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Developing an Interactive Learning Environment to teach the two-way coupling of climate-human system

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DEFINITIONS

ILE – Interactive Learning Environment
An interactive tool that helps users explore complex challenges, solve problems, and make decisions in a real-world-like setting, while communicating insights without needing direct involvement in complex modelling.

FRIDA – Feedback-based knowledge **R**epository for **I**ntegrate**D A**ssessments
A new global Integrated Assessment Model focused on closing key human–climate feedback loops and advancing interdisciplinary climate education through a feedback-based, systems approach (Schoenberg et al., 2025; WorldTrans Consortium, 2023).

PROBLEM

Interactive Learning Environments (ILEs) must meet users' needs beyond traditional scientific norms (Bremer et al., 2021; Rajah et al., 2024). However, gathering meaningful input is difficult without users first experiencing the tool. To explore preliminary needs, we learned from workshops using En-ROADS climate simulator, role-playing, and co-evaluation with graduate students, using both interviews and quantitative assessment (Cash et al., 2023).

Users want ILEs to be transparent, relevant, and practical, but often struggle to see how system elements connect. Addressing all these needs is challenging and requires balancing clear explanations, actionable insights, and model trade-offs.

OBJECTIVE

Target Audience: The FRIDA ILE is designed for high school to postgraduate students and adult learners interested in climate–human systems. Prior knowledge of climate change, socio-economic systems, and cause–effect relationships is helpful but not required.

❑ Design and developing and ILE based on the FRIDA model with the objectives
  • Help users understand WHY things happen
  • Let users represent their own perspective
  • Show users where and how they can make an impact

❑ Use the ILE in **Bergen Summer Research School (BSRS)** and collect structured feedback.

❑ Assessment of the structured feedback and comparison with feedback from En-ROADS workshops.

SNAPSHOTS FROM THE FRIDA ILE

STRUCTURE OF THE FRIDA ILE

❑ Home

Users begin in the Home section with an introduction to the FRIDA ILE tool and how to navigate it. A terminology guide explains key terms such as Endogenous Model Behavior (EMB), confidence boundary graphs, and box-and-whisker plots, etc. This section sets clear expectations and prepares users for smoother exploration in the following sections.

❑ Guided Demonstration

The Guided Demonstration focuses on our first learning objective and walks users through simplified explanations and system interactions, introducing the underlying logic and cause–effect relationships between human and climate systems. This builds a foundation for understanding feedback loops and dynamics and prepares users to use the Dashboard for policy testing and exploration later.

❑ Model Behavior / Goal-Setting Section

This section addresses the first two objectives: helping users understand why things happen and acknowledging diverse perspectives on desired outcomes. Users observe the behavior of key system variables over time and explore possible future scenarios by following current trends. They then set their own goals by choosing target values and a future year for three critical variables. These goals, visible in the Dashboard section, create a personalized experience and allow users to compare their desired outcomes with actual results from policy interventions.

❑ Interactive Dashboard

The Dashboard addresses the third objective: helping users understand how and to what extent they can make an impact. Users adjust input variables from the FRIDA model to test policy interventions, with over 225 variables available for tracking. Results are displayed using confidence boundary and box-and-whisker graphs, allowing users to compare outcomes with their pre-set targets. Real-time visual feedback highlights system responses, trade-offs, and ripple effects, deepening users' understanding of complex human–climate system dynamics.

CO-EVALUATION RESULTS

After the BSRS workshop, a co-evaluation was conducted using Mentimeter to assess key quality constructs, including **Salience**, **Accessibility**, **Credibility**, **Legitimacy**, and **Effectiveness** for systems understanding. Participants rated the ILE individually based on these criteria.

The co-evaluation results from the FRIDA workshop (28 participants) were compared with results from previous En-ROADS workshops (54 participants). This comparison, based on the same set of questions, aimed to position FRIDA's effectiveness relative to En-ROADS rather than rank the tools. Weighted responses were analysed by calculating mean scores for each question across all participants.

The ILE helped users gain practical insights and feel motivated to act. It also supported their understanding of feedback loops, leverage points, and unintended consequences, while being perceived as internally consistent and trustworthy in its inputs and outputs.

