DIFFERENT APPROACHES TO MATHEMATICAL MODELING: POSSIBILITIES FOR THE DEDUCTION OF MODELS AND THE STUDENT'S ACTIONS

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The idea about a general mathematical modeling process is one of the main components of the studies for teaching and learning mathematical modeling.

Here we are interested in showing that the approaches given to mathematical modeling activities, even if they are in perspective related to learning and instruction, may be distinguished, especially as regards the construction and use of mathematical models. If, on the one hand, quantitative information about a phenomenon underlies the construction of mathematical models to study the problem, on the other hand, a qualitative analysis of a problem situation may also be supported by mathematical models.

So, although we have phases for the development of a modeling activity, the actions of students, during these phases, may be essentially different in terms of these different approaches.

In this work we will refer to a set of phases characterized in Almeida, Silva and Vertuan (2012) and the actions of students during these phases. According to these authors, the phases are related to the set of procedures required for configuration, structuring and solving of a problem situation and are characterized as: Becoming aware, Mathematisation, Resolution, Interpretation and Validation.

Becoming aware: becoming aware of something refers to "being familiarized with", "collecting information about" and "the act of being aware". In terms of mathematical modeling activity this phase represents a first contact with a problem situation which is intended to be studied in order to know the characteristics and specificities of the situation.

Mathematisation: this phase is characterized by "identifying the relevant mathematics with respect to a problem situated in reality, representing the problem in a different way, including organising it according to mathematical concepts and making appropriate assumptions, understanding the relationships between the language of the problem and the symbolic and formal language needed to understand

it mathematically, finding regularities, relations and patterns, translating the problem into mathematics i.e. to a mathematical model" (PISA 2006, p.96),

Resolution: working accurately within the mathematic world, which includes "using and switching between different representations, using symbolic, formal and technical language and operations, refining and adjusting mathematical models, combining and integrating models, argumentation, generalisation"(PISA 2006, p.96).

Interpretation and Validation: interpreting the result and validating a model, includes interpretation of mathematical results in a real solution in the real world, "understanding the extent and limits of mathematical concepts, reflecting on mathematical arguments and explaining and justifying results […], critiquing the model and its limits" (PISA 2006, p.96),

In order to illustrate the student's actions in these phases of modeling, we have discussed two activities involving environmental issues.

The first, "A qualitative study for the biological control of an infestation", represents a propose to be developed with students of a course of biology, for example, in order to indicate what actions students and/or teachers could be performed during different phases of mathematical modeling. The second activity, "Global warming as an investigation", was developed by students of a Master Degree course in Mathematics Education during the discipline of Mathematical Modeling in the Perspective on Mathematics Education. In this activity we present the records done by students which are in the report delivered by them in order to identify their actions.

In the first activity the qualitative pieces of information on the problem and the mathematical knowledge of students and/or teachers lead to the use of models already known in literature and the solutions to the problem arise from an analysis of solutions of these models, either in algebraic solutions or in graphical representations of these solutions.

In the second activity the students presented a mathematical treatment of the situation from an analysis of quantitative data about the problem and, from this point on, using some mathematical knowledge, they were able to build mathematical models that supported the analysis of the global warming problem.

The reconstruction of students' modeling processes can be found in many different studies within the literature of mathematical modeling. Many of these studies refer to different cycles or even different modeling perspectives for modeling in mathematics education. However, we must consider that other specificities may arise from the very nature of the data used and the problem that you want to develop, even when the cycle or perspective is already defined.

Thus, different approaches to mathematical modeling may lead to different actions of the students and it is up to the teacher to define what it expects students learn to organize classes with mathematical modeling.