Our study demonstrates that an immersive participatory simulation may help students better understand real-world complex systems such as the Chesapeake Bay Watershed. Understanding complex systems is essential for creating effective solutions to ecological, economic, and social problems.

The UVA Bay Game represents next generation participatory agent-based simulations that accurately model real-world data from coupled human-natural systems with complex properties. Complex systems are difficult for students to comprehend because they arise from interactions that are often invisible, indirect, and constantly changing. Agent-based simulations have the potential to facilitate greater understanding by making interactions tangible and focusing attention on counterintuitive outcomes.

The UVA Bay Game is an interdisciplinary collaboration between nine different schools at UVA since 2008. The study reported here engaged students enrolled in AP environmental science courses at a public high school in Virginia.

For more information, see www.globalwatergames.org

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**Background**

- **Context:** Pollution and overharvesting of aquatic species present an unsustainable relationship with the Chesapeake Bay. Despite decades of effort and hundreds of millions of dollars, Bay health has not recovered.

- **Complex Systems:** The Bay is a complex system where outcomes are emergent and interactions change, causing unpredictable non-linear effects.

- **Teaching Complex Systems:** Creating effective and sustainable solutions requires training future scientists (students) to better understand such highly complex systems and the impacts of interventions. The UVA Bay Game accurately models this complex ecosystem and immerses students in an active learning experience to aid their understanding.

- **Research Question:** Is participating in a single gameplay associated with enhanced student understanding of key features in complex systems?

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**Ecosystems: The Chesapeake Bay is a Complex System**

- During one school day, two classes of high school students (n=44) participated in a gameplay of the UVA Bay Game simulation.

- The UVA Bay Game is an agent-based participatory simulation that allows students to take roles such as farmers and developers as they attempt to both make money and sustain the health of the Bay.

- Students (n=32) completed pre and post essays describing the roles and interactions of components of the ecosystem. Essays were graded on their understanding of 6 hallmarks of complex systems.

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**The UVA Bay Game: An Immersive Intervention**

- At post-test, students showed significantly greater understanding of 3 important aspects of complex systems: Emergence, Locus of Control, and Adaptation.

- Simulation use was associated with gains in complex systems understanding, suggesting a promising tactic for instruction.

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**Student Gain in Understanding after Playing the UVA Bay Game**

<table>
<thead>
<tr>
<th></th>
<th>Emergence</th>
<th>Non-Lin. Interaction</th>
<th>Non-Lin. Effect</th>
<th>Adaptation</th>
<th>Locus of Control</th>
<th>Tradeoffs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Z</td>
<td>2.111</td>
<td>1.604</td>
<td>.221</td>
<td>.019</td>
<td>2.985</td>
<td>3.529</td>
</tr>
<tr>
<td>Exact Sig. (1-tailed)</td>
<td>.033*</td>
<td>.07</td>
<td>.437</td>
<td>.5</td>
<td>.002**</td>
<td>.000**</td>
</tr>
<tr>
<td>R (Effect Size)</td>
<td>.37</td>
<td>.28</td>
<td>.32</td>
<td>0</td>
<td>.53</td>
<td>.62</td>
</tr>
</tbody>
</table>

Note: *p <.05, **p<.01

**Simulation Use**

- Simulation use was associated with gains in complex systems understanding, suggesting a promising tactic for instruction.