GEOMETRICAL ACTIVITIES FOR CHILDREN WITH INTELLECTUAL DISABILITIES INSPIRED IN EDOUARD SEGUIN'S (1812-1880) APPROACH.

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ABSTRACT

This workshop takes inspiration from the work of Édouard Séguin (1812-1880), the French pedagogue and philosopher of education generally considered as the outstanding pioneer of special needs education and disability studies and is addressed to Primary and Lower Secondary teachers (both future and in-service).

In the workshop the participants will experience his research on the human mind and geometrical concepts. Trying to overcome the isolation of the so-called "idiot" children (in fact, the Greek stem of the word makes reference to their difficulties understanding and communicating with the outside world by means of speech), he devised an educational path focused on the awakening of awareness. His physiological method included smart, carefully designed activities intended to awake the five senses and develop "notions". The passage from notions to "ideas" asked for connections between perceptive notions: for this, Séguin turned to geometry: equal, greater than, composition and decomposition were the starting actions and comparisons that he proposed to children, using wooden bricks, rods, and frames (a context of 3D geometry). These materials were crucial to establishing a joint frame of intentions, to prompt the child's activity, intelligence, and finally his will. The workshop is organized in three steps and encapsulates the reading of some excerpts from his work and the presentation of a leisure time mathematical workshop held in Spain with children with Trisomy 21 following Seguin's approach

1 Who was Edouard Séguin? A pioneer in the use of geometrical means to break the isolation of idiot children in nineteenth century.

It is convenient to start the workshop with some information on the figure of Edouard Séguin, his personality, his broad culture, and his humanity being moved by the situation of cognitively impaired children and adults in France in the nineteenth century.

Edouard Séguin had a polyhedric personality (see Gil-Clemente & Millán Gasca, 2022 for more information). He was a doctor and pedagogue, a man of

action but also a deep thinker. His convictions that children with disabilities can be educated and deserve, like the rest of children, an integral education that makes them free people with their own thoughts permeates all of his work.

His books are tightly linked to life. He used to say that they are a unique book rewritten in several moments, taking into account his progressive experiences working with "idiot" children.

Personal circumstances lead him to work with the renowned physician Jean Itard, in the education of Adrien, a so-called "idiot". This changed his life devoting it to the upbringing of children that were institutionalized and mixed with people who had different mental illnesses. He wrote his two first short book in 1839 after the experience with Adrien and the third in 1842 after three months of work at Hospice des Incurables in Paris with a group of nine children (see references for the tittles). He ended his first block of books with the one he wrote in 1843, two years after leaving Bicetre Hospital, because of disagreements with the director.

In 1846, he wrote his last book in French where he reaffirmed and further developed the ideas stated in the previous books. In 1850, he emigrated to the USA due to a mixture of political reasons and lack of recognition. There, in 1866, he systematized his method and in 1873, he also wrote a final book, a bit different from the others, after Vienna World's Fair.

His ideas about education are born out of this personal experience of encounter with "idiots" and from considering them as human beings that deserve an integral education. He put all his previous background (he was a cultivated person, with studies of medicine, law and art) at the service of their education.

He opposed method to chance, and he designed a clear path to follow in the training of idiots: beginning from the education of the muscular system, following by the education of the nervous system, by which they acquire notions for arriving to ideas first and finally to morality. The bases of his method are: 1) the triad *action, intelligence, will*, the goals of his paideia. Acquisition of will is a guide for him. 2) The crucial opposition *myself /not-myself*, being the transition between both, a key in the process of growing. This opposition is a guide for the design of educational exercises based upon imitation: personal imitation for the developing of notions on *myself*, and impersonal or objective for the developing of notions on *not-myself*. In this educational path, Séguin attributes a central role to Geometry. Geometry act as a bridge to construct the necessary relationship, between myself and my non-self His work is better understood in the wider context of the early initiatives to stablish compulsory primary education for citizens in modern states in XIX century. The introduction of geometrical contents to make the instruction evolve from rote training to methods that help understanding is one of the most relevant aspects in these initiatives. In this way the formative role of mathematics is extended to all and not only to those who will continue higher-education. In this "all", the originality of Séguin was to include "idiots".

2 The workshop proposed

The workshop is organized in three steps: 1) A starting activity to enable participants to get to grips with the meaning of disability; 2) A journey through the learning path proposed by Séguin with special emphasis on the role he attributes to Geometry. This phase is conducted by the leader of the workshop and it combines reading some excerpts from Séguin's work with commenting the most significant issues with participants; 3) An audiovisual presentation, of a collection of geometrical activities for intellectually disabled children, designed following Séguin's approach and held in Spain.

