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# The teaching-learning process and the Spanish Sign Language (LSE): “prime number” concept

Enseñanza-aprendizaje y Lengua de Signos Española (LSE): el concepto “número primo”

教学和西班牙语手语 (LSE) : “质数” 概念

Преподавание-обучение и испанский жестовый язык (LSE): концепция «простого числа»

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**Aránzazu Valdés-González**

University of Oviedo  
uo81833@uniovi.es  
<https://orcid.org/0000-0003-3698-8308>

**Emilio Álvarez-Arregui**

University of Oviedo  
alvarezemilio@uniovi.es  
<http://orcid.org/0000-0002-4657-753X>

**Alejandro Rodríguez-Martín**

University of Oviedo  
rodriguezmalejandro@uniovi.es  
<http://orcid.org/0000-0002-4230-4243>

**Javier Martín-Antón**

University of Oviedo  
martinajavier@uniovi.es  
<https://orcid.org/0000-0002-6698-6736>

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## Abstract

The aim of this paper is to collect and share the whole process that has been developed to transmit the concepts of *prime number* and *composite number* to Deaf people who use Spanish Sign Language (LSE) as their first language and who are semi-lingual in oral language. During this teaching-learning process, we came across shortcomings in the lexicographic materials of LSE. On the one hand, LSE dictionaries do not include a valid lexical unit for the concepts we were working on; and, on the other hand, the shortcomings detected prevented us from defining them in LSE. Therefore, we resorted to the use of manipulative materials to make it possible –on the basis of our collaborators' previous knowledge– to teach them the difference between prime and composite numbers and, in addition, to encourage the emergence of a *mental image* that benefits internalisation and long-term remembrance. As a final result, two lexical units were created for NÚMERO.PRIMO and NÚMERO.COMPUESTO

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Keywords: Teaching-learning, Spanish Sign Language, prime number, neologisms, manipulative materials.

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## Resumen

Este trabajo tiene como finalidad recoger y compartir el proceso íntegro que se ha desarrollado para transmitir los conceptos *número primo* y *número compuesto* a personas Sordas usuarias de la Lengua de Signos Española (LSE) como primera lengua y semilingües en lengua oral. Durante este proceso de enseñanza-aprendizaje nos encontramos con carencias en los materiales lexicográficos de la LSE. Por un lado, los diccionarios de LSE no recogen una unidad léxica válida para los conceptos trabajados; y, por otro lado, las carencias detectadas nos impidieron definirlos en LSE. Por ello, recurrimos al empleo de materiales manipulativos para –a partir de los conocimientos previos de nuestros colaboradores– enseñarles la diferencia entre números primos y compuestos y, además, fomentar la aparición de una *imagen mental* que beneficia la interiorización y el recuerdo a largo plazo. Como resultado final se crearon dos unidades léxicas para NÚMERO.PRIMO y NÚMERO.COMPUESTO.

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Palabras clave: Enseñanza-aprendizaje, Lengua de Signos Española, número primo, neologismos, materiales manipulativos.

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## 概要

本研究的目的收集和分享如何把质数和合数的概念传递给将西班牙语手语 (LSE) 作为第一语言和半语言口语的聋人的整个过程。在这个教学过程中, 我们发现 LSE 的词典编纂材料存在缺陷。一方面, LSE 词典没有收集与上述所学概念相关的词汇单元; 另一方面, 该缺陷导致我们无法在 LSE 中对其进行定义。因此, 我们根据之前合作者提供的知识, 依靠使用可操纵的材料教他们质数和合数之间的区别。此外, 通过使其在头脑中形成该概念的形象, 促进对该知识点的内化和长期记忆。最终, 我们为质数和合数创建了两个词法单元。

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关键词: 教学, 西班牙语手语, 质数, 新词, 操纵材料。

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## Аннотация

Цель данной работы - сбор и обмен информацией о процессе, который был разработан для передачи понятий простого числа и составного числа глухим людям, использующим испанский язык жестов (LSE) в качестве своего первого языка, и частично владеющим устным языком. В процессе обучения мы столкнулись с недостатками

лексикографических материалов LSE. С одной стороны, словари LSE не содержат допустимых лексических единиц для понятий, над которыми мы работали, а с другой стороны, обнаруженные недостатки не позволили нам определить их в LSE. Поэтому мы прибегли к использованию манипулятивных материалов, чтобы на основе предыдущих знаний наших сотрудников научить их разнице между простыми и составными числами и, кроме того, способствовать возникновению ментального образа, который способствует интернализации и долгосрочной памяти. В итоге были созданы две лексические единицы для ПРОСТОГО.ЧИСЛА и СЛОЖНОГО.ЧИСЛА.

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Ключевые слова: Преподавание-обучение, испанский жестовый язык, простое число, неологизмы, манипулятивные материалы.

