicated in text / visuals

- Provide a stereo/mono toggle

Advanced

- Ensure that subtitles/captions are cut down to and presented at an appropriate words-per-minute for the target age-group

- Provide signing

10.1.6 Speech

Basic

- Ensure that speech input is not required, and included only as a supplementary / alternative input method

Intermediate

- Allow a preference to be set for playing online multiplayer with players who will only play with / are willing to play without voice chat

- Support text chat as well as voice for online multiplayer

- Provide visual means of communicating in multiplayer

- Base speech recognition on individual words from a small vocabulary (eg. 'yes' 'no' 'open') instead of long phrases or multi-syllable words

Advanced

- Base speech recognition on hitting a volume threshold (eg. 50%) instead of words