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THE COMPLEXITY OF THE MATHEMATICS' TEACHING-LEARNING IN THE PRIMARY CYCLE

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Abstract

As we all know, teaching mathematics so that it is understood by students is one of the fundamental problems in mathematics. It is approached both from the point of view of communication in mathematical language in the classroom, and from the point of view of pedagogy and general didactics as an integrative means of formal education. Both perspectives are complex. The objective of this article is a concise analysis of a fundamental concept, namely the mathematics knowledge of the teacher (MKT), both for the teaching of mathematics for the primary cycle and for the way in which teachers are trained. for the primary cycle. (MKT) is analyzed in terms of the curriculum of the subject study program "Mathematics and exploration of the environment" for the first three classes of primary school. The importance of (MKT) to "decipher" the complexity of teaching and learning mathematics in primary school in the context of theories of integration of sciences is a current challenge for mathematics education and also for pedagogy.

Keywords: Complexity of teaching-learning, mathematics education, mathematical knowledge for teaching

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1. Introduction

When we speak of complexity, without resorting to the linguistic dictionary, we are thinking in opposition to simplicity. People, in general, believe that in the knowledge of the real world, there are things (phenomena, processes, etc.) which are simple and others which are complex. If you ask someone to give you an example of a simple thing, then they usually think and give you an example from their own teaching experience and that they believe to have understood. He will not do a complexity analysis of what he claims to be simple. If he knows or thinks he understands, then it's simple. Is it true? A complex is a set composed of several parts (a system built by several subsystems), themselves whole, in interaction (dynamic system or not). Of course, a complex is analyzed from the point of view of its structure to decide the complexity of its systemic interactions. A simple is a whole which is seen/considered as a single part or if you like it is a monad, in the sense of Leibniz. Simplicity can be seen as a measure of a simple. But, the simple vs the complex and the simple vs. the complexity are in dialectical relations and these obviously depend on the knowledge of the object/process (whatever it is!). On the other hand, complexity is a property of all things in the universe. The description of a thing to be defined (specified) in a unique way supposes the knowledge of a set of its properties and its interactions with its exterior, its position in a reference frame established by convention at a certain moment, the knowledge of the dynamics of sales evolution etc. Last but not least, all these are intrinsically linked to their understanding and their communication in a language specific to a science, an art, etc. to be understood by all of us to be able to "integrate into the universe of knowledge". Theoretical approaches on the complexity are enormous in almost all conceptual fields (philosophy, medicine, biology, physics, chemistry, mathematics, engineering, psychology, social sciences, education, etc.) (Davis & Sumara, 2006; Livingston, 2017; Montuori, 2022; Potari, 2012). Each of these approaches is a complexity, and their epistemology is in turn a complex process of reflection and understanding. But, all together, they act as a block of knowledge of humanity, which is a complex thing.

In this respect, the holistic paradigm adopted by education in 2000 and the transdisciplinary approach of the primary cycle mathematics curriculum, in particular, have brought, from our point of view, many new dimensions to the process of thought formation. mathematics of the student, amplifying the teaching-learning-assessment complexity of mathematics for the educational process. The teacher and the student are both placed in the didactic situations (Brousseau, 1997), designed by the teacher on the basis of purely formal hypotheses on a priori knowledge or on his experience in other conceptual fields than mathematics. By analyzing some of these new dimensions of the complexity of primary school mathematics education brought about by holism, transdisciplinarity, the integration of scientific theories, globalization, etc. we intend to draw attention to how education is changing in the 21st century (Bocchi et al., 2014).

2. A little about the complexity of math education

Related to the complexity of teaching - learning a subject through a school curriculum, over the past decade, this theory has been addressed and developed in conceptual areas, such as psychology, education, science exact, etc. From a mathematical point of view, complexity theory has developed over

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time to Kolmogorov's theory (1963, 1998). In information algorithm theory, Kolmogorov complexity is a measure of the computational resources needed to specify the object (program) and is also known as the Solomonoff-Kolmogorov-Chaitin complexity, which is a descriptive complexity or algorithmic entropy. Nicolescu and Petrescu (2017) dealt with the complexity of a dynamic system, formulated in a mathematical sense, trying to embed this mathematical theory in the conceptual field of mathematics education. This approach is specific to the description of the complexity of the teacher-student dynamic system in the teaching-learning interaction. Here, by complexity, we mean only the non-linearity of the equations that govern the educational process and, what is more, their incompleteness on the knowledge of the real process of educational interactions and didactic communication that is observed within them. Can the didactic communication of the teacher be "similar" to an "object" from the algorithmic information theory (AIT) designed by the teacher to lead the student towards the knowledge that the this possesses? But, the student's understanding of them will be correct? We believe that this issue is a challenge which we must assume it. If we approach the teacher-student pedagogical interaction in this way, then we may be able to measure the complexity of these pedagogical interactions in order to improve the quality of the pedagogical act.

2.1. What is already known about the complexity of mathematics education?

The teaching mathematics to be understood by students is one of the essential problems of the mathematics education (Eisenhart et al., 1993; Sullivan et al., 2006). This is debated both from the point of view of communication in mathematical language in the classroom, and from the point of view of pedagogy and general didactics as an integrative medium of formal education. Unfortunately, the line between the two approaches tends to blur in the favour of the latter. we do not want to get into controversy (God forbid!) or to make an "order" of the importance of the sciences involved in the educational process. We only consider the naturalness of the things we keep talking about: the mathematics education of the student for the formation of his mathematical thinking.

