MultiMath: Numeric keypads for math learning on shared personal computers

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***Abstract*—Past research has shown the benefits of increased engagement and collaboration for learning using multiple inputs for children sharing computers. Taking the work forth beyond clicks, we demonstrate the use of inexpensive numeric keypads as multiple input devices in shared computing scenarios, as many have argued are well-suited to the developing world, and show its utility in mathematical learning for young children.**

I. Introduction

While a significant amount of work exists in the use of gaming in education, there is little literature on the value of multi-player gaming environments in developing world contexts. The work with multiple mice (Pawar, Pal et al. 2006) has succeeded in showing some gains with multiple-choice environments for young children constrained to sharing computers, and subsequent work has shown the impacts of split screens (Moed, Otto et al. 2009) in increasing the collaboration and engagement for learning. MultiMath is a multi-player educational game for basic arithmetic skills. Utilizing input via multiple numeric keypads and a split-screen display, the application allows for multiple individuals to participate at their own speed and skill level while simultaneously introducing competition between players. The split screen concept enables the application to provide each player with personalized curriculum and also allows for the use of adaptive questioning.

II. Technical Implementation

The MultiMath game is implemented as a desktop application using the Microsoft .NET framework. While Windows does support multiple mice and keyboards, it does not make any distinction between devices by default, as all mice control the same cursor and all keyboards provide a combined stream of input. However, Windows offers a RawInput API which can be used to simultaneously interface with multiple human interface devices by identifying each event, such as a key press, as corresponding to a specific device identifier. Using this information, we can correlate each key input with a specific user and react accordingly.

We employ USB numeric keypads because each unit costs approximately four dollars and can be used with virtually any modern computer, thus allowing for low-cost deployment in resource-constrained environments. Moreover, they offer a high degree of versatility, as they can be used for both numeric and directional input, and their keys can be re-mapped and labeled for specialized applications. Previous applications have used soft keyboards on the display which depend on mouse input (Moraveji, Kim et al. 2008) – we demonstrate that hardware input devices offer several advantages, such as by allowing faster input and by saving valuable screen real estate for other purposes.

For display purposes, we split the screen area into portions reserved for each participant, allowing for individualized attention. Not only does this enable each player to complete problems presented to them at their own pace, but this also allows us to introduce adaptive questioning in order to best address the skill level of each individual.

III. Demonstration

In this demonstration we will present an initial version of the MultiMath application, including multiple keypad input, split screen display, and a simple problem set. Using the implementation described above, the application will comprise of a game in which four players can individually complete randomly generated arithmetic questions and receive visual feedback of their progress and ranking within the game, through display elements such as a progress bar. At the demonstration, we also plan to display results from preliminary field tests with children during our iterative design process.

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