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## Introduction

Society and education are intimately related due to the concurrent conditioning factors and decisions adopted at each historical moment. The proposals deployed in the past have been, are and will be controversial because they are not neutral and are linked to the power and knowledge systems in force, legitimised by experience and by the norm in the geographical areas in which they are integrated (Álvarez-Arregui & Arreguit, 2019). Nowadays, we are witnessing how teachers have been opting for alternative methodologies, which in our cultural environment have been translated into actions whereby students have been acquiring a more central role and more importance has been given to the connections they establish with themselves, with others and with the world (Goleman & Senge, 2014). The development of intelligence is thus understood as a continuous learning process wherein individual (Bruner, 1988), social (Pérez, 1993) and cultural aspects are taken into account. In this way, cognitive development is conceived as a “two-way process that develops from the subject to the environment and from the environment to the subject, highlighting the subject’s capacity for self-regulation with respect to the environment [...]” (Pastor & Sastre, 1994, cited by Tonda, 2001, p. 45). Taking into account the individual characteristics of the subject and the environment, interactionist theory emphasises the learner’s self-regulating role in his or her own development process, which allows him or her to adapt and regulate the activity on the basis of the demands of the environment. In this sense, following Zimmerman (1989), the self-regulation of learning can be defined as the process whereby learners activate cognitions, feelings and behaviours mainly oriented towards the achievement of their goals. In this way, the affective and relational sphere –that is, one’s interaction with the environment– leads us to view human development as linked to social interaction, which means that, as pointed out by Bruner (1988), the defence of human development without any dependence on the social environment within which it takes place is inconceivable.

## Mathematics and Deaf people<sup>1</sup>: conditioning factors

In this context, we consider that the Didactics of Mathematics “must assume the responsibility of elaborating and systematising knowledge that is useful for describing,

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<sup>1</sup> The phrase *Deaf person* will be used throughout the text to refer to individuals who use a signed language and identify with a linguistic-cultural community, as opposed to *deaf person*, which has a generic use without social connotations (Serrat-Manén & Fernández-Viader, 2015).

designing, implementing and assessing processes for teaching and learning mathematics" (Godino et al., 2008, p. 25) on the basis of "studying the factors that condition the processes regarding the teaching-learning of mathematics and the development of programmes to improve these processes" (Godino, 2003, p. 14) and where socio-cultural theories (Noss et al., 1997), multimodal communication (Krause et al., 2019) and the study of sociocultural theories (Noss et al., 1997) are used to develop theories of mathematics teaching and learning. and where sociocultural theories (Noss et al., 1997), multimodal communication (Krause et al., 1997) and the study of the LSE-Spanish bilingual context (Planas et al., 2018; Planas & Valero, 2016) are key to a correct teaching-learning process of mathematics by people with hearing impairment. In the specific case of Spanish Sign Language (hereinafter, LSE) users, who depend on an LSE Interpreter (hereinafter, ILSE) to access curricular content, the quality of the interpretations is a determining factor and, accordingly, the success of the teaching-learning process is directly proportional to the quality of the LSE lexicographic materials. This is all the more important for students who, in addition to being LSE users, are semi-lingual in the spoken language– i.e. individuals who are not fluent in the spoken language and have reading and writing problems that prevent them from accessing information orally or in writing- and/or in cases where the interpreting professional is not fluent in the mathematical content to be interpreted.

ILSEs are a fundamental part in the learning process of Deaf students (Uría & Ferreira, 2017), but it is important to emphasise that, in the case of students who are semi-lingual LSE users in oral language, the role of ILSEs is indispensable and irreplaceable. In this sense, Cámara (2008) points out that, while hearing students complete their teachers' explanations by reading the textbook, students who communicate exclusively in LSE only receive the explanation, and therefore the knowledge, through what they see on the blackboard and the Signs<sup>2</sup> (which their ILSE uses to interpret the teacher's explanations). Moreover, when these students go back home and have to revise and work on the curricular contents, they do not have the support of the ILSE and, as Cámara (2008, p. 34) states, several questions must be raised: "[what happens] when the student reads the words "square root", "three quarters", "one hundred and twenty-seven",...?, is the terminology used in the textbooks understandable for a person with hearing impairment?, what is more difficult for the student to understand, the expressions in Spanish in a textbook or the mathematical concept?"

On the other hand, in relation to the number and quality of entries in LSE materials –dictionaries or specific glossaries– their importance lies not only in their use by deaf individuals to learn new lexical units and/or concepts, but also in the use that interpreting professionals make of them. The ILSE will make more use of dictionaries in inverse proportion to their proficiency in the subject matter to be interpreted. In this regard, it is extremely important to draw the conclusions put forward by Santos and Takeco (2014) on the subject, when they state that

[...] the interpreter had no mastery of the physical concepts and, in trying to explain these concepts, contributed to reinforcing spontaneous conceptions, as is very common in the Sciences, or could generate misconceptions regarding the concepts or content, as the interpreter was not trained in the disciplines he interpreted. (p. 457)

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<sup>2</sup> We will use the term *Sign* –in capital letters– to refer to lexical units of signed languages and, *sign* to refer to linguistic signs (spoken or written words, Signs, etc.) or lexical units of a language regardless of their modality.

Santos and Takeco's (2014) statement referring to the field of physics can be extrapolated to interpreting situations bearing on mathematics –both subjects involve a high number of abstract concepts- so it is possible to envisage that the scarcity of terms or the low quality of the entries in the lexicographical materials of the LSE will lead to complex interpretations, especially if the ILSEs – on account of their personal academic training or professional career- have no in-depth knowledge of mathematical vocabulary. Thus, in their efforts to offer quality interpretations, due to a reliance on paraphrasing or defining terms, they may fall into errors linked to the meaning of concepts or other curricular content.

