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Explosion of Forces: the Provance of Mathematical Modeling in Brazilian Mathematics Education

Maria Carolina Machado Magnus
Universidade Federal de Santa Catarina
Florianópolis, SC — Brasil
maria.carolina.magnus@ufsc.br
0000-0002-2834-9293

Ademir Donizeti Caldeira
Universidade Federal de São Carlos
São Carlos, SP — Brasil
mirocaldeira@gmail.com
0000-0003-0290-9851

Claudia Glavam Duarte
Universidade Federal do Rio Grande do Sul
Tramandaí, RS — Brasil
claudiaglavam@hotmail.com
0000-0002-8608-5855

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Abstract: This article reports the analysis, based on the power relations of an era, of the reasons for the emergence of the mathematical modeling discourse in Brazilian mathematics education. Pointedly, we used theoretical-methodological contributions linked to the theories of the philosopher Michel Foucault. The analytical material includes master's and doctoral thesis defended in Brazil between the years 1976 to 1999, focusing on mathematical modeling in mathematics education. The research highlighted a crisis in mathematics teaching based on two statements: "Students find it hard to learn mathematics" and "Mathematics is far from reality." Furthermore, we discuss the origin of the modeling out of political, economic, and educational discourses. This explosion of forces was problematized based on some events: the Cold War, the military dictatorship, capitalism, industrial expansion, technicist pedagogy, and the Modern Mathematics Movement.

Keywords: Mathematical Modeling. Provenance. Emergency. Power.

Explosión de Fuerzas: la Procedencia de la Modelización Matemática en la Educación Matemática Brasileña

Resumen: el artículo tiene como objetivo analizar, a partir de las relaciones de poder de una época, las razones por las cuales emerge el discurso de la Modelación Matemática en la Educación Matemática brasileña. Para lograrlo, utilizamos aportes teórico-metodológicos vinculados a las teorías del filósofo Michel Foucault. El material analítico cubre tesis y disertaciones defendidas en Brasil entre 1976 y 1999, que se centraron en la Modelación Matemática en la Educación Matemática. La investigación destacó una crisis en la enseñanza de las matemáticas a partir de dos afirmaciones: "los estudiantes tienen dificultades para aprender matemáticas" y "las matemáticas están lejos de la realidad". Además, discutimos el origen de la Modelización Matemática desde los

discursos políticos, económicos y educativos. Esta explosión de fuerzas fue problematizada a partir de algunos acontecimientos: Guerra Fría, Dictadura Militar, capitalismo, expansión industrial, pedagogía técnica, Movimiento de Matemática Moderna.

Palabras clave: Modelo Matematico. Procedencia. Emergencia. Fuerza.

Explosão de Forças: a Proveniência da Modelagem Matemática na Educação Matemática Brasileira

Resumo: o artigo tem por objetivo analisar, a partir das relações de poder de uma época, os motivos pelos quais o discurso da Modelagem Matemática emerge na Educação Matemática Brasileira. Para isso, lançou-se mão de aportes teórico-metodológicos vinculados às teorizações do filósofo Michel Foucault. O material analítico abrange teses e dissertações defendidas no Brasil entre os anos de 1976 a 1999, as quais tematizaram a Modelagem Matemática na Educação Matemática. A pesquisa evidenciou uma crise no ensino de matemática a partir de dois enunciados: "os alunos têm dificuldade na aprendizagem da Matemática" e "a Matemática é distante da realidade". Ainda, discutimos a proveniência da Modelagem Matemática a partir dos discursos político, econômico e educacional. Essa explosão de forças foi problematizada a partir de alguns acontecimentos: Guerra Fria, Ditadura Militar, capitalismo, expansão industrial, pedagogia tecnicista, Movimento da Matemática Moderna.

Palavras-chave: Modelagem Matemática. Proveniência. Emergência. Poder.

1 Power and Biopower: Clash of Forces

In genealogy, "discourse is taken as a historically determined social practice, constituting subjects and objects" (Gregolin, 2007, p. 13) and is established through power relations, which determine, control, select, organize, and redistribute what should circulate as truth in society. From power relations, Foucault starts to reflect on *why* discourses emerge and which external conditions enable their entry into the scene.

In 1975, with the book *Vigiar e Punir* [Discipline & Punish: The Birth of the Prision], and in 1976, with the first volume of *História da Sexualidade: vontade de saber* [The History of Sexuality: The Will to Knowledge], Foucault inaugurates the genealogical phase of his research. In genealogy, knowledge will be illuminated based on conditions of possibilities outside them and will have power as its central issue, as an instrument that enables explaining its production and emergence. And "although the final objective of the analyses has continued being the constitution of knowledge, Foucault focused primarily on investigating the powers that are intrinsically linked to it" (Machado, 2007, p. 177).

When introducing power as a fundamental issue in his analyses, Foucault rebels against the idea that power is centered in a single body, the State. The State is not the starting point or the origin of power; power is not something one possesses "with its own, unitary, and localizable nature or substance" (Veiga-Neto, 2007, p. 120). Power is not located at any specific point in the social body; it works like a network from which nothing or no one escapes. In this way, the State would not possess it; it would not be the origin from which power emanates. Some have power, and some do not. Foucault understands power does not exist; instead, there are power relations,

i.e., power is something that is exercised, functions, is performed, and disseminated throughout the social body; it is not located at any privileged place. Power is omnipresent because "it is everywhere; not because it encompasses everything but because it comes from everywhere" (Foucault, 2014, p. 101).