The workshop has been designed following the experiential *ANFoMAM* workshops, for training Pre-school and Primary School teachers (Lizasoain Iriso, Magrone, Millan Gasca, et al. 2022) and it is recommended for 20 participants. It is to be held in a classroom with an open plane space, chairs and tables equipped with a projector. During the workshop, participants will be provided with a dossier with a wide selection of texts to help them understand the learning path proposed by Séguin which includes a timeline of his life and work

For the presentation of the workshop in these proceedings we have opted to: 1) explain the starting activity; 2) describe the main stages of the path proposed by Séguin introduced by one of the selected excerpts and including some keys about the activities developed in Spain for children with intellectual disabilities.

2.1. Starting activity: a blind comparison of lengths.

We ask participants to form groups of four people, look for a place in the room and sit on the floor. One of them is going to be the observer and the others are going to close their eyes using a blindfold. We give the observer a set of ten wooden bars of increasing length from 10 cm to 1 m. The members of the group have the mission of ordering them. While they face the challenge, the observer can help the group only with practical issues. We ask the observer to watch carefully what the group does and which is the process they follow. We give them time to order the bars (more or less 10-15 minutes) and afterwards we invite the participants to share their experience. The leader of the activity says: "You have experienced firsthand what it means to face the challenge of being deprived of one sense: the sight. We encourage you to share: 1) the process followed for ordering the bars, 2) what other senses or capacities did you have to put into play; 3) any preliminary reflection of what disabilities means".

We expect certain ideas to appear such as the use of tact or the need to match the ends in order to compare their length.

We finish the activity explaining that this is an exercise that Séguin describes as infallible to help "idiotic children" to connect their inner and outer worlds, and finally reading together the following excerpt from his 1843 book written after his work with nine children in the Hospice des Incurables in Paris

On fait scier vingt règles: la première a 5 centimètres de longueur, la seconde en a 10, la troisième, 15, etc., jusqu'à la vingtième, qui en a 100. Chaque intervalle de 5 centimètres est indiqué sur les quatre faces de chaque règle par un trait [à la scie et au crayon] noir. On commence par poser l'une à côté de l'autre la plus grande, le mètre, et la plus petite, celle de 5 centimètres. On demande alternativement à l'enfant la plus grande et la plus petite. On en ajoute une troisième, la moyenne; puis on rapproche les extrêmes jusqu'à ce que ces règles [offertes à l'appréciation visuelle de l'enfant] ne différent plus [entre elles] que par leur différence progressive de 5 centimètres, toujours en demandant la petite, la moyenne, la grande. Enfin on jette confusément à terre toutes ces règles, et on demande à l'enfant la plus petite, la suivante, la suivante, etc., jusqu'à la dernière, la plus petite. Enfin on jette confusément à terre toutes ces règles, et on demande à l'enfant la plus petite jusqu'à la plus grande, ou la plus grande jusqu'à la plus petite, et quand il les prend et les range ainsi progressivement de la première à la dernière, on peut compter que le regard, habitué à ce genre de comparaison, saura l'appliquer ensuite à tous les objets, ce dont on s'assure d'ailleurs par l'expérience (Séguin, 1843)

The last sentence is especially interesting because points out his broad goals: he uses an educational material but aims to getting children used to comparing objects in general.

2.2. Educational path proposed by Séguin. Selected excerpts and recent reformulation for children with Trisomy 21

In order to describe the method Séguin proposed, we have chosen his first four works collected by Bourneville in 1897: *Premiers memoires de Séguin sur l'idiotie (1838-1843)*. In them, we can see the young Séguin, the curious Séguin who learns after observing, the courageous Séguin who goes against the tide, moved by what he sees at the Hospice des Incurables and at Bicétre, the one that uses all his background to go out to the encounter of the young people living there and to try to bring them out of their isolation.

In this paragraph we describe the main steps of the educational path proposed by Séguin trying to bring to light their geometrical basis. In each step we combine the more relevant selected texts that can be discussed by the participants and the results of a research developed in Spain about the mathematical education of children with Trisomy 21 aged between 3 and 15 years old (Cogolludo & Gil-Clemente, 2019; Agudo, Cogolludo & Gil-Clemente,2021; Gil-Clemente, 2022), that appear in this audiovisual presentation (https://www.youtube.com/watch?v=mEXPc-rr3Oc)

2.2.1 Standing still, alignment and march.

Trouvant un corps agité de mouvements convulsifs et incessants, je l'ai condamné à une immobilité d'un mois; et l'immobilité était le seul point du levier sur lequel on pût s'appuyer pour obtenir une action régulière. La marche du soldat, l'imitation de divers mouvements de la tête et des bras ont commencé à donner à l'enfant les notions du moi. (Séguin, 1838)

In his first encounter with Adrian and the other nine children in Hospice des Incurables, Séguin speaks about their convulsive or chaotic movement. He designed exercises, meant to help children in the passage from this convulsive movements to regular movements in time and space. They have clear geometrical basis and are the core of the so-called *personal imitation*, for the formation of notions of *myself*. He designed also some stopgaps for facilitating the immobility needed to learn (see figure 1a)). Séguin links these exercises

with the arising of awareness (linked with the modern concept of "proprioception", that means to be conscious of the position of our limbs and our movements).

