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Modelling process of complex problems from a teaching perspective

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Abstract: Models help people make decisions, but teaching how to model a complex problem is challenging. Traditionally, modellers implement an iterative modelling process integrated by problem articulation, dynamic hypothesis, modelling formulation, validation, policy and strategy analysis (Sterman, 2000). From our teaching experience, we wonder if students see this approach as an iterative process or instead as a linear and sequential approach. In addition, when teaching system dynamics, we perceived that students were overwhelmed by the phenomenon's complexity and the modelling process of identifying causal relationships, polarities, feedback loops, stocks, flows, and delays.

One approach to teaching system dynamics is to introduce causal loop diagrams (CLD) to represent the dynamic hypothesis and subsequently convert the CLD into a more detailed stock and flow diagram (SFD). When teaching system modelling using this approach, we note that it presents extra challenges to students rather than benefits. Other approaches to teaching system dynamics divide the process into system thinking and system modelling to reach different public targets or divide the teaching process into two complementary or independent courses. (i) Teaching systems thinking has focused on building CLDs and archetypes to represent the system structure. The focus on systems thinking and CLDs lack in testing mental models captured in the CLD. We have also identified that students try to fit all systems into the archetype structures without knowing if the problem modelled generates a similar behaviour to the archetypes. (ii) Teaching system dynamics modelling has focused on constructing a SFD or a hybrid between CLD and SFD to understand the system structure and run policy and strategy analysis. We have noticed that teaching systems modelling by jumping directly to stock and flow diagrams reduces the limitations of teaching from CLD but has a disadvantage that increases the complexity of the modelling process, especially for those students without prior experience in modelling.

Based on our professional experience teaching system dynamics and system thinking, we highlight some issues students face about modelling complex problems using traditional system modelling approaches. Here, we present a modelling process to help students with no prior systems modelling background tackle complex problems and develop a modelling skill set. The modelling process proposed advocates teaching system dynamics and systems modelling through incremental learning and a learning-by-doing approach (Elsawah, McLucas, & Mazanov, 2017) that can help teachers in system modelling to capture the best elements from both. The approach proposed focuses on representing the dynamic hypothesis in one or two simple feedback loops based on key variables. Then, students are guided to turn the CLD into SFD and run initial simulations. The initial and simple SFD is improved incrementally by reviewing additional variables and drivers in the problem articulation and initial CLD. The final SFD is used to ground the final version of the CLD, and this CLD is used to communicate the dynamics that help understand the problem. This circular learning process helps students understand the problem, from simple to complex, improves modelling skills and grounds the CLD.

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