Disciplinary power acts on the human body to make it more obedient and valuable. The body enters a piece of machinery that scrutinizes it, disarticulates it, and recomposes it (Foucault, 2013), thus producing submissive and exercised bodies, "docile" bodies. It is worth highlighting that disciplinary power is different from slavery, as it is not an appropriation of bodies; different from domesticity, which is a relationship of constant domination and is established by the boss's will; other from vassalage, which is a highly codified relationship of submission; different from asceticism and monastic-type "disciplines," which have the function of making renunciations rather than increasing utility (Foucault, 2013). Disciplines are techniques that allow "the detailed control of the body's operations, which carry out the constant subjection of its forces and impose on them a relationship of docility-utility" (Foucault, 2013, p. 133).

The great importance of disciplinary power comes from the fact that it is not negative but somewhat positive when we remove any moral value judgment from these terms (Machado, 2007). Disciplinary power produces individualities; it "manufactures" the individual; it does not destroy them. The individual is the most important effect of power. In this way, "we must stop always describing the effects of power in negative terms: it 'excludes,' 'represses,' 'subdues,' 'censors,' 'abstracts,' 'masks,' 'hides,' In truth, power produces. It produces reality; it produces fields of objects and rituals of truth" (Foucault, 2013, p. 185). The individual and their knowledge are manufactured in this production.

Foucault (2014, p.28) states that "one of the great novelties in the techniques of power, in the 18th century, was the emergence of 'population'". It is "a technology of power that does not exclude the first, that does not exclude the disciplinary technique; instead, it embeds it, integrates it, partially modifies it [...]" (Foucault, 2010, p. 203).

This new technology of power will apply "to the lives of beings, or even, if you prefer, it is directed not at the being-as-body, but at the living being; at the limit, if you want, to being-as-species" (Foucault, 2010, p. 204). This technology addresses the multiplicity of beings, a mass power that targets the being-as-species, a multiple body with countless heads. It is a power that intervenes "to increase life, to control its accidents, eventualities, deficiencies, henceforth death, as the end of life, is evidently the term, the limit, the extremity of power" (Foucault, 2010, p. 208).

This power, this biopower[1], takes bodies collectively, "it applies to individuals' lives; even if we talk about the individuals' bodies, what matters is that such bodies are taken in terms of what they share: life, belonging to a species" (Veiga-Neto, 2007, p. 73). This biopower is the power to "make" live and "let" die. Contrary to the sovereign power that was to "make" die and "let" live. This "make" live emerges when

> Governments realize that they do not have to deal simply with subjects, not even with a 'people,' but with a population, with its specific phenomena and variables: birth rate,

[1] Research on biopower and governmentality, and particularly on the history of sexuality lead Foucault to develop a genealogy of ethics.

> morbidity, life expectancy, fertility, health status, the incidence of diseases, diet, and *habitat.* (Foucault, 2014, p. 28)

Disciplinary power is individualizing and acts on bodies to make them docile. Biopower is massive, and acts on a multiple body to control accidents that may occur to a population, with the aim of managing life. Although different, they are linked to each other. Let us consider the case of sexuality: Foucault realizes that the devices of sexuality are not only of the disciplinary type; that is, "they do not act solely to form and transform the individual by controlling time, space, activity [...]" (Machado, 2011, p. XXII).

Thus, given this picture of the power relations that are established in the sense of operating in a given society, not individually but from a collective perspective of individuals, we will analyze, from the power relations of a time, the reasons for the emergence of the mathematical modeling discourse in Brazilian mathematics education.

2 Analytical Materials

To compose the analytical material, we selected master's and doctoral theses focusing on mathematical modeling, defended in Brazil between 1976 and 1999. We chose this period because of the emergence and institution of modeling as a true discourse (Magnus, 2018). This research arose because, in that period, the main place for discussion and circulation of that discourse was through scientific production, which materialized in master's and doctoral theses.

A university is a place of production, control, and selection of discourses that come into order, into circulation, and into operation (Magnus, 2018). Each society has its own regimes of truth (Foucault, 2011c), and at universities, these regimes can be found in different spaces: undergraduate, postgraduate, study and research groups, etc. In our research, we privileged the spaces of postgraduate courses because they are seen as places where discourses are accepted as true based on the techniques that characterize them as scientific (Magnus, 2018). They would differ from false discourses because academic courses have the responsibility and credibility to say what works as true and what is relegated to a wild exterior (Foucault, 2011c). The production of knowledge, in this way, is intertwined with power, and these courses have the power to say what is considered true and what is false (Foucault, 2014b).

3 About the Gaze

Gazing at the analytical material is not just skimming. It's staring, glancing slowly through it, lingering on details, and listening to others; gazing needs patience, time, and space.

This long, patient, and meticulous gaze does not search for what is hidden between the lines, it does not seek the meaning of a text in the heights or the depths. It remains on the surface of events. It is a gaze that does not seek the unsaid, because "even silences are just silences, for which there is no point in looking for fillers; they must be read for what they are and not as unsaid that would hide a meaning that did not come to the surface of the discourse" (Veiga-Neto, 2007, p. 98). Under the manifest statements, this gaze does not consider that something remains hidden and underlying, as if another statement were below it, hidden, waiting to be unveiled. The analysis was carried out under what has already been said. From this perspective, our gaze at the empirical

material did not seek to "discover hidden truths, but to make visible exactly what is already visible" (Artières, 2004, p. 15).

When scrutinizing the analytical material, we were careful to "analyze the *dictum* as a *monument* and not as a *document*. This means that the reading (or listening) of the statement is done through the exterior of the text, without properly entering the internal logic that controls the order of the statements" (Veiga-Neto, 2007, p. 104, emphasis added). In other words, we look at the discontinuities in its exteriority through what surrounds and sustains it. (Foucault, 2013).