At this point, and in relation to what was indicated in the previous paragraph, we must remember that the main role of the ILS is: “to interpret, not to explain or amplify the information. It is the voice and the ear of the deaf person. Its function is limited to faithfully interpreting what is said in the classroom [...]” (Nogueira et al., 2012, p. 407). In other words, “in the classroom, the ILSE has the task of interpreting what the teachers, the hearing students and the Deaf students say; and, in addition, he or she also conveys any sound-produced information that may be of interest to Deaf students” (Valdés-González, 2017, p. 361), but at no time does the ILSE have the responsibility –or the entitlement to take on the responsibility– of explaining or expanding on the information given by the teacher.

Rodríguez and Mora (2007), for their part, point out a new conditioning factor in the social and educational reality of people with hearing loss: the low level of proficiency in LSE among secondary school students. This is a consequence of two established realities. On the one hand, approximately 95% of deaf people have hearing parents who are not proficient in LSE (Massone et al., 2003). On the other hand, Bixquert et al. (2003, p. 14) indicate that “more than 90% of deaf children are born into families whose parents are hearing persons. [...] 80% of cases of permanent childhood deafness is present at birth”. Consequently, in deaf children born to hearing parents “[...] a conflict arises within the dichotomy of one's mother tongue and one's natural language. For a Deaf child, the naturally acquired language will be Sign Language, while the language regarded as their mother tongue - that of their parents - will require a learning process, with pedagogical intervention.” (Valdés-González, 2017, p. 57). On the other hand, Deaf children of Deaf parents will acquire the signed language naturally. In this sense, the importance of Sign Language for a Deaf person (regardless of whether or not their parents are Deaf) is vital and lies in the fact that, for these individuals, signed languages are the languages they acquire naturally and, what is most relevant to them, the signed language is the language “in which they think, which they know best, in which they communicate more spontaneously and fluently and with less effort. It is the language they prefer to use in situations of maximum complexity and intimacy” (Báez, 2014, p.7).

In addition to the variables mentioned above, and directly related to the fact that, in 90-95% of cases, Deaf people are children of hearing parents, Costello, Fernández et al. (2009) present us with a new conditioning factor that influences the variability of signed languages:

One of the most relevant sociolinguistic characteristics of sign languages is the lack of generational continuity: most deaf people are born to and grow up in hearing families and, as a consequence, do not have the opportunity to acquire sign language in a normal context. [...] The small number of native users has important consequences for the language, both at the level of its structure and evolution, [...] the vast majority of LSE

users are non-native,<sup>3</sup> and as a result the language shows a high degree of variation (both regional and generational). (p. 371)

In other words, the scarcity of native users implies that most signers learn the sign language non-spontaneously and in many cases at an advanced age, each of them presenting a different linguistic profile –exclusively signers, bilingual Sign Language-speakers, with greater or lesser proficiency in one or the other, etc.–. In short, (Costello et al., 2009) conclude that “the most significant consequences of a language with very few native speakers can be summed up in two words: variety and heterogeneity” (p. 377).

To conclude this section, it is important to point out that linguistic signs, whether words or signs, must evoke an “image in the brain” in the receiver. Otherwise, the sign is empty of meaning and will not lead to effective communicative processes. In this sense Pierce (Vázquez, 2010) indicates “A sign stands for something for the idea it produces or modifies. [...] it is a vehicle that conveys something from the outside to the mind. What it stands for is called its object; what it conveys is its meaning; and the idea to which it gives rise, its interpreter” (p. 13). In this sense, dactylogogy, lip reading, the use of commonly used signs for specific terms and, in short, the resources based on oral language will generate a disadvantage in the teaching-learning process of new concepts on the part of Deaf students and, ultimately, in their access to information.

To sum up, it is worth mentioning that we are dealing with a language of great variety and heterogeneity which, moreover, will serve as the language of access to curricular contents for users who, being predominantly Deaf children of hearing parents, have had access to it at a late stage. Consequently, the work of the ILSE will be decisive in the teaching-learning process of Deaf students; and, therefore, the quality and number of entries in the LSE lexicographic materials will also be of great importance, as the LSE lexical units will be the basic features of the LSE-Spanish interpreting process (and vice versa).

## Deaf people and the acquisition of mathematical competence

In relation to the mathematical competence of people with hearing impairment, there are numerous studies comparing children with and without hearing loss (Allen, 1995, cited by Pagliaro, 1998; Leybaert & Van Cutsen, 2002; Nunes & Moreno, 1998a; Traxler, 2000, cited by Pagliaro & Ansell, 2002; Wollman, 1965; Wood et al., 1983; Swanwick et al., 2005) which conclude that, at the same age, the former show lower results in mathematics tests, with a time lag of at least two years (Wollman, 1965; Wood et al., 1984) from pre-school levels (Kritzer, 2009).

In the study by Wood et al. (1983), which followed 1005 children –540 of whom had different levels of hearing loss– who were schooled in integrated systems with different characteristics, it was concluded that there is no reason to suppose that the mathematical reasoning process of people with a hearing loss is different from that of hearing people. On the contrary, the authors indicated that Deaf people would go through the same stages as hearing people but with slower progress.

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<sup>3</sup> A native user is understood as “a person who has acquired the language spontaneously from birth” (Costello, Fernández, Villameriel and Mosella, 2009, p. 374). In other words, an individual is a native user of the LSE if he or she has acquired it naturally from birth, whether it be his or her parents’ language or not.

