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A Fabricação de Cidadãos Qualificados:

Do "Expert-Hand Worker" ao "Scientific Minded”

The Fabrication of Qualified Citizens:

from the “Expert-Hand Worker” to the “Scientific Minded”

Melissa Andrade-Molina[1]

RESUMO

Dentro das práticas da matemática escolar existem numerosas verdades naturalizadas que têm sido (re)produzidas em diferentes épocas e em diferentes lugares. A crença de que a educação matemática se torna a chave para o progresso econômico assegurando o crescimento futuro das nações é problematizada. Seguindo um movimento analítico rizomático, uma historização do presente é empregada para mapear a fabricação do cidadão qualificado desejado no Chile. A análise evidencia a (re)produção de narrativas dominantes sobre o "cidadão qualificado" são e têm sido enredadas com o funcionamento da geometria escolar e matemática escolar, como uma tecnologia de governo do eu para a fabricação o sujeito racional Moderno, inserindo alunos em particular formas de ser e conhecer no mundo.

PALAVRAS-CHAVE: tecnologias de governo. historização do presente. Ciência. práticas de matemática escolar. crescimento econômico.

ABSTRACT

Within the practices of school mathematics there exists many naturalized truths that have been (re)produced in different times and in different places. The belief of mathematics education becoming the key to economical progress assuring the future growth of nations is problematized. By following a rhizomatic analytical move, a historization of the present is deployed to map the fabrication of the desired qualified citizen in Chile. The analysis evidences the (re)production of dominant narratives about the “qualified citizen” are and have been entangled with the functioning of school geometry and school mathematics, as a technology of government of the self to fabricate the Modern rational subject by inserting students in particular forms of being and knowing in the world.

KEYWORDS: Technologies of government. historization of the present. Subjectivity. Science. practices of school mathematics. economic growth.

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Introduction

According to Foucault (1982) "taken-as-truth" statements circulate within social discourses. Such discourses are not isolated from each other, but these are entangled within diverse spheres of social life and are shaped by statements and their related truths (Foucault, 1972). Within the practices of school mathematics there exists many naturalized truths that have been (re)produced in different times and in different places. One of these naturalized truths is that mathematics education becomes the key to economical progress assuring the future growth of nations. Over the years, OECD has voiced the need of equipping citizens with the necessary skills to achieve a state of welfare. By doing this, it is believed that investing in the proper acquisition of mathematical skills is required for "all" citizens of "all" nations to achieve their full potential (OECD, 2014). Such assumptions help taking school mathematics as a salvation narrative to enlighten and save not just individuals but also society. For example, the importance that mathematic literacy has within OECD's indicators has contributed to move nations towards the desired to improve "all" students' performances in school mathematics to fit in the world leading economies. This dominant narrative about school mathematics is not recent. UNESCO, in 1964, held in collaboration with the Inter-Union Commission on Science Teaching a congress on science teaching and economic development. Here, the movement of *Modern Mathematics* acquired great importance due to the believed implications of mathematics, as a form of language, to science. The usefulness of mathematics was understood as an effective tool significantly beneficial for improving the teaching of science in schools (Deschamps et al., 1970). Particularly in Chile, an increasing necessity of a scientific and rational citizen for the economic development has been vibrant for many years. There were expressed aims of shaping the "qualified citizen" productive for society. "Qualified" in terms of competencies and functionality. For example, the one of the "expert-hand worker" needed to overcome misery and poverty after the Pacific war (Encina, 1981). And, therefore, "scientific minded" citizens became the qualified citizens thought to open the doors towards the first world—according to European standards.