This detailed look also did not pursue an origin, it did not pursue the "first time" that modeling was said. The search for an origin is "striving to collect in it the exact essence of the thing, its purest possibility, its identity carefully collected within itself" (Foucault, 2011b, p.17). Our gaze did not seek an essence for modeling, what this discourse is, what its origin is. It aimed at constituting a diagnosis of the present of modeling based on its historical formation, i.e., we tried to return to our present, "to our silent and naively immobile soil [...] its ruptures, its instability, its failures; and see it restless again under new steps" (Artières, 2004, p.15).

To return the ruptures and instabilities to the modeling discourse, we sought to map the *provenance*, in the form of conditions of possibility for its *emergence*. This mapping gave visibility to the visible that was blurred in the dispersions of statements that relate to the emergence of discourse.

Provenance is the term used by Foucault, which was also used by Nietzsche to contrast his historical research with origin research. Origin research seeks, from the present, to return to the past looking for an original essence, as if they would find there the "raw" and immobile form waiting to be "discovered" and polished. It often "believes that things were in a state of perfection at the beginning; that they came out shining from the hands of the creator, or in the shadowless light of the first morning" (Foucault, 2011b, p. 18).

Provenance, or ancestry, according to Veiga-Neto (2007), can be understood as origin, in its weak sense; that is, a point set back in time, a place –or rather a non-place– of confrontation, of combat of forces. Provenance research "shakes what was perceived as immobile, it fragments what was thought to be united; it shows the heterogeneity of what was imagined in conformity with itself" (Foucault, 2011b, p.21).

Going back to the past to tell the story of the present of modeling is not seeking its raw form, its original essence, it is ruining the "essentialities, denying the existence of an in-itself of things, showing them as fabrications from dispersed elements" (Albuquerque Junior, 2008, p. 99); it is to show the combat of forces, to shake what is perceived as immobile; it is looking for quicksand, fragments that have been marginalized by traditional history.

This return to the past, to its provenance, will allow us to map the conditions of possibilities for the emergence of that discourse. Emergence is the entry of forces onto the scene, coming out from behind the scenes onto the stage (Foucault, 2011b); it is coming to the surface, the point of appearance of discourse in the past. When looking at the past, we must be careful to avoid putting in place "a current concept, idea, or understanding. [...] One should not try to understand the past based on categories of the present. [...] For genealogy, the present can never be the court of law of the past" (Veiga-Neto, 2007, p. 60-61).

4 A Non-Place: Mathematics Teaching is Going Through One of its Most Serious Crises

> *The last two decades have shown that teaching in general and, more particularly,* ***mathematics teaching, is going through one of its most serious crises*** *regarding the* ***teaching-learning*** *binomial.* ***The crisis in mathematics teaching has repercussions at all levels of education,*** *whether primary, secondary, or higher education. (Burak, 1987, p. 12, emphasis added)*

A careful and thorough reading of the empirical material showed some statements that signaled a crisis in mathematics teaching, from the 1970s to the 1990s. This crisis is evidenced by two distinct but intertwined statements: "Students find it hard to learn mathematics" and "Mathematics is far from reality."

4.1 Students Find it Hard to Learn Mathematics

The statements below give visibility to the first statement, "Students find it hard to learn mathematics."

> **Teachers from 5th to 8th grades complaining about the mathematical background of students coming from the 1st to 4th grades; secondary school teachers complaining about primary school students** and, finally, teachers of undergraduate teaching and research degrees **unhappy with the level of mathematical knowledge of secondary school students.** (Burak, 1987, p. 12, emphasis added)
>
> The teachers of that course realized that, although most students were Calculus teachers **at higher education institutions practically from all over the country, they knew almost nothing of Calculus.** What should I do? The **idea of changing the learning strategy appeared** because they had already taken Calculus courses and hadn't learned it; **transmitting the same content in the hope that this time they would learn was not a rational strategy.** (Gazzetta, 1989, p. 88, emphasis added)
>
> It became **common for teachers at more advanced levels to warn about the mathematical knowledge of graduates from previous levels**, saying that **they do not have enough base to follow a specific grade** and, therefore, the teacher wastes a lot of time to "recover them". (Burak, 1987, p. 12, our emphasis)
>
> although we can see that educators are aware **of students' problems in mastering mathematical knowledge and their difficulties in understanding and applying mathematical concepts when solving a problem**. And the most serious thing is that this situation seems to occur at **any education level.** (Sánchez, 1979, p. 3, emphasis added)

Mathematics teaching is going through one of its most serious crises regarding the teaching-learning binomial. Those statements show that this learning difficulty seemed to *occur at any level of education*, and there was always a complaint from teachers about this difficulty and also a search for culprits, i.e., *teachers from grades 5 to 8 complaining about the mathematical background of students from 1 to 4; secondary teachers complaining about students coming from primary education and, finally, teachers of undergraduate teaching and research degrees unhappy with the level of mathematical knowledge of secondary students.* From that, *the idea of changing the learning strategy was born* because *it was not a rational strategy to transmit the same content in the hope that this time, they would learn.*

From those statements, we can infer that the difficulty in learning mathematics was justified because the students had no basis, that is, they had not learned the content addressed in the previous grades. In this way, unlearned content accumulated and, consequently, students struggled in subsequent courses. Henriques (1998) argues that the school curriculum was formed in a way that was compatible with the rational-positivist model based on the notions of norm, sequence, and discipline. Regarding norms, the curriculum is prescriptive, imposing obedience, without the possibility of deviations. The notion of sequence emphasizes that the curriculum presupposes an ordering of content in line with a pre-defined sequence. And the discipline organizes content within disciplinary matrices.