Constructive feedback has been carefully considered to guide further enhancements and future development.

RADAR CHART SHOWING MEAN CATEGORY SCORES FOR FRIDA AND EN-ROADS

En-ROADS   FRIDA
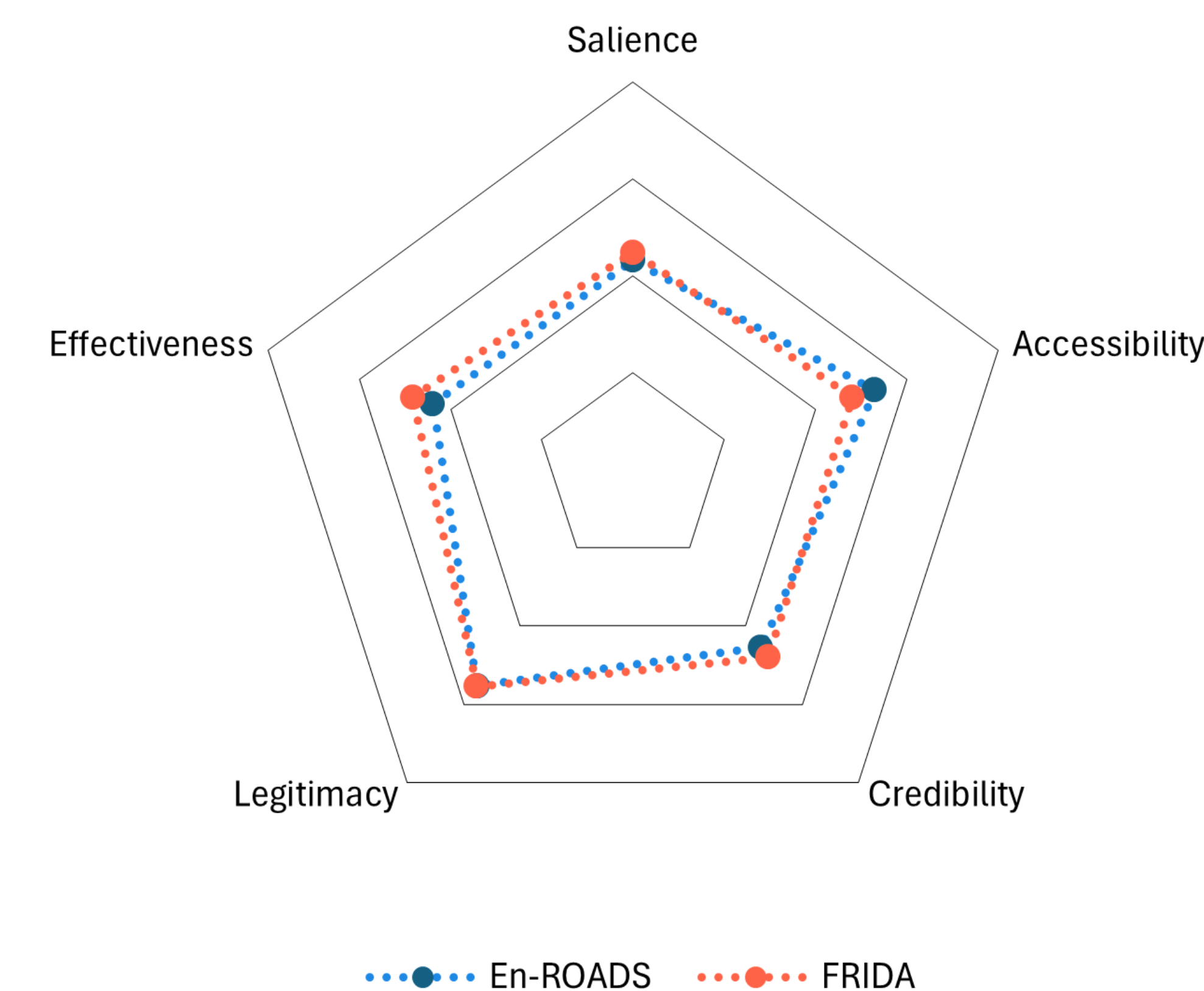
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