Is in this light that this paper aims at exploring the practices of mathematics education to evidence how schooling, as a social institution in concrete historical configurations, has been taking part of the technologies of power/knowledge for the making of rational and

enlightened subjects. Such exploration allows problematizing how modern narratives about the fabrication of the Modern 'reasonable citizen' (Andrade-Molina, forthcoming) through the learning of school mathematics bring science and mathematics together. Elsewhere it has been discussed that school geometry has power effects in the shaping of the productive scientific minds of the future by educating students to see not with the eyes of their bodies, but with the eyes of reason and logic (Andrade-Molina; Valero, 2017). My contention in this paper is that the dominant narratives about the "qualified citizen" are and have been entangled with the functioning of school geometry, as a technology of government of the self (Foucault, 1997), to fabricate a the Modern rational subject by inserting students in particular forms of being and knowing. Here a historization of the present is deployed to map the fabrication of the desired qualified citizen in Chile as a rhizomatic analytical move (Deleuze; Guattari, 1987), by building on the toolbox of Foucaultian studies about the constitution of historical subjects:

> I wanted to see how these problems of constitution could be resolved within a historical framework, instead of referring them to a constituent object (madness, criminality, or whatever)…. I don't believe the problem can be solved by historicizing the subject as posited by the phenomenologists, fabricating a subject that evolves through the course of history. One has to dispense with the constituent subject, to get rid of the subject itself, that's to say, to arrive at an analysis which can account for the constitution of the subject within a historical framework. And this is what I would call genealogy, that is, a form of history which can account for the constitution of knowledge, discourses, domains of objects, etc., without having to make reference to a subject which is either transcendental in relation to the field of events or runs in empty sameness through the course of history. (Foucault, 1980, p. 117)

This exploration begins by evidencing, first, the Chilean need of bringing foreign experts to enhance education for the proper instruction of science in school, and, also, importing European methods of teaching that were taken as the avant-garde. Second, the analysis moves towards the fabrication of the "qualified citizens" for achieving progress and leaving the state of underdevelopment. Such analysis starts at the need of "expert-hand workers" as a form of securing a solid ground for a more advance society. With the advances of technology, workers left the necessity of using their hands and knowledge, but other skills were required. This led to the need of "technical workers" shaped with applied practical and useful knowledge. Finally, the "scientific minded" emerged as a need of a rational citizen,

shaped under reason and logic. The Modern citizen, fabricated on the desired of the rational subject, was, and still is, the very image of assuring progress and welfare.

The need for the "wise" Europeans

Since 1810, when Chile proclaimed its independence from the Spanish colonial power, there have been several attempts to overcome a state of underdevelopment compared to European countries. Regarding schooling, the first schools in Chile began as churches imparting lessons of reading and writing, and where constituted mainly by Dominican and Jesuit orders. In 1818,

> An administration of primary teaching was created and adopted the Lancaster method […] The English educator Diego Thomson, was invited by Bernardo O'Higgins to work in the alphabetization according to the Lancastrian system, which was a method of teaching through the Bible. (Cancino, 2012, p. 150, own translation).

By 1820, schools in Chile were framed either religiously or militarily. But neither the men of faith nor the men of the army could help achieving the current desired of progress and development in accordance to European levels. In this light, it was raised, in 1823, a concern about the necessity of a more suitable education for the shaping of the 'men needed' for science, commerce, industry, agriculture, and arts for the State to achieve higher power and richness (Labarca, 1939). Miguel Luis Amunategui—minister of public instruction since 1852—stated, in 1856, that ignorance, mainly regarding analphabetic citizens, was the only source able to keep the society on an underdevelopment state. He acknowledged that Chilean society was struggling with a very real and powerful enemy, but just not an enemy of flesh and bones.

> There exists in our land an enemy worse that an invasion, more tremendous than barbarian colonizers […] An enemy that impedes us from breathing […] that stops us from taking the steps towards the path of progress […] That enemy is ignorance […] It is necessary, it is urgent for us to declare the war against this domestic enemy. (Amunategui in the establishment of the Society of Primary Instruction in Santiago, in Labarca, 1939, p. 141, own translation)