These notions –norm, sequence, and discipline– contribute to students' learning difficulties. Modeling could be a way to alleviate this situation since, according to Caldeira (1998), modeling would work with a spiral curriculum, where the contents of the previous grades would 'return,' if necessary, for the discussion of the activities. This way, there would not necessarily be a linear and hierarchical way to teach content.

> In our case, **we work on decimal numbers together with geometry without first having worked on fractions**, all this resulting from the need for specific concepts so that we could answer students' questions based on the facts. **Here, the curriculum appears as a spiral.** (Caldeira, 1998, p. 177, emphasis added)
>
> It is a teaching practice where **there is no rigid sequence of content**, verified in traditional teaching, and each topic in the program studied is treated in depth due to the level and grade. (Burak, 1987, p. 18, emphasis added)

The statements above show a clash of forces between the curriculum based on the notions of norm, sequence, and discipline and the curriculum presented as a spiral. The use of activities involving modeling would bring a new practice to the teaching of mathematics, reconfiguring the way in which the teaching of mathematical content had been carried out. The curriculum would continue to be fulfilled; however, the way it would be worked on would break with linearity and prerequisites. This would happen because when working with real facts, the contents would not always 'appear' sequentially organized. It would be the reality situation and the problem to be solved that would determine what content would be necessary to solve the activity.

4.2 Mathematics is Far from Reality

The statement "Mathematics is far from reality" is intertwined with the statement "Students find it hard to learn mathematics." Not applying mathematical concepts to reality may have made teaching and learning difficult, causing difficulties in learning.

The statements, extracted from the analytical material, show that the distance between mathematics and reality occurred at a historical moment and rendered its teaching devoid of meaning. Students saw no point in learning mathematics if it "was good for nothing." Below, I outline the statements:

> Students often asked: **"What is this content for?" or "Where will I use this?"** At the time, the answers did not provoke serious feelings of guilt. We admit we did not lie to students, but, on the other hand, we were far from providing them with answers that were

> more dignified and consistent with their real questions. (Corrêa, 1992, p. 8, our emphasis)
>
> However, with this approach, we can give a broad view of what mathematics is and will be able to answer the famous questions: **"What is it for?" or "Where will I use this?".** (Müller, 1986, p. 125, emphasis added)
>
> Traditional teaching has been little concerned with this aspect, even to answer –**Where can I apply this content? or –What is this for in my life?** The study through mathematical modeling seems to meet students' expectations and needs; it seeks to encourage interaction with their environment since this educational practice is fundamentally based on the "real" problems of the student's daily life, whether at home, in sports, at work, or in entertainment. (Burak, 1987, p. 36, emphasis added)
>
> The problem of planting potatoes arose in a Differential and Integral Calculus course for Food Technology students at UNICAMP, taught by Prof. Rodney C. Bassanezi. Despite being the first contact, these students would have with mathematics at the university, many were already wearing the t-shirt symbol **of the course with the words "I HATE CALCULUS."** Evidently, this reflected the feeling of the veterans of the course, who saw no satisfactory reason to study three semesters in a row a **"useless" subject** responsible for the **highest failure rate** in the course. (Gazzetta, 1989, p. 36-37, emphasis added)
>
> Students who seek courses in applied sciences are generally not motivated toward mathematics, especially **because they cannot see a relationship between the content and the purpose of their specific area**, because **the traditional teaching methodology generally dissociates mathematics from each subject's life experience and their professional choice**, fragmenting its fundamental formation. This work proposes **mathematical modeling as a methodological path to remedy those deficiencies**, considering that its focus consists exactly of using real-life problems to introduce the various specific mathematical techniques for the questions. (Almeida, 1993, p. 3, our emphasis)

The statements show complaints about the mathematics teaching and learning process. The students did not feel motivated to learn because the *traditional teaching methodology usually dissociated mathematics from each person's life experience,* making *mathematics useless and responsible for the highest failure rate.* This context provided the following questions, *"What is this content for?" "Where will I use it?" "Where can I apply this content?"* and *"What is this for in my life?"* There was no point in learning mathematics if it had no use outside school walls.

This destitution of reality in the teaching of mathematics is intertwined by relations of power/knowledge that, at a particular historical moment, insert a technicist pedagogy into schools and, together with this pedagogy, "the proposal of teaching mathematics for use in extracurricular situations gave way, during the 1960s, to the teaching of mathematics for mathematics' sake, mainly due to the Modern Mathematics Movement" (Brito, 2008, p. 16). That movement proposed modernizing mathematics teaching, and its entry into education, according to research, is related to the economic, educational, scientific, and technological happenings of the time that also sought modernization.

From that movement onwards, teaching began to be concerned with excessive abstractions internal to the very mathematics, being "more focused on theory than on practice. The language of set theory, for example, was introduced with such emphasis that learning symbols and endless terminology compromised the teaching of calculation, geometry, and measurements" (Brasil, 1997, p. 20).

Possibly, the modern mathematics movement constituted fertile ground for modeling to emerge in mathematics education. This was possible because modeling uses another logic, another gear than abstraction. A new practice comes into play, reconfiguring mathematics teaching based on the student's reality and a spiral curriculum. In this way, there would be a "[...] reversal of a relationship of forces, the usurpation of power, a vocabulary taken back and turned against its users, a domination that weakens, distends, poisons itself, and the other that, masked, makes its entry" (Foucault, 2011, p. 28). Thus, the high degree of abstraction provided by modern mathematics weakens, and another discourse enters as an event, resuming and reconfiguring mathematics teaching.

