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## Modeling tasks and mathematical work

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In the Mathematical Working Space (MWS) model, an epistemological plane and a cognitive plane are introduced with a focus on their interactions related to semiotic, instrumental and discursive dimensions (Figure 1a). The model is devoted to the analysis of mathematical work with, specifically, paradigms guiding and orienting the work. Numerous researches are based on the MWS model and the reader may refer to special issues in journals such as *Bolema* 30(54) and *ZDM-Mathematics Education* 48(6) in which an introduction to the model is given in the survey paper. Nevertheless, until now, few studies on modeling tasks have been based on the MWS model and we want to highlight recent researches, in particular coming from PhD studies within our team.

Based on the modeling cycle (figure 1b) proposed by Blum and Leiss (2005), we suggest, in the poster, some adaptations which help to understand how MWSs can be used. The whole modeling process is not taken in its whole, and we focus more on how the analysis can be refined, mostly between phases 3 and 5 of the cycle, in relation to activity in different mathematical domains.

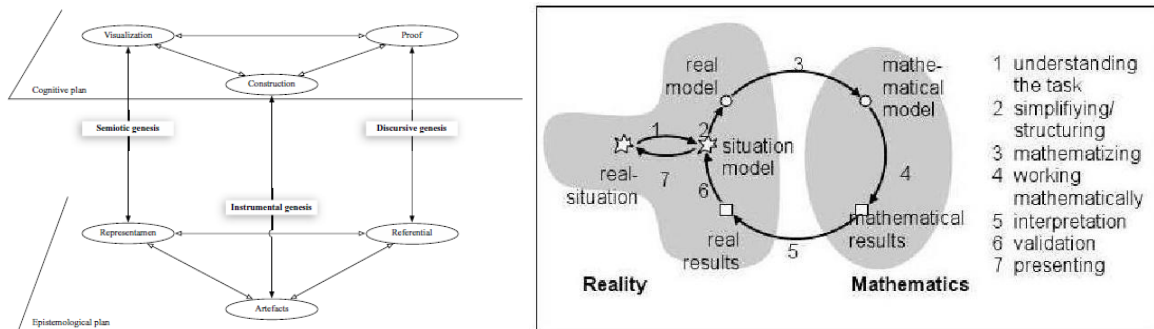


Figure 1a: MWS diagram; Figure 1b: modeling cycle (Blum & Leiss, 2005)

Nechache (2016) suggests describing the modeling work in probability situations, with the MWS framework. She identifies the importance of the theoretical referential of the  $MWS_{Proba}$  in the constitution of the real model. Then, for the analysis of the mathematical part, she fully uses the  $MWS_{Proba}$ . In the same way, the MWS model can be used for studying other mathematical domains.

Derouet (2016) proposes a similar type of use for the mathematical part, but she associates sub-phases to the stages of the cycle in order to investigate the progress of the modeling process. She isolates a part of the cycle containing “real model” and “real results” that she names pseudo-concrete. It allows her to identify, in a modeling situation related to continuous probability, a work within the  $MWS_{Proba}$  in various working paradigms.

In these studies, the MWS model allows to refine the analysis of the mathematical part by taking into account a first horizontal mathematization followed by a second vertical mathematization allowing to strengthen the mathematical model. Other types of change, or transition, are possible,

like the change of MWS or mathematical domains. In his study in relativist kinematics, Moutet (2016) suggests an extension of the MWS model to take into account a change of matters. He considers a second epistemological plane for physics, and he studies the interactions between these two planes and the cognitive level.

In these studies, simulation associated with digital models can also be considered as an important stage of the modeling process. It plays two different roles. The first one is in relation to the development of the real model with a simulation close to the initial situation (urn model or a calculator which proposes rolls of dice or coin, in probability). The second role presupposes a stronger mathematical expertise in the MWS of the domain at stake as, for example, the implementation of an algorithm of dichotomy in analysis.

Hence, the use of the MWS framework can enrich and strengthen the analysis of the modeling process based on the study of a cycle (figure 1b) in connection with a first resolution of the problem. It constitutes a first interaction between MWS and the modeling cycle, as a *first cycle*<sup>1</sup>: The modeling problem has been mathematized and it is possible to identify the epistemological and cognitive components of the MWS in relation to the student's activity and realization in the different domains and paradigms. But we can also, in a more didactic way, think of a *second cycle* aiming at a better understanding of the model and of the mathematical objects introduced to solve the problem by students. In that case, the modeling task proposed by a teacher aims not only at solving a real problem but more deeply at exploring and understanding the numerous uses of a mathematical notion, enriching the MWS, in particular the theoretical referential. This is what we are developing in a work on progress on the exponential function.

### Acknowledgment

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<sup>1</sup> Even if, of course, one should not understand the cycle as requiring to go through every stage, in a linear way.