Chileans were attempting to build a path towards progress. And the way thought to scape from a society without industries, without commerce, without economy, and without enough intellectual knowledge was to increase agriculture and, of course, industries by

trusting in science. The Chilean state began implementing policies for hiring the "wise" foreign people to bring science to the country, which has been a constant practice since the first years of its independence (Gutiérrez; Gutiérrez, 2004). Chile started to fall in love of the French sophistication, in which education was completely separated from theology. Even since 1818, Chile was drowned by the French's liberal thinking (Cancino, 2012). The importing of knowledge and techniques of the "wise" led to the use of exact translations of French textbooks (Gutiérrez; Gutiérrez, 2004) and to the adaptation of the educational system of French schools to, what Labarca (1939) calls, a society orphan of cultural traditions. After Chile's independence, the Chilean school system was structured as a precise image of the French system. French mathematics textbooks were of particular interest for achieving the desired European quality, being translated and put into operation in Chilean schools. Gorbea—a Spanish engineer—in 1831 organized the teaching of mathematics according to the European French style and he translated a textbook written for the École Polytechnique, *the complete pure mathematics course of Francoeur*—El curso completo de matemáticas puras de Francoeur— (Gutiérrez; Gutiérrez, 2004). At the same time, Ignacy Domeyko—a Polish Educator—was making several improvements in the University of Chile. He, Domeyko, was the first to proposed the creation of a School dedicated only to the training of teachers for secondary school under European guides (Amunátegui, 1913).

French's influence dominated Chilean education in schools until 1880. After the Battle of Sedan, Chile started to be amaze by the German army and public education. 1878 was a year of exploration, Nuñez was asked by the government to travel to the United States and to Europe to learn about how these first world countries organized their system of education and their teaching methods. After this travel, he wrote "Organización de las escuelas normales" a highly influential book that set plenty of changes in Chilean education (Labarca, 1939). And Chile left the enchantment of Parisian horizons to turn to the German standards and structuring of school mathematics. In 1886, Pedro Montt—president of the Chamber of Deputies at the time, and the president of Chile from 1906 to 1910—presented a reform to group school subjects according to clusters of knowledge (implemented in 1889). In this reform, the sciences—biology, physics, and chemistry—were accentuated (Labarca, 1939). As consequence, Chilean schools were beginning to resemble the German Realgymnasium.

From the fabrication of expert-hand workers…

> If Chile wants progress […] it is necessary to disseminate primary instruction to all. Making science popular is the only path to improve […] To think the opposite, is expecting the impossible. The earth does not produce what it should without expert hands to grow it. (Amunategui, 1856. In Labarca, 1939, p. 144, own translation)

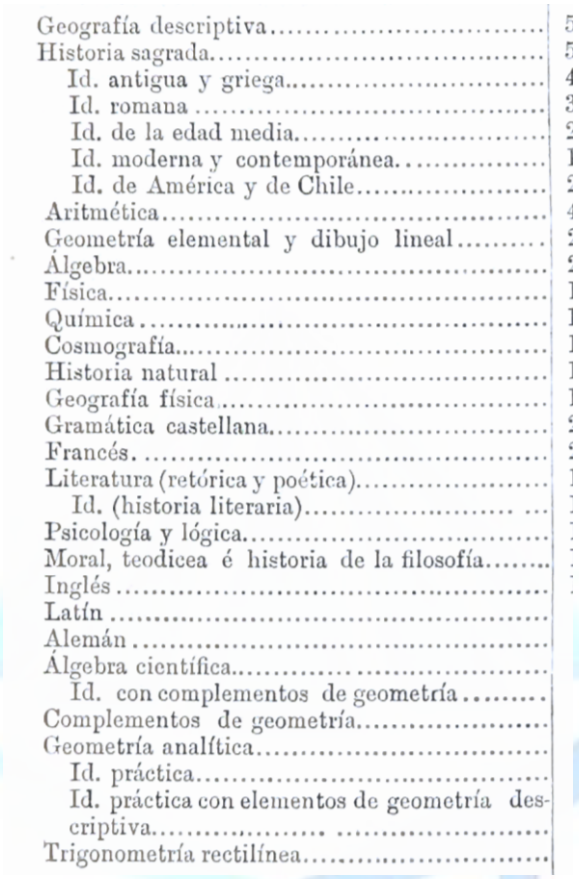
As aforementioned, Chile was a society lacking of commerce, industries, intellectual knowledge and experts to overcome these deficiencies. One solution was to import knowledgeable Europeans. The other was to instruct all citizens in all areas of labour possible to the time. "The earth does not produce what it should without expert hands too grow it", this expertise was not in terms of knowledge gained by experience but to knowledge gained by proper instructions, in which science was positioned as key. As Amunategui called them, the 'expert-hand' workers had their own technical schools. In those schools, mathematics played a central role while instructing students. For example the School of Arts and Occupations had courses of arithmetic, elemental geometry and applied drawing specifically aimed at industrial workers (Labarca, 1939). In 1890, geometry and drawing were thought to have a close connection, and therefore elemental geometry was not separated from line drawing, being together the same subject (Consejo de Instrucción Pública, 1890).