5 Explosion of Forces: its Ruptures, its Instabilities, and its Failures

Given the findings that the statements "Students find it hard to learn mathematics" and "Mathematics is far from reality" enabled the emergence of modeling, and we intend to show how these were constituted and configured as constituents. Therefore, to understand the formation of these events in the form of statements, we return to the provenance of the modeling discourse, composed of political, economic, and educational discourses, to show the "explosion of forces" that were being engendered so that these statements were formed while paving the way for modeling to enter the scene.

It is worth highlighting that "discourses emerge and are constructed exactly to the extent that they also break with a particular order of knowledge" (Fonseca, 2009, p. 1). Problematizing the emergence of modeling based on statements concerning the difficulty of learning mathematics and the distance between mathematics and reality also shows what the discourse of modeling comes to break with. What knowledge is broken by this discourse? What order does the emergence of modeling intend to establish? How does an explosion of forces –provenance– create a crack in their knowledge and enable the emergence of another knowledge(s)?

To understand which order of knowledge(s) the emergence of modeling is trying to break, we described some events experienced in Brazil in the 1960s/70s in the political, educational, and economic fields. Those events, when engendered, intertwined, crossed, woven, interlaced, constitute what Foucault, based on Nietzsche, calls provenance.

Looking for provenance, here are some events: in 1968[2], Brazil was shaken by student demonstrations. The Hundred Thousand March (Passeata dos Cem Mil) in Rio de Janeiro, authorized by Governor Negrão de Lima, was a milestone of student strength. Students took to the streets to demand more funds, more vacancies in higher education, quality teaching, and the end of the MEC-USAID agreement. Vacancies in higher education were limited, too many students passed the entrance exam but could not attend because they exceeded the available seats (Piletti, 2008; Romanelli, 2007; Pereira, 2012). There was also a high rate of school failure and dropout rates (Piletti, 2008).

In their demonstrations, students also demanded their participation in the draft of a university reform (Ventura, 2013). The reforms carried out to date were from the top down, without

[2] 1968 was characterized by protests in various parts of the world: student demonstrations in France protesting for reform in the educational system; the Prague Spring, which aimed to bring about changes in the political structure; feminist protests –in Brazil, in the United States, in France– that fought against male domination; etc.

students' and teachers' participation (Piletti, 2008). Such reforms followed the MEC-USAID agreements, which students demanded for their purposes.

The MEC-USAID agreements began in 1964 and lasted until 1968, some until 1971, signed between the Brazilian Ministry of Education and Culture and the United States *Agency for International Development* (AID) for technical assistance and financial cooperation to assist on the organization of the Brazilian educational system (Romanelli, 2007). Those agreements, according to Romanelli (2007), affected the entire Brazilian education system: primary, secondary, and higher education.

Indeed, the MEC-USAID agreements allowed the foreign government to control, regulate, and govern the Brazilian government. And, in the case of Brazil, take advantage of these agreements to control, discipline, regulate, and govern the population through education. The educational field, in this way, was operated by economic and political interests at both national and international levels.

Subsequently, and because of these agreements, in 1967/68, in the economic field, Brazil was experiencing an expansion of the industrial sector that would be essential for other reforms in the education system to be considered by the Brazilian government. Reforms that operated as population regulation mechanisms (Foucault, 2010), reforms that worked as machinery designed to manufacture "necessary" individuals to act in that society.

To understand that expansion, it is worth highlighting that, until the mid-1950s, the industrial sector was focused on basic industries, mineral extraction, steel, energy, transport, engines, etc. With the inauguration, in 1956, of Juscelino Kubitschek, whose motto was "50 years in 5," the industrial sector began to focus on products considered very durable, such as automobiles and household appliances. Due to serious economic problems represented by inflation and external deficit, from 1962 onwards, the industrial sector slowed down. Jânio Quadros succeeds Juscelino but resigned after seven months of office. João Goulart, his vice-president, assumed the presidency and governed the country from 1961 to 1964. Goulart was identified as having a leftist stance, and on March 31, 1964, a military coup seized power under the pretext of restoring the country's economic and financial order and removing any threat of communism. (Peinado, Aguiar, Graeml, 2007, p 4-5)

This pretext was accompanied by international advice. At the beginning of the military dictatorship, when the world was experiencing the so-called Cold War, Brazil received help from the United States of America. The support given to Brazil is part of the confrontation between the United States and the Soviet Union. "The history of this period was brought together under a single pattern by the peculiar international situation that dominated it until the fall of the USSR: the constant confrontation of the superpowers that emerged from the Second World War in the so-called 'Cold War'" (Hobsbawn, 1995, p.223). This confrontation was not warlike, hence the title "Cold War." Those superpowers –one communist [USSR] and the other capitalist [USA]– competed for political, economic, ideological, social, and military influence worldwide.

> The USSR controlled a part of the globe or exerted predominant influence over it –the zone occupied by the Red Army and/or other communist armed forces at the end of the war– and did not attempt to expand it with military force. **The USA exercised control and predominance over the rest of the capitalist world**, in addition to the northern

> hemisphere and oceans [...]. In return, it did not intervene in the accepted zone of Soviet hegemony. (Hobsbawn, 1995, p. 224, emphasis added)

The aid given to Brazil was part of this dispute and the US objective of advising underdeveloped countries through a capitalist system. The fear that Brazil, like Cuba, could become communist made the USA begin advising the country, which had been requesting help for some time, through agreements signed between Brazil and the U.S. AID (Agency for International Development)[3]. This advisory covered several areas, as previously mentioned, such as the MEC-USAID agreements on education and the CONTAP-USAID agreements on the education of rural technicians.