The relationship between deafness and lower mathematical achievement has been ruled out (Nunes & Moreno, 1998a; Wood et al., 1983; Wood et al., 1984). In this sense, over the last decades, researchers have analysed different factors related to the mathematical skills of Deaf students and have proposed intervention processes based on the design of strategies and tools that meet the demands of the Deaf population and provide problem resolution (Nunes & Moreno, 1998a, 1998b, 2002).

In relation to our field of study, which focuses on Deaf people who use LSE as their first language and who are semi-lingual in oral language –that is to say, who present literacy problems that limit their access to information through reading and/or lip-reading– Kidd et al. (1993) point to the use of polysemous words (whose meaning differs outside and inside the classroom) as a detrimental agent, as their use harms people for whom the spoken language is not their native language by making access to information and new concepts more difficult. In his study on the influence of language on the development of mathematical competences, Serrano (1993) shows that Deaf and hearing people solve mathematical problems without verbal content with an equivalent level of success, whereas when the problems have a significant verbal content, the former have difficulties and their performance is lower. The same conclusion was reached by Cámara (2008) when she observed, as a teacher of Deaf students, that when faced with statements such as “find the square root” or “decompose into factors”, she did not obtain an answer to the correct resolution of or “find the l.c.m and G.C.D. of 1014 and 500”. This evidence led the author to design booklets taking into account the linguistic needs of Sign Language learners. These adaptations were carried out for natural numbers, integers, rational, irrational and real numbers (Cámara, 2002).

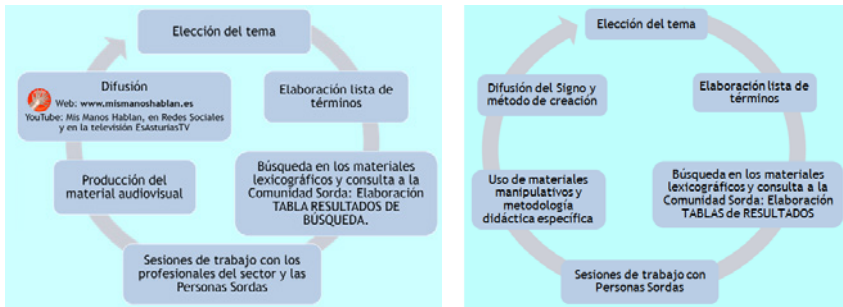
## Objectives and methodology

The lexicological analysis of the entries present in the LSE lexicographic materials for the Spanish words *número primo* and *número compuesto* is carried out through the implementation of a systematic process of search, comparison, discussion and –if necessary– creation of Signs. In this way, the general aim or objective is to contribute to the adaptation of LSE to the linguistic needs of a mathematics session, favouring the work of the ILSE and, at the same time, the access to the curriculum for signers. In this context, the specific objectives are: (a) to identify errors or deficiencies in the LSE materials linked to the lexical units NÚMERO-PRIMO and NÚMERO-COMPUESTO; and, (b) to create and propose new Signs, if necessary.

In the present research, focused on two specific mathematical terms, the working method followed for the search, analysis and creation of the signs NÚMERO-PRIMO and NÚMERO-COMPUESTO differs from that published by Valdés-González and Martín-Antón (2020) in several of its stages (see Figure 1). The differences between both methodological designs –fifth and sixth steps– are mainly due to the use of simple manipulative material over several weeks. On the other hand, on this occasion, in addition to the production of audiovisual material for the dissemination of the lexical units created, it was considered appropriate to disseminate in detail each of the steps of the experimental phase carried out.

Figure 1

Summary of the work method



Note. Adapted from “Lengua de Signos Española y Clasificación de los Números: Análisis y Propuesta de Neologismos”, by A. Valdés-González, A. Rodríguez-Martín, E. Álvarez-Arregui, & J. Martín-Antón, 2020, *Revista Brasileira de Educação Especial*, 26(2)

Next, in the results section, the reader –as he/she reads on– will be able to detect each of the stages or steps of the work method carried out and reflected in Figure 1.

## Analysis and findings

After choosing the topic, determining the concepts to work on with the Deaf people under study and verifying that they knew neither the concepts of *prime number* and *composite number*, nor their signs in LSE. A search was carried out in the lexicographic LSE materials.

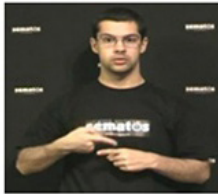
The lexical unit provided by Aroca et al. (2002), the University of Seville and Sématos is the same and consists of two signs: NÚMERO<sup>4</sup> followed by the lexical unit PRIMO (see Figure 2). A calque can be observed in this NÚMERO+PRIMO unit. In all three cases, the PRIMO lexical unit related to kinship (cousin) has been used (Figure 2 and Figure 3).

<sup>4</sup> To refer to a Sign, that is, a linguistic sign or lexical unit of the LSE, we will write it in capital letters. Therefore with NÚMERO we are referring to the Sign in LSE of the Spanish word *número*.



Figure 2

Findings for *NÚMERO.PRIMO* and *NÚMERO.COMPUESTO*



NÚMERO. PRIMO

NÚMERO.  
COMPUESTO

Note. Adapted from *Glosario de Lengua de Signos Española. N.º4. Matemáticas* (p. 72), by E. Aroca, M. A. Díez, D. Isa de los Santos, M. J. Nieto, E. M. Sánchez, & N. Marras, 2002, Fundación CNSE.

