



## **What do we need to know to predict ENSO? Student-centered learning in a Master course in Climate Physics**

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An important learning outcome of a Master of Sciences program is to empower students to understand which information they need, how they can gain the required knowledge and skills, and how to apply those to solve a given scientific problem.

In designing a class on the El-Nino-Southern-Oscillation (ENSO) for students in the Climate Physics program at Kiel University, Germany, we have implemented various active learning strategies to meet this goal. The course is guided by an overarching question, embedded in a short story: What would we need to know to successfully predict ENSO? The students identify desired learning outcomes and collaboratively construct a concept map which then serves as a structure for the 12 weeks of the course, where each individual topic is situated in the larger context of the students' own concept map. Each learning outcome of the course is therefore directly motivated by a need to know expressed by the students themselves. During each session, students are actively involved in the learning process. They work individually or in small groups, for example testing different index definitions, analyzing data sets, setting up simple numerical models and planning and constructing hands-on experiments to demonstrate physical processes involved in the formation of El Niño events. The instructor's role is to provide the necessary background information and guide the students where it is needed. Insights are shared between groups as students present their findings to each other and combine the information, for example by cooperatively constructing a world map displaying the impacts of ENSO or by exchanging experts on different ENSO oscillator theories between groups.

Development of this course was supported by the PerLe Fonds for teaching innovations at Kiel University. A preliminary evaluation has been very positive with students in particular appreciating their active involvement in the class.