

SpellCraft—Montessori Lab Letter Block Research Project

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Abstract

Montessori education is a pedagogical approach characterized by students teaching themselves through hands-on, self-led activities. Students are encouraged to embrace their creativity by experimenting with specially designed tools to learn new information through the process of discovery. One such tool involves a set of blocks representing the alphabet and a dictionary—students can arrange the blocks to form words and reference the dictionary to find out more about these words. This project aims to facilitate Montessori education by augmenting the word-forming learning tool, turning the letter blocks into a tangible user interface and replacing the dictionary with a responsive application that can offer multimodal information about newly created words such as pronunciations and images. It is critical to note that this project, SpellCraft, intends to enhance the current tool and promote Montessori principles rather than replacing it with an entirely screen-based approach. Spellcraft will be realized through the combination of relevant hardware and software technologies, such as the Unity game engine and RFID detection.

Table of Contents

| | |
|---|---|
| Abstract | 2 |
| Introduction and Motivation for Project | 3 |
| Objectives | 4 |
| Literature Survey | 4 |
| Proposed Work | 5 |
| Project Plan | 6 |
| Conclusion | 6 |

Introduction and Motivation for Project

The Montessori style of learning emphasizes the idea of self-learning for students and pushes them to discover new things on their own. The standard teaching method involves vocabulary lists in which students are simply given new words and explained their definitions. This does not follow the principles given by Montessori learning since the students have no sense of self-discovery. In order to create a method which does adhere to these principles, the proposed solution is to create a software which allows students to discover new words on their own. This will be accomplished through the use of letter blocks in which the order can be recognized by a computer. An accompanying application will then showcase various features such as the definition of the word, a picture, and sounds. The project will utilize an application programming interface (API) to connect to a word database.

The project will explore the use of RFID technology and how it can be utilized to enhance physical technology. Furthermore, we will be exploring potential opportunities to implement technology into Montessori styles of learning, which can have real-world applications in schools and other learning environments.

Objectives

The main functionality of the project is to display the word and image created by the user's letter block combination. If possible, a sound should be displayed with the image, such as a barking sound with a dog. If a non-existent word is constructed, the program should only display the word.

To achieve the project goals, the software must first be able to detect the order in which the letter blocks are positioned; the letter blocks have RFID tags that are placed on a surface that

has an RFID reader, which feeds into the program. The program will read the input and form a string that will be used to display images and sounds from relevant APIs.

Literature Survey

Montessori education is an alternative pedagogical method that emphasizes the student's ability to freely explore learning objectives to the extent that students are allowed to move around the learning environment as long as they are doing something educational (Hudson, 2023). Montessori education's effectiveness has been demonstrated both independently and against traditional education methods at multiple levels of education. In their review, Randolph et al. (2023) found evidence that Montessori education was more effective than traditional methods in all academic outcomes except science (for which they felt the quality of evidence was too low to assess via their methodology) and was even effective at achieving nonacademic outcomes such as social skill development. At the preschool level, both Lillard et al. (2017) and Hudson (2023) found that child-driven Montessori education was successful at improving academic and nonacademic outcomes over time as well as in comparison to traditional education.

Larsen Mamani (2022) outlined concerns with integrating screen-based technology into education methods—preschool-age children demonstrate smart device-related addictive behaviors and screen media devices replace the physical exploration that Montessori education prioritizes, often negatively impacting students' working memory function. However, she also noted that Montessori education already has techniques that address these concerns, such as the intentional reduction of distractions to reduce cognitive load and the incorporation of tactile experiences to improve cognitive memory function (Larsen Mamani, 2022).

As an application of embedded computing that employs a tangible user interface, SpellCraft mitigates the concerns posed by screen media by augmenting an existing, physical

approach rather than supplanting it. In fact, Chettaoui et al. (2022) found that preschool- and kindergarten-age students saw improved outcomes in short-term memory retention after using a computer-based education tool with a tangible user interface, demonstrating how these systems can be introduced to Montessori learning environments without disrupting their principles.

Proposed Work

Our project will be created using the Unity interface, written in C#. We will be utilizing RFID and Arduino hardware to detect input from the user, as well as a screen to display the information to the user. We will be testing our project throughout its development, and we will utilize research participants to test the effectiveness at its completion.

The first step of the project is to create the functionality of detecting RFID tags on letter blocks, which includes the ability to display the word created by the user. The next step will be to display images and sounds of the word created through the use of APIs and other libraries.

We will be using the Agile methodology for our project management system. Through utilizing this, we will be able to have clear goals and increments for each phase of development. This creates an efficient environment and allows us to easily track our progress.

Jira will be used as our technology for project management. This will allow us a space to plan out the distribution of work and document updates for scrum meetings. Github will be utilized for the development of the software and version control.

Project Plan

- **Jan 28**
 - Finish Project Proposal
- **Feb 18 (Presentation 1)**
 - Letter Block detection functioning
 - Basic UI
- **Mar 24 (Presentation 2)**
 - API integration for words implemented
- **April 21**
 - Display pictures and sound for words
 - Fully-realized UI
 - Finish final presentation and paper
- **April 24**
 - Finish poster

Conclusion

In accordance with the literature reviewed, a tangible user interface would help to facilitate the substantial benefits that students in Montessori education environments receive, such as increased academic achievement, executive function development, and self-determination. SpellCraft is a project intended to spark curiosity and creativity rather than stifle it—interaction with it would be to explore in physical and digital media simultaneously. We hope our research under Dr. Siqueira leads to promising results.

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