> The teaching of drawing, which completes the study of forms and enables to exercise the hand and children's sight, giving him the means to represent graphically the objects that surround him, it is also one of the most powerful agents used nowadays for the education of the senses. The application of drawing to all professions and most general uses in life adds to this study an interest and importance that would not be possible to unknown. And which scope could only be appreciated according to the advantages that a labourer or an industrial worker could have of drawing. (Nuñez, 1883, p. 104, own translation)

The desirable "expert-hand" workers were thought to use geometry and drawing as tools to link their senses—sight—with the abstractions of geometrical knowledge. Geometry was not to instruct students to forms of proof and calculation, but to educate the senses. Also, compared to other school subjects, school geometry was the most repeated subject taught: Elemental geometry and line drawing, complements of geometry, analytical geometry and trigonometry (Figure 1). However, the teaching of school geometry through drawing was difficult due to the required use of specific devices. Henceforth, the first years of school were

mainly dedicated to intuitive geometry—drawings—, and after a few years, to practical geometry—calculation and demonstration—(Consejo de Institución Pública, 1893). Geometry started to be taken as a school subject that "need exact notions [and] the child would not be able to develop these notions unless he has time to study and is aware of the new notions, that most of the times are abstract" (Op. cit., p. 95, own translation). According to Labarca (1939) several schools that taught young students the traditional elementary program—consisting of religion (Catholic), reading, writing, arithmetic, grammar, line drawing, geography, and finally, only for boys, history and Chilean constitution, and only for girls, household's economy, sewing and embroidering—were severely criticized because it was thought that teaching science to all students was dangerous for the conservation of faith, and therefore, was considered detrimental for Catholics.

By late 19th century, Chile began to introduce the teaching of mathematics as a rational and analytical model and as a mode of the most powerful intellectual gymnastic (Nuñez, 1883). According to Nuñez (1883)—the author of the most influential educational book of this period: *Organización de escuelas normales*—, number and form were keys, in which school geometry was taken as the fundamental topic of the most elevated principle of pedagogy at that time: Fröebel's. Suddenly, the Pacific war opened the new form of maximizing the saltpeter extraction and agriculture in the Central Valley, and therefore highly qualified engineers and technicians were urgently needed (Labarca, 1939). And mathematics in schools was taken as a skill for the development of reasoning and logical thinking (Ministerio de Educación, & CPEIP, 1967).



Geografía descriptiva	5
Historia sagrada	5
Id. antigua y griega	4
Id. romana	3
Id. de la edad media	2
Id. moderna y contemporánea	1
Id. de América y de Chile	2
Aritmética	4
Geometría elemental y dibujo lineal	2
Álgebra	2
Física	1
Química	1
Cosmografía	1
Historia natural	1
Geografía física	1
Gramática castellana	2
Francés	2
Literatura (retórica y poética)	1
Id. (historia literaria)	...
Psicología y lógica	
Moral, teodicea é historia de la filosofía	
Inglés	
Latín	
Alemán	
Álgebra científica	
Id. con complementos de geometría	
Complementos de geometría	
Geometría analítica	
Id. práctica	
Id. práctica con elementos de geometría descriptiva	
Trigonometría rectilínea	

Figure 1- School subjects in 1890
Source: (CONSEJO DE INSTRUCCIÓN PÚBLICA, 1890, p. 15).

