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EDITORIAL

Models as the subject of education

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The title of the editorial for SoSyM vol. 16 (9) was "Models as the Subject of Research" [1], which focused on modeling as a pure topic for research. In a similar theme to that past editorial, we also believe that the modeling community has much to contribute on the topic of education, as related specifically to modeling, and also how modeling is used within the general context of computer science (CS) and software engineering (SE) education. However, the global interest and influence of modeling as a topic of education seems to be silent outside of the modeling community. We ask, "Why?"

The annual ACM SIGCSE conference on Computer Science Education attracts over 1500 attendees from an international audience of CS education researchers and teachers across a broad range of interests. Those from the SoSyM community may be surprised to learn that among the 171 accepted papers at the SIGCSE 2020 conference, there does not appear to be a single paper that addresses modeling concerns, of any form, in CS education research. In fact, since 2010, we can only find three papers that discuss software and systems modeling in a general CS context (and the three that we found address modeling more in passing, not as the primary theme). Similarly, in one of the most prestigious journals on CS education, we could find only one recent publication on modeling education [2]. Very clearly, software and systems modeling is not on the radar of the CS education community, at large.

Even at the main venue for modeling research and practice, topics on modeling education appear less frequently in the main conference proceedings of MODELS (over the past 3 years [3], is a representative of modeling education in the main proceedings). Instead of being showcased in the main proceedings, the Educators Symposium is the main venue for publishing results in modeling education. More recently, SoSyM has started to receive submissions of education papers, often backed by empirical evaluation of modeling approaches in the classroom [4, 5]. We encourage authors to prepare SoSyM submissions that are based on deep empirical investigations on education topics in modeling.

Several curriculum and standards efforts have occasionally included modeling topics as core learning objectives, but often at a superficial level. In the high school grades, the Advanced Placement test for Computer Science in the United States includes mention of UML and modeling of object-oriented solutions. The ACM curriculum guide for undergraduate programs has over 100 mentions of the term "modeling," but in a broad sense to cover mostly things outside of the scope of the SoSyM or MODELS usage (although the UML is mentioned 6 times in passing without any details). Furthermore, the major CS accreditation board for higher education in the US does not recognize modeling as a core competency for CS students. Likewise, efforts in Europe to identify core knowledge for IT professionals lack a deep modeling imprint [6]. Influential curriculum standardization efforts and accreditation bodies should consider efforts like the Model-Based Software Engineering Body of Knowledge in future revisions [7, 8].

When software and systems modeling is taught within a CS curriculum, it is usually found at the undergraduate level in the context of using UML to articulate concepts of a software engineering course. Unfortunately, this may be the only exposure to modeling concepts that an undergraduate student will see. At the graduate level, a specific course on modeling can provide an opportunity to go deeper in both practical and theoretical aspects of modeling, but such a course is a rare exception among most curricula pathways. Challenges faced by efforts to include modeling in a curriculum pathway are influenced by factors such as which tools to use, and where to find suitable artifacts for course focused

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case studies (a challenge addressed by the ReMoDD project [9] for over a decade).

All across the world, there has been a surge of interest in teaching CS and programming to younger children, typically using a block-based language. What are the opportunities to bring modeling education down into earlier grades? What would education materials look like for students who have less experience and background, and whose abstraction abilities may not be fully developed? These are education topics that have not been deeply considered within our community, but may introduce new opportunities to understand the benefits of using modeling concepts in general CS education for younger students.

Despite the lack of modeling as an impactful topic for CS education, we believe that there are many benefits to students of all ages. For example, modeling provides a great context for students to understand and practice abstraction skills. Furthermore, topics such as temporal properties and causality are typically best understood at the modeling level, instead of introducing such concepts purely in code. There are many modeling education research topics that need to be explored to understand the degree of such benefits, as well as many other topics that intersect modeling and CS education (e.g., what is the best age to introduce topics of modeling?; should modeling be introduced before, during, or after core programming concepts?; and what are the most appropriate tools and pedagogy that should be used?). We hope to see future papers that examine modeling education topics within a rigorous framework of empirical study.

1 Content of this issue

1. **Expert Voice**
   - "Personal programming and the object computer" by Trygve Reenskaug.
2. **MODELS 2018 Special Section**

   Guest Editors: Andrzej Wasowski, Richard F. Paige, and Øystein Haugen.
3. **Regular Papers**
   - "A model-based architecture for interactive run-time monitoring" by Nicolas Hili, Mojtaba Bagherzadeh, Karim Jahed, and Jürgen Dingel.
   - "Automated synthesis of local time requirement for service composition" by Étienne André, Tian Huat Tan, Manman Chen, Shuang Liu, Jun Sun, Yang Liu, and Jin Song Dong.
   - "Behavioral interfaces for executable DSLs" by Dorian Leroy, Erwan Bousse, Manuel Wimmer, Tanja Mayerhofer, Benoît Combemale, and Wieland Schwinger.

We hope that you develop new insights and observations when reading the articles in this issue.

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