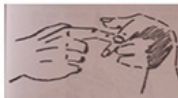
Note. Adapted from Universidad de Sevilla, 2016, <https://sacu.us.es/spp-prestaciones-discapacidad-glosario-matematicas>.

Note. Adapted from Sématos, 2009-2013. <http://www.sematos.eu/lse.html/>.

Note. Adapted from STS, s.f. <http://www.spreadthesign.com/es/>.

Figure 3

*PRIMO*. Sign linked to kinship



Note. Adapted from *El lenguaje mímico*, p. 57, by J. L. Marroquín, 1975. Caja de Ahorros de Jerez.

Note. Adapted from *Diccionario mímico español*, p. 427, by F. J. Pinedo, 1981a, Federación Nacional de Sordos

Note. Adapted from *Nuevo diccionario gestual español*, p. 574, by F. J. Pinedo, 1989, CNSE.

Note. Adapted from *Diccionario de Lengua de Signos Española*, p. 673, by F. J. Pinedo, 2000, CNSE.

Note. Adapted from *Diccionario normativo de la lengua de signos española*, p. 773, by Fundación CNSE, 2011, CNSE.

Note. Definitions accompanying the Signs.

PRIMO. Child of the uncle or aunt (Pinedo, 1981a y 1989)

PRIMO, MA: Referred to a person, son or daughter of his or her uncle or aunt (Pinedo, 2000)

PRIMO, MA: m. and f. In respect of a person, son or daughter of his or her uncle or aunt (Fundación CNSE, 2011)

As Morales et al. (2002) point out, calque “[...] consists in the literal translation into a given language of compound terms or idiomatic phrases from another language, either signed or spoken” (p. 80). In relation to calque, Barreto (2010) points out that the process of translation and/or interpretation is understood as the transfer of content from one language to another, not as a simple exchange of codes, word for word. González Montesino (2016) refers to calque as *immediate naturalisation* and indicates that it consists of the “simultaneous use of a lexical or morphosyntactic element specific to this language [the LSE] and the vocalisation of the problematic term in the spoken language” (p. 490). He also indicates that “it is a very beneficial procedure for the rapid solution of problems in the case of informants with lexical poverty in the target language”. In other words, it is a resource used by individuals with a poor knowledge of Sign Language who use resources of the spoken language when faced with terms whose sign they do not know.

The calque detected in PRIMO makes it difficult for semi-lingual Deaf people in oral language to access the concept of *prime number* as a consequence of the fact that these individuals identify “objects with images, feelings with sensations, but never with words that they do not know or which do not mean anything to them by themselves” (Pinedo, 1981b, p. 55).

We are therefore faced with a mathematical term, *prime number*, for which the lexicographical materials of the LSE do not provide us with an effective Sign. So we have to resort to the explanation of the word and, once explained and assimilated by the collaborating<sup>5</sup> Deaf people, proceed to the creation of a neologism for both words. What follows is the definition of *prime number*, followed by the definitions of all the words necessary for one to be able to understand and transmit it.

Table 1

*Definition prime number*

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**NÚMERO PRIMO**

1. m. *Mat.* Número entero que solo es exactamente divisible por sí mismo y por la unidad; p. ej., 5, 7, etc.

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Divisible 2. adj. *Mat.* Dicho de una cantidad: Que, dividida por otra, da por cociente una cantidad entera.

Divisibilidad 1. f. Cualidad de divisible.

Unidad 7. f. *Mat.* Cantidad que se toma por medida o término de comparación de las demás de su especie.

Cociente 1. m. Resultado que se obtiene al dividir una cantidad por otra, y que expresa cuántas veces está contenido el divisor en el dividendo.

Divisible 2. adj. *Mat.* Dicho de una cantidad: Que dividida por otra da por cociente una cantidad entera.

Entero/ra 14. m. *Mat.* número entero.

Dividir 4. tr. Averiguar cuántas veces una cantidad, llamada dividendo, contiene a otra, llamada divisor.

5. tr. *Mat.* Reemplazar en una proporción cada antecedente por la diferencia entre él y su consecuente.

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<sup>5</sup> Two Deaf adults, of about 43 years of age, use LSE as their first language. In both cases, the command of the spoken language is limited, being superior in one of the two subjects.

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## NÚMERO PRIMO

1. m. *Mat.* Número entero que solo es exactamente divisible por sí mismo y por la unidad; p. ej., 5, 7, etc.

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Divisor 1. adj. *Mat.* Submúltiplo. U. t. c. s.  
2. m. *Mat.* Cantidad por la cual ha de dividirse otra.

Dividendo 1. m. *Mat.* Cantidad que ha de dividirse por otra.

Número entero 1. m. *Mat.* número que consta exclusivamente de una o más unidades, a diferencia de los quebrados y de los mixtos.

Número mixto 1. m. *Mat.* número compuesto de entero y de quebrado.

Quebrado/da 7. m. *Mat.* número quebrado.

Fracción 5. f. *Mat.* número quebrado.

Quebrado decimal (1. m. *Mat.* fracción decimal.)

1. f. *Mat.* fracción cuyo denominador es una potencia de diez.

Quebrado impropio (1. m. *Mat.* fracción impropia.)