…To the “technical worker”…

Post-Pacific-war Chile required the development of specific skills in students—the fabrication of a productive ‘technical’ worker—, workers should be able to apply practical knowledge of geometry in their everyday practices in the workplace and in life. To ensure quality work force, labourers needed practical geometry for a better appropriation of space, and industrial workers also needed to connect geometry with their fields—other sciences. In 1889, as product of the reform presented by Pedro Montt in 1886 and his wishes for schools to resemble the German Realgymnasium, geometry, arithmetic and algebra were together in a new cluster of knowledge called mathematics (Labarca, 1939).

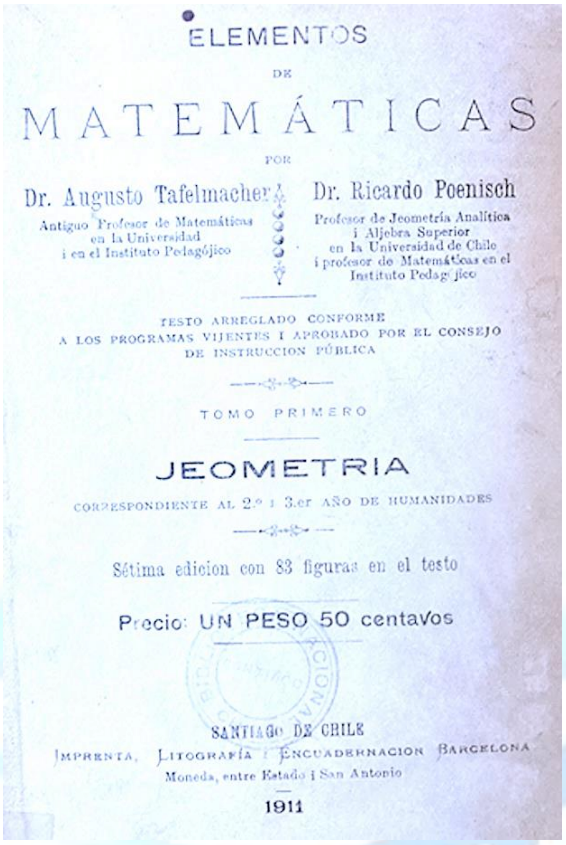

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Figure 2: Tafelmacher and Pöenish's "Elementos de Matematicas: Jeometría"
Source: author data

By 1909, some schools taught mainly "applicable knowledge" for future workers. And, therefore, students were assumed to be able, for example, to deeply study the functioning of a machine, draw it, adjust its pieces, and so on (Labarca, 1939). School textbooks needed to be rephrased since geometry was not intuitive or linked to drawing as the previous years. The Council of Public Instruction—Consejo de Instrucción Pública—start realising and approving books of the *Elements of Mathematics*, being geometry the first book in the collection (Figure 2). This book was written for the humanistic schools by the German teachers Tafelmacher and Pöenish, both brought from Germany to Chile to improve the teaching of mathematics. And so, schools that resembled the Realgymnasium and schools for occupations (technical workers) were vastly different.

Alfonso (1912), at that time wrote that the teaching of algebra and jeometría should be reduced. The motive was that it was necessary to increasing arithmetic, knowledge thought of a more practical use for students. He was not the only one, Galdámes (1912) did not see, at humanistic schools, students using mathematics in their everyday social interactions, claiming that mathematics and *jeometría* were only important if students wanted to pursue engineering,

astronomy, physics, chemistry, or even biology. Galdámes adds that knowledge in general, not only mathematical knowledge, develops reasoning if it is studied scientifically.

