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# Using an object and pattern oriented approach to hydrological modelling teaching and research

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**Abstract:** Introducing hydrological modelling in undergraduate teaching is challenging, and some of this is related to the decline in STEM knowledge in students. Enabling students to confidently work with a range of hydrological models remains difficult, particularly if the goal is to make students understand the modelling process and model structures. The limited literature points to a number of educational tools that have been developed, falling into three classes: magical box fully developed GUIs with little insight into model operation; highly theoretical command line linear reservoir and unit hydrograph tools; and model tools focusing on one single model structure. Given the current focus on model structure, uncertainty and model optimisation, students need to gain insight in these topics. Hydromad has been developed as an object and pattern oriented hydrological modelling tool that encapsulates several models, calibration routines and model structures. Object based modelling as an educational tool links to a constructivist and active learning approach to learning and allows students to experiment with different components before constructing the overall solution. In essence, hydromad consists of model objects representing the water balance (soil moisture accounting or sma) and routing. Standard methods are applied to develop patterns in analysis that help with understanding model behaviour and performance. Using hydromad over the last 5 years in a 3<sup>rd</sup> year undergraduate class, the modelling was well appreciated by students as general unit evaluation scores have been high. Future evaluation could focus on asking specific questions about the learning with models. Current development of the package includes using satellite data calibration of models, and incorporating further top-down modelling objects.

**Keywords:** Hydrology, modelling, education, hydromad