With the military coup and the US advisory, the country entered a period called "the Brazilian miracle." The military government regained the trust of international investors, and multinational companies realized that they could reduce costs by locating in countries that provided qualified people for the labor market at low costs, harmless environmental legislation, an abundance of natural resources, and basic infrastructure (Peinado, Aguiar, Graeml, 2007).

With the expansion of the industrial sector, it was necessary to adapt the educational system to the model of economic development that was intensifying in Brazil (Romanelli, 2007, p. 196). With the expansion of industries, there was also an increase in the number of jobs available. However, just an offer did not mean effective employment because for this to be effective, they needed qualified people for the job market. In this scenario, education has become an important factor in the production of human resources necessary to fill those vacancies. Education, therefore, became the closest and/or only way to obtain a place in the job market and for companies to fill their staff (Romanelli, 2007; Pereira, 2012).

From this perspective, through education, the State carries out one of the forms of regulation and control of the population (Foucault, 2014c) with the objective of constituting, manufacturing, constructing, producing, engineering, and training subjects for the labor market. Biopower will act, through education, to deal with issues of "industrialization, recruitment, and qualification of the workforce" (Bujes, 2001, p. 197). Therefore, this context, of industrial expansion and demand for qualified individuals for the job market serves as a pretext for educational MEC-USAID[4] agreements for the improvement of primary and secondary education, expansion and improvement of the secondary school teaching staff, preparation and distribution of textbooks, modernization of universities, etc.

In this scenario –of clashes, of forces, of nonsense– of student movements' demands, of industrial expansion, of MEC-USAID agreements, the Government restructures higher education through Law 5540/68, of November 28, 1968. The university reform of 68 was formulated by Government technicians in partnership with US technicians "and imposed in an authoritarian

[3] "Thus, the MEC-USAID agreement, and especially USAID's actions, not only in Brazil, but in all peripheral countries, can be understood as an action by the USA to guarantee the validity of the capitalist system in these countries and transfer to them the conceptions and social, political, and economic organization that prevailed in the United States" (PINA, 2008, p. 1).

[4] According to Cunha, [...] the conception of a university based on US models was not imposed by USAID with the connivance of the dictatorship's bureaucracy. Since the end of the 40s, it was sought by educational administrators, teachers, and students, especially those with an imperative to modernize and even democratize higher education in our country. When the US advisors arrived here, they found land plowed and fertilized for their ideas (CUNHA, 1988, p. 22).

manner by the regime**, without the participation of other sectors of society**" (Cunha, 2007, p. 7, emphasis added). One of the main concerns of the reform was the relationship between the labor market and education, in accordance with the human capital theory[5] (Sousa, 2008; Pereira, 2012).

The law gives visibility to student demonstrations to continue letting them aside. In other words, to alleviate students' struggle, whose demands were açsp for more seats in higher education, the reform institutes through article 17, paragraph *a*, the classificatory entrance exam (vestibular). By eliminating the minimum score, with as many candidates being approved as there are vacancies, the problem of "surpluses" finished.

The law also replaced the chair with departments, courses were divided into semesters with the introduction of the credit system, and undergraduate courses were divided into two cycles: a basic, common cycle for related areas and a professional cycle. Students gained the right to representation, with voice and vote, in the collegiate bodies of universities and isolated higher education establishments, and in committees established in accordance with statutes and regulations.

To meet the demand for qualified individuals for the job market, article 23 legalized vocational courses. This legalization gave visibility to the discursive intertwining of a time, in this case, the educational discourse and the economic discourse. Education is not neutral and disinterested, it is instituted through power relations that aim to form "necessary" subjects for each historical moment. In this case, the law establishes preparing qualified individuals to work in the job market.

> Art. 23. **Professional courses** may, depending on the area covered, present different modalities in terms of number and duration, to respond to **the labor market conditions**. (Repealed by Lei no. 9.394, 1996). (Emphasis added)

Later, the Government also managed to reduce student demand for higher education through Law 5692/71, legalizing the professionalization of secondary education. With this measure, high school graduates would be qualified to enter the job market and would not worry about "continuing to fight for the acquisition of a profession that, in most cases, was only obtained through higher education" (Romanelli, 2007, p 234).

The first article of Law 5692/71 mentions qualification for work as one of the objectives of primary and secondary education.

> Art. 1st **Primary and secondary education** aims to provide the student with the necessary education to develop their potential as an element of self-realization, **qualification for work**, and preparation for the conscious exercise of citizenship (Emphasis added).

As for curricula, the law establishes a common, mandatory core and a diversified part to meet local needs and peculiarities. For secondary education, besides a mandatory common core,

[5]Theodore Schultz is considered the main precursor of the human capital theory. For this theory, an important means of increasing economic productivity is the qualification of the workforce through education. See Theodore Schultz (1967), *O valor econômico da educação* [The economic value of education].

there is a minimum curriculum required for each professional qualification.

> Art. 4 **Primary and secondary education curricula will have a common core**, mandatory at the national level, and **a diverse part to serve**, according to concrete needs and possibilities, **to local peculiarities, establishment plans, and individual differences of students**. **3rd** For secondary education, the Federal Education Council will establish, in addition to the common core, **the minimum required for each professional qualification** or set of related qualifications. **4th** Upon approval by the Federal Education Council, educational establishments may **offer other professional qualifications** for which there are no curriculum minimums previously established by that body, ensuring the national validity of the respective studies (Emphasis added).