1. f. *Mat.* fracción cuyo numerador es mayor que el denominador, y por consiguiente es mayor que la unidad.

Quebrado propio (1. m. *Mat.* fracción propia.)

1. f. *Mat.* fracción que tiene el numerador menor que el denominador, y por consiguiente es menor que la unidad.

Denominador

2. m. *Mat.* En las fracciones, número que expresa las partes iguales en que una cantidad se considera dividida.

3. m. *Mat.* En los cocientes de dos expresiones o términos, el que actúa como divisor.

Numerador

2. m. *Mat.* Guarismo que señala el número de partes iguales de la unidad contenidas en un quebrado y que se escribe separado del denominador por una raya horizontal o inclinada.

3. m. *Mat.* En los cocientes de dos expresiones o términos, el que actúa como dividendo.

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Note. Adapted from *Diccionario de la lengua española* (23ª ed.), 2018.

After determining the key concepts needed to explain the concept of *prime number* (see Figure 4), a second search was carried out in LSE dictionaries and glossaries (see Table 2).

Table 2

Findings for LSE lexical units

Word (in spanish)	Pinedo (2000)	Aroca et al. (2002)	Fundación CNSE (2011)	US (2016)	STS	Sématos	Result
1 Número primo	--	¿p. 72?	--	¿?	¿?	¿?	¿?
2 Divisible	--	--	--	--	--	--	--
3 Divisibilidad	--	--	--	--	--	--	--
4 Unidad	--	--	--	--	¿unique?	¿unique?	¿?
5 Cociente	--	p. 29	--	--	YES	YES	YES
6 Divisible	--	--	--	--	--	--	--
7 Entero	p. 411	--	--	--	¿full?	¿full?	¿?
8 Dividir / División	¿p. 365? / --	-- / p. 42	p. 358 / --	-- / --	YES / YES	-- / YES	YES / YES
9 Divisor	--	p. 43	--	--	YES	YES	YES
10 Dividendo	--	p. 42	--	--	YES	YES	YES
11 Número entero	--	¿p. 70?	--	YES	¿full?	¿full?	¿?
12 Número mixto	--	--	--	--	¿mix?	--	¿?
13 Quebrado	p. 683	--	--	--	--	--	YES
14 Fracción	--	p. 49	--	YES	YES	--	YES
15 Fracción decimal	--	--	--	--	--	--	--
16 Fracción impropia	--	--	--	--	--	--	--
17 Fracción propia	--	--	--	--	--	--	--
18 Numerador	--	p. 68	--	YES	YES	YES	YES
19 Denominador	--	p. 37	--	YES	YES	YES	YES
20 Número compuesto	--	--	--	--	¿add?	--	¿?

Note. Adapted from Pinedo (2000), Aroca et al. (2002), Fundación CNSE (2011), Universidad de Sevilla (2016), STS (s.f.) y Sématos (2009-2013).

The findings of the search in LSE dictionaries and glossaries is indicated in Table 2 as follows: -- indicates that no result was obtained, "YES" or "p. number" indicates that the search was successful (in the first case, in one of the web pages consulted; and, in the second case, in one of the LSE lexicographical materials published on paper) and, finally, question marks indicate that the Sign located presents polysemy (i.e. different meanings are given to the same Sign) or calque in an unjustified way. Thus, for example, the concept *divide* is given the LSE Sign *share* (Pinedo, 2000, p. 365), *unit* that of *unique* (STS, s.f.; Sématos, 2009-2013), *integer* that of *full* (Aroca et al., 2002, p. 70; STS, s.f.; Sématos, 2009-2013), *mixed* that of *mix* (STS, s.f.) and *composite* that of *add* (STS, s.f.).

After the bibliographic research, one can observe that the searches that give no result or an ambiguous result correspond to the most abstract mathematical concepts and, therefore, cannot be easily associated with an iconic or visually motivated Sign.<sup>6</sup>

## Experimental phase: Use of manipulative material

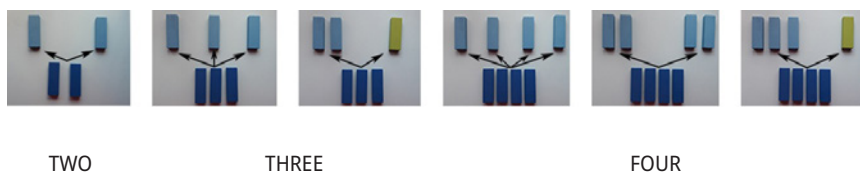
From the results obtained, we find that there is a lack of entries in the LSE materials that does not allow us to translate the contents of mathematics books as regards the *prime number* or explain its meaning from its definition and, moreover, the interpretation of an explanation during a mathematics class would be complicated as a consequence of the lack of signs. This means, first of all, that Deaf collaborators are introduced to the concepts of *prime number* and *composite number* and once they have assimilated them, this knowledge is linked to the definition in order to finally reach our objective of agreeing on a Sign for each of the two words. The procedure followed is explained in more detail below.

The process used consisted in using different coloured wooden bars. The steps followed are explained below:

- (1) Indicate that any number of bars can be placed in the same group or in isolation, one at a time.
- (2) Point out that some quantities can be distributed/divided into equal groups of more than one bar. Thus, for example, four bars can be grouped in pairs.

