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Can explicit modeling of dynamical systems in physics change students' beliefs concerning the nature of scientific knowledge?

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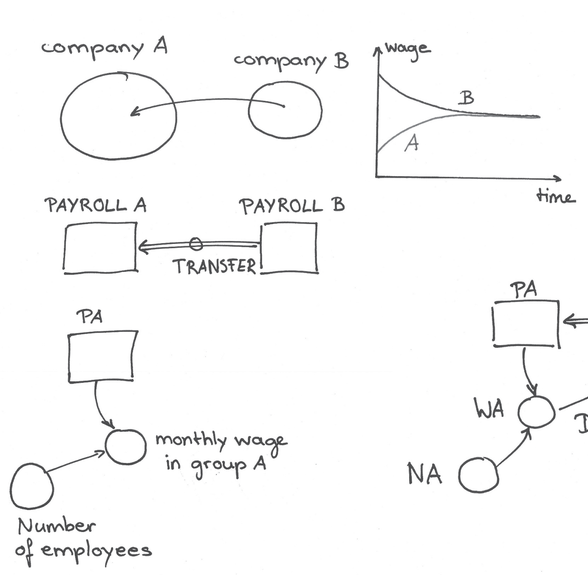
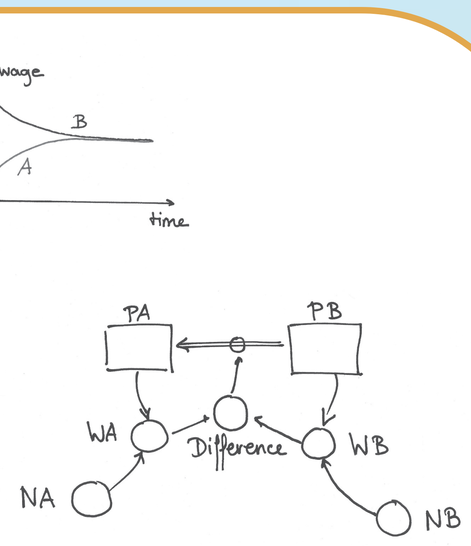
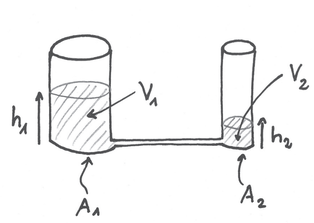
We think that students' belief that concepts, laws, theories of physics are to be taken literally severely impedes students' progress in learning about conceptual structures in their field. If a learner believes that "truth is out there," she cannot get to the laws of physics herself, and she cannot be creative in constructing models of how parts of the world work. She must be given the equations that describe truth she is to apply uncritically to sterile situations that populate school physics. In our course, however, we try to build students' confidence in their ability to create, explanatory narratives for physical processes on their own.

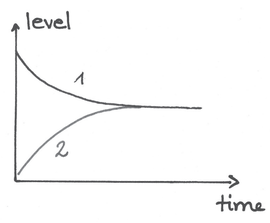


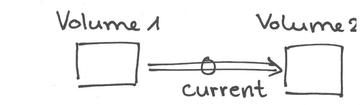


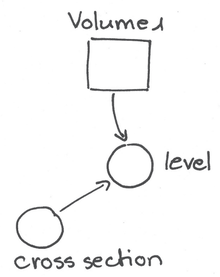
In the introductory sequence of our course, we start with a simple but ill-defined example from social science for systems modeling, where a company absorbs an engineering department from another firm and merges it with their own group of engineers.
Since employees have been paid different wages in the two companies for the same work, students are asked to describe, and then model and simulate, a process where wages in the two groups are equalized over the course of a certain period, first without increasing total payroll.

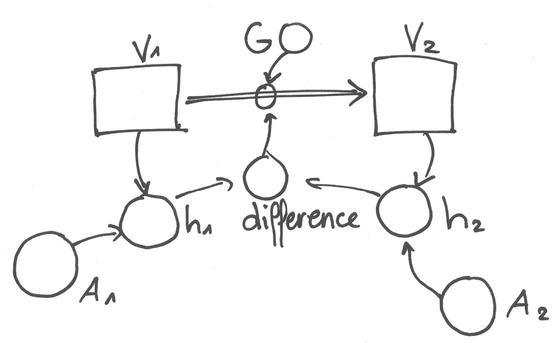
After successfully working on this assignment, students experiment with a hydraulic system where water levels in two communicating tanks equilibrate.











Subsequent computer modeling happens with barely any help! Students realize that the hydraulic model is analogous to what they create in the business case. Importantly, they do not have to be taught a law for the flow of liquid through the pipe. They have created an idea for the rate of transfer of payroll from one group of engineers to the other in order to achieve a form of equilibration of wages that is similar to what can be observed in the adjustment of levels of a liquid in two communicating tanks.

While students' progress in the course is impressive, course feedback indicates that most of them are still far from profoundly revising their beliefs concerning scientific knowledge. Typically, when they start working on chemical dynamical systems, they still want to know "how things really work," meaning how little particles behave, when the proper and successful form of modeling is derived from macroscopic physical science.

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