

Smart Blocks: A Tangible Mathematical Manipulative

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Introduction

- Smart Blocks inexpensively combine the benefits of physical manipulation with real time feedback to facilitate hands-on learning of volume and surface area of 3D shapes.
- Supports more than one user and allows trial and error exploration.



Motivations

- Physical manipulatives are used in classrooms to help children understand abstract concepts.
- In an unsupervised environment, students may develop misconceptions.
- Educational software can provide feedback & guidance but lacks physical manipulation.
- Keeping technology costs low is a priority when working with educational tools.

Design Concept

- When cubes are connected together, they create a shape that is recognized by the system.
- The system computes the volume and the surface area of that shape, and provides feedback about these characteristics to the user.

Use Scenarios

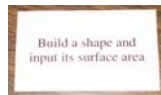
- Exploration Mode – System interactively updates the surface area and volume as the student assembles the blocks and places them on workspace.
- Question Mode – Online display is disabled. Student picks a question and places it in the workspace. Student creates a shape with the specified surface area and/or volume.



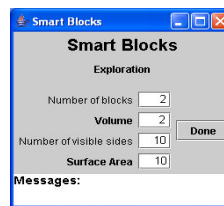
Cube containing RFID tag



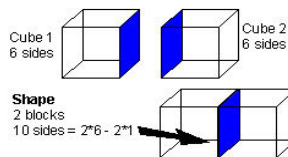
Connector containing RFID tag



Question containing RFID tag



Screenshot of the Smart Blocks interface



Calculation of surface area. RFID tags indicate the presence of cubes and connectors. Surface area and volume can be determined from this information alone.

Design Process

- Iterative process that included developing a series of prototypes and using rapid modeling to iteratively refine interaction design.
- To rapidly model the structure and behavior, we used Tangible User Interface Modeling Language (TUIML).

Design Challenges

- Determining the communication technology between the tangible manipulatives and the system.
- Determining techniques for the system to compute the surface area of the shape.
- Determining method for students to connect shapes together.
- Presentation and content of the tangible questions and feedback provided by graphical interface.

Future Work

- User evaluations.
- Enhance the user experience.
- Look into low-cost microprocessors to provide haptic and visual feedback directly to the blocks.
- Different levels of difficulty, possibly adapting to the student's performance.
- Blocks of different shapes.

Acknowledgments

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