Article 5 of the law establishes the full curriculum by dividing it into two parts: general education and special education. In secondary education, special education should predominate, the aim of which would be to assess aptitudes and professional qualifications.

> Art. 5 The subjects, areas of study and activities that result from the subjects established in the form of the previous article, with the necessary provisions for their relationship, ordering and sequence, will constitute the full curriculum for each grade of the institution. 1st Subject to the standards of each education system, the full curriculum will have a general education and a special education part, being organized in such a way that: a) in primary school, general education is exclusive in the initial grades and predominant in the final grades; b) In secondary school, special education predominates. 2nd The special education part of the curriculum: a) will aim to probe skills and **initiation into work in primary education and professional qualification in secondary education** (Our emphasis).

Article 6 establishes that **"professional qualifications may be carried out in cooperation with companies**." In this excerpt, the intertwining of political and economic discourses with educational discourse is evident. In other words, qualifications will be offered according to the needs and demand of companies.

According to Romanelli (2007), Law 5692/71 provides a principle of terminality in primary and secondary education. At the end primary school, the student can enter the job market, although they do not have a professional qualification, they have already an understanding of their vocation, which allows them to start working. At the end of high school, students already have a professional qualification, which enables them to enter the job market.

Control of the population by the State is achieved, in this case, through educational reforms that are closely linked to the country's interests: producing qualified subjects for the job market; and, through the legalization of vocational secondary education, accommodate students due to the lack of places in public universities. Thus, the State uses regulatory mechanisms, controlling and shaping the population through biopower (Foucault, 2014c). Those reforms, which affected educational discourse, functioned as a broad government strategy to implement the objectives of the political and economic discourse of that time. In other words, capitalism should "be guaranteed at the expense of the controlled insertion of bodies into the production apparatus and through an adjustment of population phenomena to economic processes" (Foucault, 2014c, p. 152). This

guarantee would be maintained through educational discourse.

Therefore, with the university reform and the reform of primary and secondary schools, "education began to be treated as another tool for industrial development" (Passos, 2009, p. 9), and this tool had the technicality or technocracism as a guiding concept (Araújo, 2003; Lira, 2012; Pereira, 2012) for education. The reforms highlight how educational discourse is intrinsically engendered by economic and political discourse.

Regarding technicality, according to Fiorentini (1995, p. 15), it was the "official" pedagogy in the post-64 military dictatorship and intended to "insert the school into the rationalization of the capitalist production system." And based on scientific neutrality inspired by the principles of rationality, efficiency, and productivity, this pedagogy would reorganize the educational process to make it objective and operational (Saviani, 2012). Education would have the "purpose of 'integrating' the individual into society, making them capable and useful to the system" (Fiorentini, 1995, p.15).

To achieve its objectives, technicist pedagogy displaces the teacher and the student from their roles, that is, in traditional pedagogy the teacher was the subject of the process, in new pedagogy the initiative belonged to the student, and in technicist pedagogy, neither student nor teacher are the center of teaching. They begin to occupy a secondary position, having as their main element the rational organization of resources, i.e., it is the process that defines what the teacher and students should do, when and how they will do it (Saviani, 2012). The technicist pedagogy focuses on instructional objectives, resources, and teaching techniques that would ensure students' achievement of learning[6] (Fiorentini, 1995). Technicist pedagogy, when trying to transfer the factory way of functioning to schools, lost sight of the specificity of education and ended up contributing to increasing chaos in the educational field (Saviani, 2012).

Regarding the curricula created at that time, Moreira cited by Jaehn (2011, p. 83) reports that they "were guided by technical rationality in search of maximum efficiency, as happened in industry assembly lines, with the disciplines understood as operative units of the process." The economic discourse captures the educational discourse and puts into operation "an" education that can "accomplish" the objectives of the industries. An education capable of manufacturing docile bodies, "a body that can be subjected, that can be used, that can be transformed and perfected is docile" (Foucault, 2013, p. 132), in this case, a body that is useful is docile for the industrial sector.

Synthesizing the discussion, we conclude that the existing crisis in mathematics teaching, constituted by the statements "Students find it hard to learn mathematics" and "Mathematics is far from reality," may have been generated from the events experienced in Brazil in the political, educational, and economic fields. The explosion of forces – the Cold War, the military dictatorship, capitalism, expansion of industries, technical pedagogy, the Modern Mathematics Movement – generate a "crisis in mathematics teaching" and constitute fertile ground for the first modeling works to emerge as a point of resistance to the current teaching "model"– this is the order of knowledge(s) that this discourse tries to break. For Foucault (2014c, p. 104) "where there is power,

[6] An authentic example of this pedagogy is the "Kumon" method of learning mathematics, according to Fiorentini (1995). The activities developed solely explore: "1st, memorization of principles and formulas; 2nd skills in manipulating algorithms or algebraic expressions; 3rd skills in solving typical problems. In fact, questions rarely appear requiring the student to explain, illustrate, construct mathematical models that describe problem situations, analyses, justifications, or deductions" (Fiorentini, 1995, p. 17).

there is resistance" and that it is certainly "the strategic codification of these points of resistance that makes a revolution possible" (Foucault, 2014c, p. 105). Would the modeling discourse be a point of resistance capable of generating a revolution in mathematics teaching?

The teaching of mathematics through technicism was marked by the Modern Mathematics Movement, whose objective was to qualify subjects "good at mathematics" to work in science and technology. Docile, useful, obedient bodies, transformed and perfected for the objectives of the economic discourse of the time. The MMM fit into the proposals for modernizing education in the 1960s. This movement prioritized the teaching of mathematics for mathematics' sake, through set theory. With MMM, reality was separated from the teaching of mathematics and students' difficulties in learning content increased, putting into circulation the statements, "Students find it hard to learn mathematics" and "Mathematics is far from reality."