Activities with children with Trisomy 21

The work with children with trisomy 21 begins with motor activities of geometrical inspiration. The possibility of learning starts when children are able to distinguish stillness from motion, when they are able to control their convulsive movement and line up in a straight line with other children and march in a coordinated manner "like soldiers". In Geometry, the primitive concepts are point and line, as Euclides in s.II b.c and Hilbert in XIX century pointed out, in a clear parallelism intuited by Séguin. The practice with these exercises help them to interiorize the primitive concepts: point, straight line, and plane and prepare them to abstraction. (see figure 1b)



Figure 1. a) Stopgaps for the progression to standing still (our design), b) Children aligned prepared for marching

2.2.2 Generation of lines

Liant la base d'une verticale à une horizontale, je les réunis aux extrémités opposées par une oblique, et l'élève exécute un triangle rectangle; quatre triangles réunis à leur sommet nous donnent un carré parfait, du centre duquel on efface ensuite les lignes obliques qui lui donnent la figure d'un sablier: puis on le trace avec des parallèles seules, après quoi, déployant les courbes autour d'une ligne droite quelconque, l'enfant produit le cercle complet; et enfin, compliquant toutes ces notions (si simples en apparence, mais si précieuses dans l'espèce), l'élève produit des figures infiniment agglomérées sans omettre les moindres détails, sans confondre les directions, les points de conjonction, les rapports de grandeur et de disposition des parties entre elles et du tout, et cela se conçoit: toutes ces figures sont exécutées méthodiquement, en partant d'une ligne qui sert de base à une seconde sur laquelle s'appuie une troisième, etc. (Séguin, 1843, p.133)

Séguin devoted much attention to the problem of *generation of lines* with a double intention: firstly as a way to prepare them for the graphical and motor aspects of reading and the painful activity of writing; secondly as a way to stablish communication in absence of speech.

He describes his initial work with Jean Itard trying to teach a single boy to draw a square and their failure (see figure 2a)). Although this boy knows how to draw lines it was impossible for Séguin and Itard to communicate with him and explain how to close the square. This leads Séguin to the discovery of the problem underlying this failure: the lack of awareness of the concept of plane and the need to design exercises to make children reach a reasoned stroke: to draw a line with a determined direction implies choice and will. A geometrical concept contributes again in his vision to the development of a free individuality.

Activities with children with Trisomy 21

Séguin identified the problem as lack of communication with the child: how to explain without words the need to cut two straight lines in order to close the square? Research with children with intellectual disabilities (see 2.2. for references) shows that the use of mimesis is a key to awake understanding. In a story of superheroes where the straight lines are lightning rays that have to touch each other to defeat a villain, children understand the idea (see figure 2b)) and afterwards are able to draw it on paper.





Figure 2a. A reconstruction of Séguin's exercise *drawing a square*, Figure 2b. Children play to touch their lightning rays

2.2.3 Dimension, configuration and layout

Progressively Séguin evolves from a utilitarian use of form (reading and writing) to a more formative one that conceives the work with geometry as a key for the awakening of awareness. Reading and commenting the following sentence can be very valuable. Il a fallu user des moyens que je crois pouvoir appeler les *forceps de l'intelligence* (Séguin, 1842, p. 45)

Séguin proposes the transition to exercises of *objective or impersonal imitation* as a turning-point in the educational process. These exercises involve 3D geometrical operations and relationships that contribute to the awakening and development of intelligence. He notes that these exercises that *connect the myself with what is non-myself*, contribute to build the individuality, and in this way they open the door to building ideas, that are particular of each person

a) The first exercises refer to dimension.

Les enfants semblent posséder cette notion plus que les autres; mais elle n'implique pas en eux comme chez l'homme, l'idée d'une échelle métrique...

.... Aussi n'ont-ils pas de degré de comparaison, et ne connaissent-ils que les extrêmes. Quant aux idiots, ils mesurent les distances en raison de leur paresse, et les trouvent toutes trop longues: la quantité de leurs aliments en raison de leur gourmandise, aussi la trouvent- ils toujours insuffisante...(Séguin, 1843, p.119)

He says that for idiotic children it is easier to perceive the dimension of objects, not with a metric scale with numbers, but by comparison, one of the central intellectual operations in his view. He is speaking about additive comparison: which one is biggest, which ones are equal. Finding the longer one between a pair of rods is the first step to ordering them by length (see figure 3a)). From a mathematical point of view it corresponds to a "total order relation".

