Addressing Assessment Challenges for a Multi-User Simulation with Handheld Integration (MUSHI)

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ABSTRACT

Complex systems present challenges for learners in understanding different levels of emergence. We addressed these challenges by developing a framework for a multi-user simulation with integrated handheld devices (MUSHI) that supports learners in negotiating between the local and global characteristics of a complex system. In this poster, we present our work-to-date on the design of a natural selection simulation using the MUSHI framework called MUSHI-Life. We also outline a set of challenges that arise in developing assessments for the unique architecture of the MUSHI framework.

Keywords

Learning technologies, assessment, handheld devices, collaboration, simulation

MOTIVATION AND BACKGROUND

Building an understanding of complex, emergent systems is critical to the comprehension of many scientific phenomena. Developing this understanding requires a learner to negotiate between *levels of granularity*: (1) the local level, where individual objects (e.g., atoms, organisms) operate according to simple rule sets; and (2) the global level, where the interactions of objects at the local level combine to create overarching systemic patterns (e.g., molecules, population dynamics) [4].

One example of a complex system is the process of natural selection. The need for understanding this process is articulated in national science education benchmarks [1]. These benchmarks suggest that middle-school students should understand: (1) variation in body plans and internal structures across different organisms (*local*); variation in environmental resources (including food, space, water, air, and shelter) that influence both (2) individual survival (*local*) and (3) population survival (*global*).

We are exploring how technology can provide learners with opportunities to see and negotiate between local and global concepts when navigating complex systems. We designed the MUSHI framework to make both the local and global levels, as well as the interactions between them, explicit and accessible to students. The students gather around a horizontal display (e.g., a Tablet PC) which presents the global level of the simulation (Figure 1). Each student has a handheld computer (e.g., a Pocket PC) that provides a local-level "window" onto the simulation world. This architecture allows learners to: (1) explore local-level information on their handhelds; (2) observe global-level information on the horizontal display; and (3) build conceptual connections between the two levels.

Figure 1: Illustration of the MUSHI system being used by three students.

THE MUSHI-LIFE SIMULATION

We designed MUSHI-Life, a simulation based on the MUSHI framework and informed by the principles of *learner-centered design* [3], to support middle-school students in understanding the systemic complexities of natural selection. The simulation depicts an environment populated with genetically diverse insect-like creatures, which feed, fight, and produce offspring according to a simple body of rules. The environmental conditions and

distribution of competitive organisms determine each individual creature's ability to survive, and in turn shape the genotypes that get passed down to subsequent generations. The environment (global-level information) is depicted on a Tablet PC. Students use their Pocket PCs to temporarily collect creatures from the Tablet PC. Creatures on the Pocket PCs can be examined in greater detail, as if through a microscope, exposing local-level traits such as mandible and limb characteristics.

ASSESSING A MUSHI-BASED SYSTEM

Assessing learning technology involves a dual focus: examining (1) the "effects of" the technology (i.e., what students *learn* from using the technology); and (2) the "effects with" the technology (i.e., how are students *working with* the technology as they engage in their learning activities) [2]. The multi-device nature of the MUSHI framework introduces several novel assessment complexities, which is the current focus of our work on MUSHI-Life.

The "effects of" MUSHI-Life simulation will follow a relatively standard approach that compares the knowledge growth of individual students on natural selection concepts via pre/post test measures. These measures rest on clearly-articulated learning goals, incorporated into corresponding instructional tasks that anchor students as they engage collaboratively in the simulation. These learning goals are aligned with the American Association for the Advancement of Science (AAAS) standards [1].

However, the "effects with" assessment is more complex, because it involves multiple users interacting with each other and the different devices in the system. We will assess MUSHI-Life by observing how students interact with the simulation as they engage in specific instructional tasks. However, because the MUSHI architecture supports two levels of interaction (between an individual student and the simulation across multiple devices as well as collaborative interactions between students), we feel it poses a unique set of observational assessment challenges. These anticipated challenges are framed for three situations: (1) how an individual user interacts with their handheld device; (2) how an individual user interacts with both their handheld device and the horizontal display device; and (3) how multiple users interact simultaneously with each other and with the devices (Table 1).

IMPLICATIONS AND FUTURE WORK

Assessing a multi-user, multi-device system for both learning and usability raises some complex and interesting methodological challenges:

(1) How do multi-device interfaces affect usability assessment? Are there efficient methods of analyzing a learner's visual attention, verbal cues, and gestures with respect to *each* device in the system? Are such analyses possible with the introduction of additional users?

(2) Is it possible to decouple the influence of the device form-factors from the influence of the instructional task (e.g., when studying collaborative student interactions)?

(3) How do you observe the use of multiple mobile devices without disrupting the natural flow of student work?

Assessment Situation	Assessment Challenge	Proposed Approach
Individual + Handheld	Do students understand how to use the handheld features	Traditional usability approach
Individual + Multiple Devices	Do students understand the correspondence between the local (handheld) and global (tablet PC) environments	Observation and focused interviews to gauge students understanding of this correspondence
Group + Multiple Devices	Can students distinguish between their local view of the environment and that of other students	Interviews to gauge student perceptions of the different representations of the simulation
	Do students interact with each other while engaged in a simulation task	Discourse analysis to disentangle the substance of student conversations and interactions
	What are the student-device interactions that occur during the simulation	Coded observations of student interactions with devices

Table 1. Assessment Challenges

As we engage in pilot testing to assess the utility of our simulation, these questions will be addressed. The results of these pilot tests will also guide further simulation development using the MUSHI framework.

ACKNOWLEDGMENTS

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