A very interesting and valuable study, in our opinion, is dedicated to the links between the teacher's mathematical knowledge (MKT) and the quality of his mathematics teaching act or, more specifically, the mathematical quality of instruction (MQI) (Hill et al., 2008). In this article, the authors are studying each teacher as a separate entity, and they compare across teachers with different levels of mathematical knowledge for teaching (MKT) to understand how MKT is expressed in mathematical instruction. One of the conclusions of the study conducted by Hill, Rowan and Ball is also an expression of the complexity of research in the educational conceptual field: „*In fact, the inescapable conclusion of this study is that there is a powerful relationship between what a teacher knows, how she knows it, and what she can do in the context of instruction. We inspected cases for the possibility that other factors might mediate this relationship and we identified a few: teacher beliefs about how mathematics should be learned and how to make it enjoyable by students; teacher beliefs about curriculum materials and how they should be used; and the availability of curriculum materials to teachers. However, these influences paled in comparison to, and in many ways were shaped by, teachers' knowledge itself. In case after case, the quality of the modifications made to curriculum materials, the goals for student learning, and even beliefs about what mathematics is were shaped by teachers' knowledge."*

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2.2. Mathematics and environmental exploration for the primary school

Since 2013, for the first part of the primary cycle (preparatory class, first class and second class), instead of the discipline "Mathematics" a new discipline "Mathematics and exploration of the environment" has been introduced. The arguments for this decision were quite numerous and they came both from the psych-pedagogy's directions, but also from the direction of the mathematics reform, which has many "faces" as "the everyday mathematics", "the application of mathematics" in other fields of knowledge (life sciences, earth sciences, physics, etc.), "applied mathematics", etc. The intentions of this educational policy may have been very good in terms of training our students, from the beginning of primary school, to acquire math skills that will allow them to integrate more easily in real life. Instead, through this attempt to integrate the knowledge of mathematics with the knowledge from other sciences, the new uncontrollable variables of the mathematics education's complexity were created/generated. Moreover, it was assumed that if students learn to apply mathematics to solve certain problems formulated within the framework of life sciences, physics, geography, etc., then they will be very involved and interesting to learn. mathematics together with knowledge of birds, animals, waves, planets, etc. As far as we know, no scientific research has been conducted on the long-term effects of this "integrated teaching for mathematics" in forming the mathematics skills of students in the very early part of primary school. Thus, from the perspective of those presented about the state of affairs regarding the discipline "Mathematics and environmental exploration", and from the perspective of (MKT) and (MQI) we can say that:

1. The mathematics knowledge of the primary school teacher is reduced to the basic ones: the set of natural numbers, the arithmetic operations defined on this set of numbers, i.e., addition, subtraction, multiplication, division. Some properties of these arithmetic operations, which would be the basis for defining the algebraic structures of additive monoid and multiplicative monoid on the set of natural numbers. Some elements of two- and three-dimensional Euclidean geometry. Something about the concept of fraction. the few knowledge of methods for solving simple arithmetic problems. That's about it. So, it's supposed to be enough for a primary school teacher concerning the mathematics knowledge. Of course, he has in-depth knowledge of the teaching-learning-assessment of mathematics for primary school, but which are "focused" on the aspects of the psychology of young schoolchildren. In the other words, (Eisenhart et al., 1993).

2. The mathematics curriculum for the discipline "Mathematics and exploration of the environment" is a complex both for the primary school teacher and for any good teacher of mathematics who aims to "translate" it into teaching activities in the primary cycle classroom (Ministry of Education, 2013).

3. Thus, the mathematics knowledge of the primary school teacher is not enough for him to approach mathematics integrated with the other sciences (Clarke, 2019; Davis & Callihan, 2013). In fact, the textbooks and auxiliaries that students have available according to the school curriculum are designed in a very interesting way, far from the philosophy of the integrated. the first part of any lesson consists of some "beginner's knowledge" of life sciences, earth sciences, physics, etc., and the second part of the lesson should be dedicated to knowledge of mathematics. For example, we have a lesson in which in the

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first part we deal with shoe hygiene, and in the second part of the lesson we teach the ordering of natural numbers in the range 0-100. And it is just one example of many such cases found in textbooks.

4. Almost no one is interested in investigating the complexity of the relationship between (MKT) and (MQI). So, we each do what we can, as much as we can in a national education system. In other words, we are assured of almost all the prerequisites that what we intend to teach for students to understand will "fall through the cracks"

3. Conclusions

Through this article, we wanted to draw a warning that some education specialists assume to understand very well certain fundamental concepts, such as holism, transdisciplinarity, the integration of various conceptual fields, etc. and, therefore, they are rushing to adopt them in order to reform their own educational system. It is not that simple! On the contrary, the reform of a national education system must be based on the results of rigorous scientific research. It is also not an easy task to do research in the conceptual field of education. Education, like sociology, is not limited to statistical techniques, such as economics, industry, etc., so the "letter of the statistical methods" cannot be applied to know the complexity of the education or human relations. As Jean Jacques Rousseau said: Usually people who know little are very talkative, while those who know a lot say little. In conclusion, specialists in education sciences have a lot to do to adapt to the "tumultuous" requirements of the needs and expectations of the future society characterized by new information technologies, major climate changes, crises of all kinds, etc. But, more than likely, mathematics will be one of the central pillars of understanding and solving these problems for the future of humanity. So, everyone has something important to do!

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