Activities with children with Trisomy 21

To compare is an abstract process that implies to find a similarity between two objects. Geometrical comparison is an intellectual operation that is linked to physical actions (putting the ends of two strips side by side to compare the unmatching ends or superimposing two similar surfaces to see which one is bigger; or using a scale to decide which object is heavier...) that helps the encounter between myself and not-myself. The research (see 2.2. for references) shows that it is easier for children with intellectual disabilities to compare for example the length of rods similar to those proposed by Séguin than to compare their own height. (see figure 3b)). This regular material leads also naturally to the idea of geometrical ratio (being a half, a quarter, a third, the double, and so on) which we have also explored. Discovery of ratio relationships encourage children to talk, which also helps them get out of the isolation Séguin spoke about. Geometry actually links myself and not-myself.



Figure 3a. Rods set for additive comparison proposed by Séguin, Figure 3b. Playing to order rods

b) The second group of exercises refer to configuration.

Tous, en effet, connaissaient par leur usage un certain nombre d'objets usuels comme une table, un couteau, un habit, etc.; mais ils ne les connaissaient pas par l'analyse raisonnée de leurs diverses parties; il n'y avait, par conséquent, nulle différence pour eux entre une veste et un habit, une table ronde ou carrée. Cette confusion semble au premier coup d'œil peu importante, [...]; il fallait l'ajouter aux notions, précédemment acquises à l'aide des figures simples (Séguin, 1842, p.50)

They are designed to perceive the form of the objects starting from contrast to analogies (see figure 5a)). Exercises for analyzing the parts of the objects are very useful to distinguish shapes by the form and not only by their use. Awareness of form is a key in the transition to ideas; and regular forms are a mean for understanding the physical world. Thus the formative value Seguin attributes to geometry appears clearly.

Activities with children with Trisomy 21

The recognition of regular shapes in everyday objects is a rich source of activities with them. These activities help them put order in a world that they perceive as chaotic due to their sensorial difficulties. Being able to discover what different objects have in common independently of their use helps them become more in charge of their own lives (see figure 5b)).





Figure 5a. Séguin form -bord (Hull 1913, p.1) Figure 5b. Discovering the form in everyday objects

c) The final block of exercises corresponds to *layout* or *arrangement*, that is to put objects in any position you can imagine.

The child being in front of the teacher, a table between them, a few blocks piled near their right hands, the teacher takes one, puts it flat before him on the table, and makes the child do the same. The T. puts his block in various positions relatively to the table and to himself, and shows, not directs, the C. to do the same. The T. puts two blocks in particular relative positions, and the C. does the same each time. What was done with two blocks is done with three, with four, with more, in succession, till the exercise of simple imitation becomes quite intellectual, requiring at least a good deal of attention and power of combination. Later, the T. creates combinations of two or more blocks at once, and the C. must imitate all of it at once; and finally the T. creates a combination of a few blocks, destroys it, and asks the C. to make the same construction, the model of which he can now find only in his mind. (Séguin, 1866, p.166)

The key idea is that of *constructing* (which geometrically means *adding*, or involves an idea on position in space linked to dihedral angle) and *destroying* (geometrically, *decomposition*). Séguin resorts again to a 3D object, the planchettes or dominoes (see figure 6a)).

Activities with children with Trisomy 21

The aspect of playing is very important. By playing, children are working, without knowing, with Eulidean concepts linked to physical actions: by pulling the bricks together, they can see they are congruent, for example. In this way children learn to combine parts to obtain a whole (see figure 6b)). The combinations of objects they make with their hands will later be reproduced in the intellectual order, combining ideas.





Figure 6a. The bricks set, ca. 27 x 13,5 x 2,7 cm: 12 dominos for Adrien, 60 planchettes for the Hospice des Incurables, **Figure 6b.** A boy with Trisomy 21 exploring symmetry

Final remarks

This workshop was attended by about 12 participants, among them some university colleagues of different nationalities who deal with the history and didactics of mathematics and some schoolteachers. They valuated the possibility of empathize with people with disabilities in the first activity. They also stated that the activities proposed by Séguin and updated in the workshop in Spain were of great help for all students, not only those with intellectual disabilities, to develop some skills. The ongoing research based on the historical analysis of Séguin's work presented in this workshop is pioneer in the field of mathematical education for people with intellectual disabilities. Séguin 's views about the formative value of Goemetry and of the virtues of mimesis as a way of learning are inspiring now a research involving the development of expressive skills in children with Trisomy 21.

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