In effect, the emergence of modeling problematizes the technicist teaching of mathematics[7]. This pedagogy would be placed under suspicion and problematized based on the modeling discourse. Mathematical modeling, through interdisciplinary activities, would make it possible to answer questions such as: "What is this for?", bringing to light the reality that had been made invisible by MMM and technicism.

Given these findings, we can conclude that the decades from 1960 to 1990 are characterized by neither neutral nor disinterested educational changes, which attempt to answer the following question "What is the type of human being desirable for a given type of society?" (Silva, 2011, p.15). Those educational reforms at all levels were engendered by power relations that sought to manufacture docile and useful bodies for the industrial sector through education. Selecting one type of education – training qualified subjects for the job market –to the detriment of another is a form of power, of exclusion. Selecting and privileging a type of knowledge, a type of curriculum, is a form of power. The power, in these decades, –which instituted technicist education as a pedagogy suitable for industrial expansions– acted on a body with multiple heads, a biopower that acts on the being-as-species, with the objective of "making" live. Biopower is engendered, with the institutionalization of technicist pedagogy, with the objective of "making" live, not the "human" body, but the body of "capitalism". Foucault (2014c, p. 151) says that biopower, "without the slightest doubt, was an indispensable element for the development of capitalism, which can only be guaranteed at the cost of the controlled insertion of bodies into the production apparatus and through an adjustment of phenomena population to economic processes." For capitalism to live, beings-as-species must be controlled and, educationally, learn the techniques necessary for work.

However, these reforms, the teaching of a technicist mathematics did not account for the constitution of identities, of subjects, for the type of society at that time, generating the "crisis in teaching". Putting it in a different way, *businesspeople complained that students graduated and when in the job market, they had difficulties understanding and applying mathematical concepts to solve problems, indicating that schools should prepare students for the job market*, i.e., *why learn mathematics if it was of no use to their education*?! This distance between mathematics and its use was due to the moment experienced at that time, that is, dictated *by the Modern Mathematics Movement in schools.* Faced with so many complaints, we can emphasize this crisis through

[7] There is no total disappearance of technical teaching practices – in contemporary times, the "Kumon" method and some courses and entrance exams maintain this form of teaching.

numbers: *of every 100 people who entered the primary school, only nine reached the secondary school. By the end of the first grade, more than 50% of students failed.* Therefore, the statements "Mathematics is far from reality" and "Students find it hard to learn mathematics" that circulate in the modeling discourse point to its emergence as a way of trying to minimize this situation.

In effect, the statements "Mathematics is far from reality" and "Students find it hard to learn mathematics" that constitute the so-called "crisis in mathematics teaching" are engendered in such a way that modeling emerges as a point of resistance to current teaching. This resistance emerges with the aim of supplying and constituting subjects that the technicist "model" was not contemplating. It is a resistance to teaching and not the model of subjects –qualified subjects for the job market.

Although there is continuity in the type of subjects to be constituted, manufactured, architected, the modeling discourse operates other displacements and discontinuities with the knowledge(s) of the time, for example: from a passive to an active student, from a transmitting teacher to an advisor, and concern with content learning.

> ***This pedagogy requires from the teacher a different stance toward teaching****, beginning by questioning their "brilliance," the belief that they are* ***the depositories of "knowledge"*** *and the expression of objective truth, the* ***ones who "teach".*** *(Burak, 1987, p. 30, emphasis added)*
>
> ***Students are agents of the process****,* ***their experiences and knowledge****, whether formally acquired or not,* ***are essential to the progress of the process.*** *(Monteiro, 1991, p. 189, emphasis added)*

In the modeling activities, students become the *subjects of the learning process, [they become the] agents of the process.* And the teacher assumes a *new stance toward teaching,* seen as a guide, a mediator, a facilitator of the process. Modeling activities would provide some displacements but would not break with the teaching of school-based mathematical content, with so-called true mathematics. This discourse proposes new ways to teach content that is proposed by the curricula, assigning "new roles" to teachers, students, and the way of teaching and learning – the discourse operates a methodological change.

6 Conclusions

To conclude, concerning the first statement, the modeling discourse breaks (or tries to break) with the structure of the hierarchical, linear, and sequential curriculum. The curriculum logic that guides the modeling activities would be unpredictability, causality, eventuality, contingency, and chaos. The emergence of modeling occurs in this shift, from curriculum order to disorder. Disorder penetrates, permeates, and modifies order, but it does not mean that it is erased.

Regarding the second statement, the order of the modeling discourse breaks with the Modern Mathematics Movement. The MMM prioritized language, symbolism, structures, formalism and, consequently, would make mathematics teaching separate from reality. The MMM allowed modeling to be thought of to face it, as it would provide interdisciplinary work – minimizing the distance between mathematics and reality – and, therefore, bring meaning to the teaching and learning of mathematics– alleviating the students' difficulties in their learning.

From the problematization of these two statements, we discuss the explosion of forces that were being generated so that these statements were constituted and, also, constituted a fertile ground for the emergence of modeling from the political, economic, and educational discourses. This explosion of forces was problematized based on some events: the Cold War, the military dictatorship, capitalism, the industrial expansion, the technicist pedagogy, the Modern Mathematics Movement. From the problematization engendered, we concluded that it was in this scenario of clash of forces between the political, economic, and educational discourses, which constitute the so-called "crisis in mathematics teaching," that the discourse of mathematical modeling in mathematics education could emerge.

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