> In this stage, [mathematics] textbooks strongly highlight geometric reasoning abilities through geometrical construction by using ruler and protractor, in addition of the deductive presentation of geometry. (Vidal, 2010, p.8, own translation)

Amunategui addressed all critiques and talked about the need of a productive citizen to overcome Chile's industrial and commercial inferiority produced by a weak economy (Labarca, 1939). For assuring the fabrication of productive minds, educational policies aimed at cutting 'impractical topics' of the curriculum. For example, plane geometry was taken as an abstraction of space; rather three-dimensional geometry was taken as intuitive and with practical applications in physics, technical and natural sciences (Consejo de Instrucción Pública, 1926).

> From the formal concept of 1900, formation of an abstract and theoretical man, we arrived to the concept of education as a social function, on the service of collective progress. (Labarca, 1939, p. 239, own translation)

School subjects began taking a new shape, in which geometry was separated from drawing as a result of an attempt of homogenizing school programs for girls and for boys (Labarca, 1939, p. 260). This measure led to cut all unnecessary topics such as sewing—one of the subjects on the program for girls.

ASIGNATURAS	AÑOS					
	I	II	III	IV	V	VI
Castellano	4	4	4	3	3	3
Filosofía	—	—	—	—	2	2
Francés	4	3	3	3	3	3
Inglés o Alemán	—	4	4	3	3	3
Historia y Geografía	3	3	3	4	3	3
Matemáticas	4	4	4	4	3	3
Ciencias naturales	2	2	2	2	2	2
Física	—	—	—	2	2	2
Química	—	—	—	2	2	2
Educación Cívica	—	—	—	—	2	2
Religión (optativa)	2	2	3	1	1	1
Dibujo y Caligrafía	5	3	2	2	2	2
Trabajos manuales	2	2	2	2	2	2
Canto y Gimnasia	3	3	3	3	3	3
	29	30	30	31	33	33

Figure 3: Chilean school program in 1893.
Source: (LABARCA, 1939, p. 240)

A Ministry of Education was formed to shape this new path of education in schools. And so, intellectual education was aimed at teaching how to think about general, clear and coherent ideas regarding all school subjects. Schools subjects were thought as the necessary knowledge students needed to be part of the economic life and to help with social welfare and to interpret the physical world around them (Ministerio de Educación Pública, 1935).

… To the fabrication of the scientific minded

By 1891 Chile entered in an economic crisis as a result of the War of the Pacific (1879–1883) and the end of the Portalian state (Góngora, 1988). And both a proper education and more suitable economic policies were the only way thought to overcome the crisis (Encima, 1981). 'Expert-hand" and "technical" workers suddenly were not enough. In schools, education was vastly criticized, mainly because of the weak implementation of policies in education since, at least, 1885 (Valdes Cange, 1910). When the German reform was brought to schools, but with inadequate translations of pedagogic materials, and German 'pseudo-teachers' that did not understand the reform (Encina, 1981). Or as Labarca (1939) expresses, German teachers that were not familiarized with Chilean culture and history when they arrived seeking for economic stability, and so, it was not strange to see these German teachers teaching students, for example, about German's flora and fauna.

With the Pedagogic Institute, created in 1889, mathematics education took a new dimension of a *corpus* of knowledge, in the hands of the German teachers Tafelmacher and Pöenisch (Gutiérrez; Gutiérrez, 2004). Although, German teachers had a great influence in teaching methods as well given that primary teachers, from Germany, brought the scientific teaching conception of Herbert's pedagogy and the first approximation of the psychology of science (Labarca, 1939). Both, mathematics as a *corpus* and more scientific approximations to teaching, lead to perceive science as a creative process. Tafelmacher and Pöenisch published a series of six books called "Elements of Mathematics"—*Elementos de Matemática*—which were used in Chilean schools until 1912 (Vidal, 2010). However it was not over for the Germanization of Chilean mathematics education. Pröschle, another German mathematics teacher, and Pöenish continue writing school mathematics textbooks (Vidal, 2010).

> Mathematics, thus, broke the mould of being a "useful" science […] and acquires the category of a cultural and autonomous discipline. Something that France, Germany and other European countries had already fulfilled since 19th century. (Gutiérrez; Gutiérrez, 2004, p. 13, own translation).