Figure 5

*Example of first distributions*



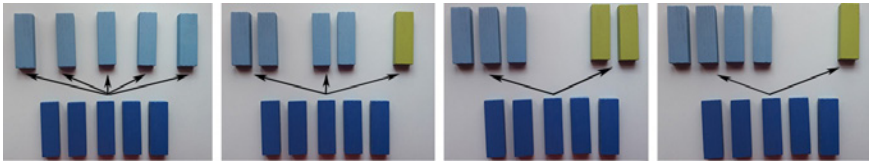
(3) After repeating the process several times and with different numbers –from 2 to 9, due to the limitation of the number of bars of each colour available– it is explained that a prime number is one that can only be separated into equal groups in two ways (all the bars together or one by one) and a composite number is one that can give rise to the same type of groupings as prime numbers and, in addition, can be grouped in other ways without having any bars left over.

Thus, five is a prime number. Since, as shown in Figure 6, five bars can only be “grouped” together or one at a time.

<sup>6</sup> Authors such as Sutton-Spence and Woll (1999, cited by Tovar, 2008, p. 258) prefer to use the term visual motivation instead of iconicity: “[...] «visually motivated» is a more appropriate term than the frequently used «iconic», as the latter has a rather limited meaning. An «icon» means precisely «image». Many hearing people still believe that all signs are only images or pantomimes, and that all deaf people can communicate everywhere in the world.”

Figure 6

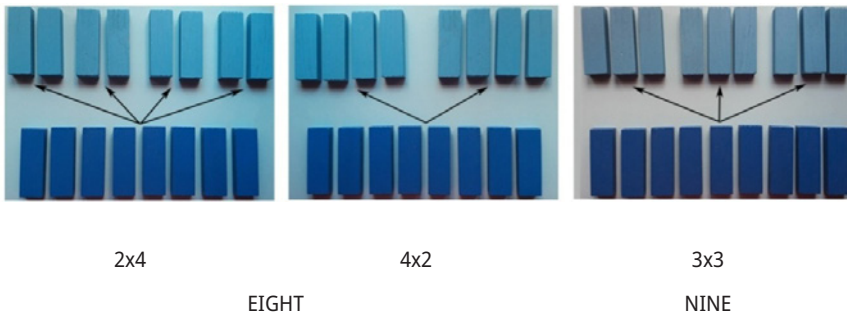
*Five is a prime number*



The numbers eight and nine, on the other hand, are composites (see Figure 7). Thus, eight bars can be separated into equal groups of two or four bars. Nine, on the other hand, gives rise to equal groups of three bars.

Figure 7

*Eight and nine are composite numbers*



(4) The process is carried out with numbers higher than nine. This time, however, without using the wooden bars, but only by means of sign language. Thus, for example, twelve is a número compuesto because twelve units can be grouped in pairs, in threes, in fours and in sixes –and they can also have twelve elements one by one and all twelve in the same group– as shown in Figure 8.

Figure 8

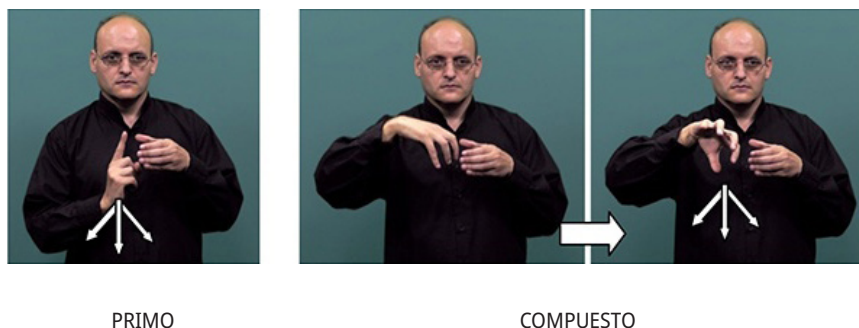
*Twelve is a composite number*



(5) Finally, on the basis of the process carried out, new Signs or neologisms are created for NÚMERO.PRIMO and NÚMERO.COMPUESTO.

Figure 9

Neologisms PRIMO and COMPUESTO



Note. Adapted from “Lengua de Signos Española y Clasificación de los Números: Análisis y Propuesta de Neologismos”, by A. Valdés-González, A. Rodríguez-Martín, E. Álvarez-Arregui, & J. Martín-Antón, 2020, *Revista Brasileira de Educação Especial*, 26(2).

(6) At a later stage, during the writing of the present text, more than two years after carrying out the experimental phase, the collaborators can be verified as remembering what a *prime number* and *composite number* are, as well as the Signs agreed upon and their interpretation into Spanish; they can give examples of each type of number and explain both concepts to other people. In this specific testing session the two Deaf partners, an ILSE, a mathematics teacher and a learning specialist participated once again and steps 3 and 4 of the experimentation phase, described above, were reproduced.

## Conclusions

Exploration, experimentation and manipulation are actions that favour the improvement of skills that contribute to comprehensive development and benefit the teaching-learning process (Alsina & Martínez, 2016). In our case, we were provided with the emergence of mental representations in our Deaf collaborators and on this basis, as mentioned above, we provided them with the definition of the concepts worked on and a neologism was agreed upon. In relation to mental representations, Lang and Pagliaro (2007) indicate that the presence of *mental images* promotes long-term memorisation and conclude, in relation to the field we are concerned with, that as students with deafness learn mathematics, their ability to remember vocabulary is determined by the presence of mental images linked to the different referents. Furthermore, these authors indicate that teachers with a deep knowledge of mathematical concepts are more likely to make it easy for their students to acquire these mental images as they themselves possess them.

