Preliminary Evaluation of a Synchronous, Co-located Educational Simulation Framework

MUSHI: Multi-User Simulation with Handheld Integration

Educational Goals

We designed the **MUSHI** (**M**ulti-**U**ser **S**imulation with **H**andheld **I**ntegration) framework to address two educational needs:

(1) to help students learn about **complex, multi-scalar systems**

(2) to help students **collaborate** with one another in small groups.

To support these needs, we:

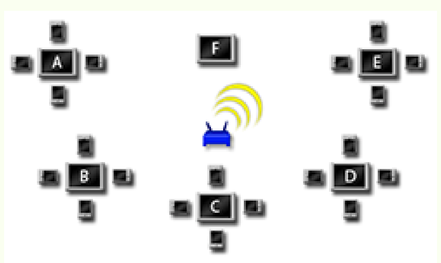
(1a) present a **dynamic, rule-based simulation** of a complex, multi-scalar system

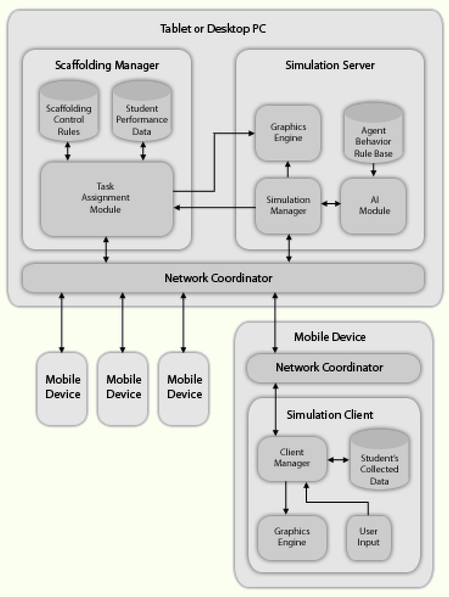
(1b) use **M**ultiple **L**inked **R**epresentations (**MLR**) to simultaneously visualize different levels of scale (large and small) of the simulated system

(2) provide students with **equal access** to both the **simulation** and to **each other** by providing each a **wirelessly-connected mobile device**

Architecture

The MUSHI architecture (see figure) separates each of the challenge areas (simulation, scaffolding, networking) into discrete modules. The majority of the simulation computation occurs on the desktop device, both to take advantage of the computational power of the desktop and to ensure consistency across the handheld devices. A separate scaffolding manager, whose development is guided by this work, helps to both guide inquiry learning and to foster natural collaboration activities between multiple users. Due to its complexity and inconsistency, networking is separated as much as possible from the other key systems.





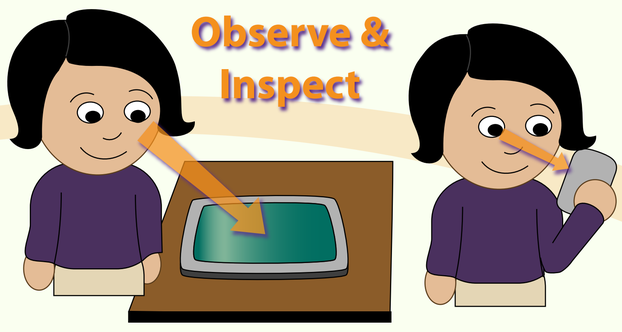
MUSHI-Life

MUSHI-Life, the first simulation developed for the MUSHI framework, presents users with a simulated ecology. The ecology is poulated with plants and insect-like "bugs" which eat, breed, and die. The "bugs" have genes which express themselves as different phenotypical traits, like specialized mandibles. Different traits result in survival advantages or disadvantagesm depending on the environmental conditions of the ecology.

Supported Activities

Students will engage in inquiry-based learning activities that allow them to behave as scientists would: by making observations, developing hypotheses, devising experiments to test those hypotheses, analyzing the results of those experiments, and revising the hypotheses as needed.

Observe & Inspect

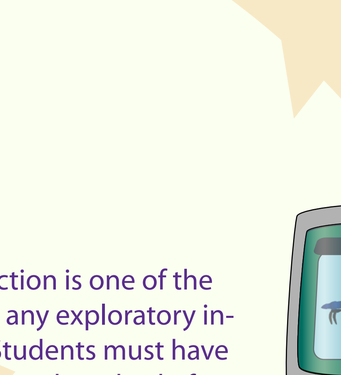


The shared global display on a tablet PC, allows students to observe an overview of the simulation. Students can use handhelds to inspect the details of a simulation at a small level of scale. Students can use both displays to observe how large-scale global characteristics impact small-scale local-level interactions, and vice-versa.

Capture & Tag

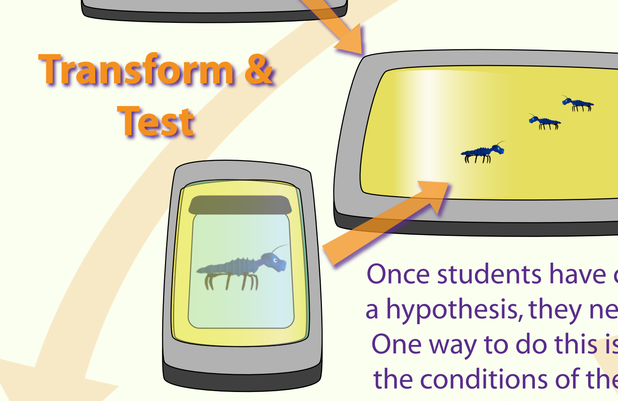
Data collection is one of the first steps in any exploratory inquiry task. Students must have a straightforward method of acquiring relevant data, whether that data concerns structure or behavior.

Annotate & Analyze



It's not enough to merely have some data; students must actively interpret it to understand it, and must share that interpretation with others. Labeling data is one way to help students and their audience understand their analysis.

Share & Predict



Sharing findings helps students articulate and refine their ideas, which they can then use to make predictions about the system under study. Different students bring different observations to the discussion, which can help students come to a more complete understanding.

Transform & Test

Once students have constructed a hypothesis, they need to test it. One way to do this is to perturb the conditions of the simulated system, to determine if that perturbation leads to their predicted outcome.

Future Research

Additionally, we identified a **potential gender disparity** that needs to be investigated. Our prior lab experiments showed no disparities, so one explanation for the classroom performance gap is that intermittent technical problems occurred more frequently with the female participants. We should repeat in-class trials to see if the disparity only emerges in classroom-based actvities.

Our other findings will **guide future design**:

- Students need **reminders to use shared displays** when Multiple Linked Representations are reified onto different devices
- Indicators of partners' actions should be depicted on the shared display to aid **implicit coordination of actions**
- **Regulation of shared resource** use must be investigated

Because our lab trials were conducted with dyads:

- We also plan to study how **larger groups** (3-5 members) do (or do not) coordinate their actions while using MUSHI.

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