Since 1902, as part of the pedagogic conference and also of the scientific conference of 1910, Chilean teachers started to walk away from the "German enchantment", alongside, they started to argue that Chilean citizens should be taught by Chilean teachers, within this demand, education should be adapted to social necessities of Chilean people (Labarca, 1939). Enrique Villegas, the minister of instruction—on behalf of the Chilean government—opened the conference by mentioning the need of an education towards the shaping of a modern citizen.

> [Secondary education] is the centre of the whole educational system. It tends to shape children towards the development and equilibrium of all their faculties, preparing them for the highest profession in letters or sciences and for the life of citizens aware on their civic and moral duties corresponding to a member of modern democracies. (Villegas, 1913, p. 4, own translation).

All of these changes or improvements led teachers perceiving school mathematics as operations students solve by using logical methods, not for the development of a useful tool. Mathematics was taught "in a particular way, as submitted to abstract science and not as realities that construct the principal objects of science" (Galdámes, 1913, p. 79, own translation). Galdámes (1913) critique moved towards how mathematics in school left the status of being operational for the workers and applicable to their lives, and so, school mathematics became a training of the scientific knowledge needed for University. The qualified citizen needed was the highly educated to achieve Europeans standards of development, a "scientific minded".

> We like to think that the Chilean child is the same child from Germany, France or England, subjected to the same influences of the environment, of an equal mentality than them […], of an organic and psychological development […] The difference is not anymore on the language or on skin and hair colors. And our simplistic view conducts us to educate him as German, French or English children are educated. (Galdámes, 1913, p. 86, own translation).

But Chile continued his path to Europe. Also from Germany, Karl Gandjot, participated in the creation of the instructions for the progress and growing of national sciences, he also made major contributions in bringing Modern Mathematics in Chile at University level (Gutiérrez; Gutiérrez, 2004). On 1926, discussions were still vibrant. The

Pedagogic Assembly of the National Society of Teachers tried to put an end to this admiration Chile had to foreign lands, not only Europe, but the United States too—Dewey was also very influential in education—(Labarca, 1939).

The Sputnik shock changed it all, Mathematicians met in Edinburg and concluded that Western mathematics needed a change, and Modern Mathematics emerged (Vidal, 2010). Which led to "more advanced mathematics in all schools to give a greater scientific knowledge to students; men of science were needed" (Op cit, p. 9, own translation).

The modern citizen

> Governing people is not a way to force people to do what the governor wants; it is always a versatile equilibrium, with complementarity and conflicts between techniques which assure coercion and processes through which the self is constructed or modified by himself (Foucault, 1993, p. 204).

Naturalized truths are and have been circulating amongst diverse times and places. The need of science for progress and welfare is a taken-as-granted truth that has been circulating since the independence of Chile, in 1810, to overcome the state of poverty as a result of the colonization and the aspiration to become a developed country. This truth has been naturalized and it has been knitting a web to govern the self and to regulate habits and desires of cultural and historical subjects through school mathematics.

From a Foucaultian perspective, conduct is governed, through diverse techniques, strategies, and devices (Foucault, 1991). The mapping of school mathematics as a technology for the government of the self, evidences the effects of power that geometry has had in fabricating the desired subject of schooling: the qualified citizen for economic growth. In doing so, each "qualified citizen"—the expert-hand worker, the technical worker, and the scientific minded—conducts him/herself by (re)shaping his/her own modes of being and acting in a space of 'regulated freedom' and under a promised state of welfare. In which, the belief of needing more mathematics for greater scientific skills opened the path for assuming that advanced mathematics—as rational and analytic model—should fabricated a more suitable qualified citizen for society. This embodies salvation narratives of mathematics, for example, to overcome the misery in Chile as a product of the war, the economic crises or colonization itself. As Egaña said, "without education it is not possible to shape the men

needed, instructed in diverse scientific fields. By putting in action commerce, agriculture, industry, arts and science, they work for giving to the State power and richness" (Egaña, 1823, in Amunategui, 1913, p. 14, own translation).

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