As a consequence of the work carried out, the new concepts were adapted to the mathematical competences that the Deaf individuals already possessed –the meaning

of the actions *distribute* and *divide* were reinforced with the explanation of the terms *dividend*, *divisor*, *quotient* and *remainder*– resulting in meaningful and long-term learning. In this way, a process was defined through which the new knowledge was related in a non-arbitrary way to the recipients' prior knowledge (Moreira, 2012).

In this way, through simple manipulative experiences, we have favoured the process of internalisation, the long-term memorisation of abstract mathematical concepts. Moreover, as a result of the process, two new lexical units –two neologisms– were created for NUMERO.PRIMO and NÚMERO.COMPUESTO, two signifiers which, as we have recorded, had entries in the lexicographical materials of the LSE based on literal translation or calque –the influence of the oral language– which we have saved by providing two Signs for the mathematical concepts *prime* and *composite*. The proposal of the two new Signs avoids the use of polysemous lexical units, whose meaning differs inside and outside the classroom; it reduces the influence of spoken on signed language; it facilitates the work of LSE interpreting professionals by providing them with two lexical units that they can use according to the needs of the interpreting process; and, furthermore, it facilitates the teaching-learning process of deaf learners by encouraging the use of Signs which allow them to create a mental image of the concept and which, unlike the entries collected so far in LSE dictionaries and glossaries (see Figure 2 and Figure 3), are not linked to polysemous Signs with everyday meanings which, as stated by Kidd et al. (1993), make access to information difficult.

As presented above, the neologisms created are the result of a careful process in which the characteristics of the visual-gestural modality languages have been respected and the influence of the spoken language on LSE has been avoided. Furthermore, they are lexical units which, after their publication, will be disseminated in audiovisual format so that the Deaf Community can use them, transmit them and, if necessary, modify them. Lexical units and neologisms evolve and we agree with Sánchez (2014) when he states that what matters is not the sign but the concept. Furthermore, we also agree with Barreto (2015) that it will be the users who, in everyday and/or academic life, will bring these neologisms to life.

Regarding the neologisms proposed for NÚMERO.PRIMO and NÚMERO.COMPUESTO, it is important to emphasise that their use is determined by the context. Thus, for example, they could be used during an explanation, but they should be avoided when presenting or interpreting exercises on the classification of numbers into prime or composite numbers, since their use would be giving the student the answer when presenting the characteristic part of the numbers that is the main one in these types of numbers: they are divisible or not by numbers other than themselves and the unit. In the second case, the teacher or interpreting professional should opt for the use of the dactylological –NÚMERO P-R-I-M-O o NÚMERO C-O-M-P-U-E-S-T-O or, failing that, use only the initial NÚMERO+P or NÚMERO+C– or make use of a linguistic buoy. In this sense, and in direct relation to the creation of new lexical units, Tovar (2010) indicates “the advantage for the LSC<sup>7</sup> of having different ways of denoting the same entity or activity, [...]” (p. 304) so that, when faced with different ways of signing, one or another option is used depending on the context, the degree of technicality or its formality.

Along the same lines, we should point out that, like all languages, regardless of their modality, LSE requires the creation of new lexical units. In the specific case of signed languages, this need is greater as a direct consequence of the fact that they are historically minority languages and minoritised in a largely oralist environment. Lexical

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7 For Tovar, LSC is the acronym for Lengua de Señas Colombiana (Colombian Sign Language)



creation processes are necessary and a sign that visual-gestural languages are living languages but, as Moral (2008) points out, it is important to bear in mind that they are procedures in which creation is determined by knowledge of the context, of the mother tongue and of the language being learnt. In other words, the learning of concepts involving the creation of a lexical unit by Deaf LSE learners –who in addition to learning mathematics have to remember the words in Spanish– must take into account the context (in our case the field of mathematics), the Deaf students' command of the LSE, the learners' level of knowledge of Spanish and, in addition, the teacher's and/or interpreting professional's command of the subject of mathematics and/or the LSE.

Finally, we can affirm that the use of manipulative material has allowed us to “concretise” an abstract mathematical concept –the definition of which is related to lexical deficiencies in LSE lexicographic materials– and, at the same time, to create mental images that will favour long-term memorisation (Lang et al., 2007; Lang & Pagliaro, 2007) of the new concepts acquired by our collaborators. Moreover, the linking of the concepts –*prime number* and *composite number*–, their spelling and the creation of two neologisms allow us to provide the Deaf Community with “[...] sufficient keys or the ability to cope [...] with complex texts and different textual conventions, text types, situations and topics, taking into account the sender and receiver, the aim of the text, etc.” (Moral, 2008, p. 191). In other words, the two neologisms created in connection to the Spanish terms will favour the interpretation and access to written information for Deaf students who now have a lexical unit for the two concepts worked on in their own language in addition to the Spanish units. In this sense, based on the recognition and enhancement of the characteristics of the LSE for the creation of neologisms, we agree with Lang et al. (2007) in recognizing that an effective teaching-learning process through signed languages must combine the LSE with the spelling of words, the printed word and clear explanations to promote and facilitate learning among Deaf students.

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