

Supporting Children's Collaboration Across Handheld Computers

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ABSTRACT

This paper describes the use of multiple interconnected handheld devices to support children's collocated collaboration. Handhelds are a relatively inexpensive, highly mobile platform, making them potentially useful in educational settings [3]. Two shortcomings of students' use of handhelds are: 1) achieving the benefits of collaborative learning may be difficult given the personal nature of these devices, and 2) the small size of a PDA constrains the amount of information that can be meaningfully displayed on a single device. In our research, we address these shortcomings by utilizing multiple devices to form a larger surface that can display more information than any individual handheld. This interaction technique encourages collaboration and helps engage all students in the activity. To explore this style of collaboration, we extended an educational application with a shared screen information view that we call WHAT-IF¹.

KEYWORDS

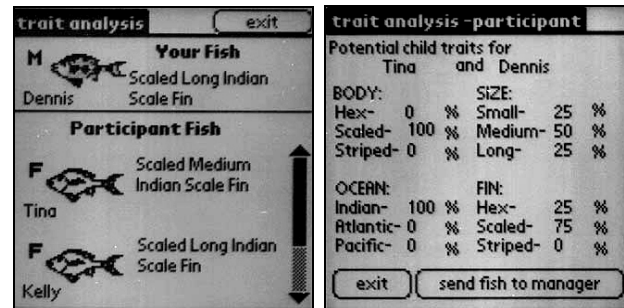
Collaboration, Palm, education, CSCW, CSCL, handheld computers, children, PDA, information design, genetics.

GENEY: OUR TESTBED APPLICATION

Geney [1] is a Palm-based educational game that assists children in exploring genetics concepts. Geney simulates a population of fish, representing a gene pool that is distributed across multiple handheld computers. Each handheld contains a single pond of fish and students can view the genetic traits of fish in their pond. In Geney, students work together to produce a fish with a particular set of characteristics by exchanging fish with their friends through the handheld's infrared port. Two fish in a pond can be mated and the offspring will have genetic traits that are derived from their parents' genes. Only by collaborating with other students playing the game can the group achieve the desired goal.

MOTIVATION FOR A MULTI-DEVICE DISPLAY

Observations of children playing Geney showed that they had difficulty deciding which fish to mate. Details were given about the traits of each fish, and family trees were



(a) manager

(b) participant

Figure 1: The analysis screens of the WHAT-IF feature.

accessible, but the children needed more information to resolve the complexities of dominant and recessive genes. To facilitate discussion of these concepts, we wanted to develop a tool to address these complexities in a way that the children could understand.

Participatory design sessions were held with children to explore ways to scaffold the children's decision making process while playing Geney. Design activities with children, such as this, can provide valuable insights into appropriate software design for children [2]. In these sessions, a tool that allows children to compare pairs of fish (from various ponds) without actually mating them was explored. Given the limited screen real estate of each handheld and the fact that information would be combined from several devices, a mechanism to distribute the information across multiple displays was investigated. This feature, termed WHAT-IF, provided children with genetic possibilities for a number of pairings of fish. We designed and evaluated paper prototypes of the interface with a class of 30 students, implemented this new feature on top of Geney, and conducted an initial evaluation.

INTERACTING WITH WHAT-IF

The WHAT-IF feature provides information that children can use together to make decisions in Geney. To use WHAT-IF, children form ad-hoc groups of two to five players; the groups can change with each running of WHAT-IF. We use the handheld's infrared port to beam information between

¹ Download Geney WHAT-IF at <http://guir.berkeley.edu/geney>

devices. One child in the group is the *manager*; the others are *participants*. First, the manager chooses one fish in her pond. Each participant chooses a fish in his or her pond that is the opposite gender of the manager's fish. One at a time, each participant beams his or her fish to the manager's handheld, and the manager sends her fish's information to the participant. After beaming, the manager's screen provides an overview of the traits of her fish and the participant fish. Each participant's screen shows a detailed view with per trait odds of the potential offspring arising from mating that fish with the manager's (Figure 1).

We originally intended to treat the set of handhelds as a single display by requiring the handhelds be in a particular formation, and visually slicing a large visualization across the multiple displays. In our design studies, we found that children felt requiring a static formation of handhelds compromised their mobility and that the physical borders between the devices' screens would be distracting. Instead, we opted for a semantic partitioning of the data, placing the overview on the manager's screens, and the detailed views on the participant's screens.

As a learning tool, one of the most compelling aspects of WHAT-IF analysis is that it combines individual and social processes; this is often a key to successful collaboration. Children individually contribute fish and maintain information for one pair of fish. The group synthesizes and discusses the information, generating hypotheses about the best fish pairings. Positive interdependence (individual success only happens when everyone succeeds) is often cited as being a core requirement of cooperative learning. By distributing information across individual handheld computers, WHAT-IF helps promote interdependent goals, tasks, resources, and roles.

EXPLORATORY STUDY

We conducted an exploratory study to gain insight into children's use of WHAT-IF, with seven students (five girls and two boys), ages 12 to 14 (Figure 2). We instrumented the application with a logging feature for later analysis. In the first session, the children were given an introduction to the Palm handhelds. We then gave the children an introduction to Geney and allowed them to play for 20 minutes to become familiar with the game. The children did not use WHAT-IF in this first session.

We conducted a second session the following week with the same children. In this session, we gave the children an introduction to WHAT-IF. The children were given an hour to play together, utilizing the WHAT-IF feature if they desired. Afterwards, the children filled out a post-session questionnaire. All seven students reported that they would prefer to play Geney with a friend than by themselves. The children reported overwhelmingly that the face-to-face component was their favorite part of the experience. All seven children were extremely positive; six of the children ranked their enjoyment as either a four or a five on a five-point scale and the remaining child ranked their enjoyment



Figure 2: Students using WHAT-IF while playing Geney.

a three. The children reported that they liked beaming information, especially trading fish.

Examination of the computer logs generated during the session revealed that the children spent a great deal of time interacting with each other. Each child performed a WHAT-IF analysis between 5 and 15 times, and 13 different WHAT-IF subgroups were formed during the session.

CONCLUSION

This research demonstrates that the combined use of multiple interconnected devices to form a larger, shared workspace can be an effective collaboration technique. We focused on children's social interactions in a learning environment because of the potential of handheld computing to support both individual and social processes. As observed in our initial study, children were excited by the notion of sharing information across handheld computers and were motivated to interact in this environment. They also made extensive use of the use of the WHAT-IF feature. This approach of semantically partitioning information across handheld displays can take advantage of rich face-to-face interactions and can help children synthesize information, creating a dynamic and engaging learning environment.

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