

Movable Alipbi

Senior Project

Final Report

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Executive Summary

Movable Alipbi is an iPad application designed to address the handwriting difficulties faced by children with dysgraphia syndrome, enhancing their cognitive development and handwriting skills. This project, targeting children aged 5-12, provides engaging, gamified exercises tailored to individual learning needs in handwriting. The application is a user-friendly, effective solution that includes interactive gaming elements to promote handwriting improvement in kids.

Introduction

The project is inspired by the need to address challenges faced by children with dysgraphia, a learning disability that affects handwriting abilities (*What Is Dysgraphia?* | *Reading Rockets*, n.d.). Dysgraphia significantly affects a kid's daily life negatively, emphasizing the importance of identifying handwriting issues in children at an early age.

Many children struggle with legible and fluent handwriting (Asselborn et al., 2020), creating a demand for an engaging and effective solution to support their improvement. This project addresses the need to improve children's handwriting skills, which are crucial for cognitive development and enhanced communication. Therefore, we aimed to develop a user-friendly, engaging, and effective iPad application called "Movable Alipbi".

Specifically designed for children aged 5-12 with poor handwriting skills, the app provides interactive games that target specific areas for improvement and track the progress. Such a digital tool with a personalized approach will deliver an effective and enjoyable solution for children with handwriting issues. Combining iPad pen Stylus's handwriting indicators, such as pressure, speed and static, with dynamic learning experiences, "Movable Alipbi" promises to be a transformative tool for children with handwriting challenges.

The report will first discuss other approaches, such as the app "Dynamilis," that were used to solve the same issue. This is followed by a brief description of our solution, including Backend and UI implementation. Further, the progress over two semesters will be covered, highlighting changes in the project, the issues faced, and design decisions made. The evaluation of the project solution will be introduced to determine whether the problem was solved. Lastly, it will conclude with possible future work that can be done to develop the project further.

Background and Related Work

No member has experience in either mobile development or machine learning. So we started learning the basics of the technologies we used to develop our application. Links to the courses we have taken are shown below:

Swift for beginners tutorial.

<https://www.youtube.com/watch?v=bjPENR6sHRU&list=PL5PR3UyfTWyfacnfUsvNcxLiKIgidNRoW>

Apple Developer Documentation. <https://developer.apple.com/documentation/swift>

Swift documentation. <https://www.swift.org/documentation/>

Hacking with Swift. <https://www.hackingwithswift.com/>

FastAPI tutorial. <https://fastapi.tiangolo.com/>

Django tutorial. <https://docs.djangoproject.com/en/4.2/>

To develop "Movable Alipbi," we took inspiration from the app named "Dynamilis," which has similar goals and functions. The research papers guiding Dynamilis's developers were helpful in the game development for this project. According to these sources, common indicators of handwriting issues in children include inconsistent letter formation, slow writing speed, incorrect grip, excessive pressure or lightness, difficulty copying text, frequent erasures, and inconsistent letter sizing. These symptoms align with those listed in the article by Srinivasan and Bobby (2021).

Using these indicators, we have identified three main features of children's handwriting that will be the focus of our games: pressure, speed, and consistency. Our games are specifically designed to improve these features.

Ediger (2002) proposes a practical remedial approach for addressing dysgraphia through drill and practice exercises. This approach involves teachers providing a model of correct handwriting and students practicing copying it. This method is useful for people with dysgraphia who have problems with letter formation due to difficulty retrieving and reproducing letters from memory.

Additionally, research by Richards (1998) suggests that repetition, combined with proper positioning and pencil grip, can enhance this process. Another supported practice is developing fine motor skills through targeted exercises. Strengthening the muscles in fine motor movements

leads to better handwriting by improving hand functioning. Berry (1999) and Keller (2001) successfully implemented these techniques in their work with individuals with dysgraphia.

Project Approach

The handwriting enhancement tool integrated with the iPad provides a user-friendly interface for children to improve their writing skills. The program is designed to deliver the necessary functions while making user interactions and data collection a seamless experience. The iPad serves as the system's central hub, providing a unique opportunity to enhance children's handwriting skills.

The development team employed the agile methodology to realize the project, which aligns with its main requirements. The project was mainly developed using SwiftUI language, additionally Firestore was used to integrate Database. One of the main components of iPad is the Stylus. Thanks to it, various aspects of handwriting like letter formation, static, pressure, and speed can be analyzed. Since the app focuses on the development of handwriting, it is vital to monitor improvements over time, therefore we integrated a progress tracking system. Moreover, interactive games integrate different levels of difficulty which are dynamically adjusted to the child's level to improve specific handwriting aspects.

The project is divided into two main phases, the Fall and Spring semesters, with each phase having two smaller feedback sessions. In the fall semester, needed hardware and software requirements, execution criteria, plan, and huge work on project management and tasking were done. Our team has organized tasks and procedures using boards, lists, and visual Gantt charts.

Dilyara Zhalgasbayeva mainly focused on developing the application's UI. While every UI element has been the basis of her work since the beginning of the project, the design was made on the basis of the Figma style prepared by Magzhan Zhuzimkhan.

Moreover, Magzhan Zhuzimkhan and Aslanbek Turar were involved in developing and implementing three games based on the project's scope.

The first game is called "Balloon" and is dedicated to pressure ability and works only with the Stylus, an alternative to the pen. The game's concept is to press the Stylus according to the game rules and to pass the obstacles by applying proper pressure (The space between balloons widens as you apply more pressure, and it shrinks as you ease up the pressure).

The second game is called "Cupcake", the purpose of which is to improve children's writing speed. The rule of the game is to draw lines between the cupcakes, starting with the smallest one and then moving to the larger one. The number of points depends on the time

performance to finish the game. It has 3 difficulty levels, the higher the level, the more cupcakes appear are needed to connect.

The last game is “Submarine” which helps children with consistency or static. The child needs to hold the pencil and navigate the submarine properly to pass the obstacles and reach the finish line. In addition, navigation is important to collect the stars, which in turn give points. So the game score depends on two factors, the first one is the time spent on avoiding obstacles and the second is the number of stars collected during the game.

According to the game and progress, records are saved in the respected Database, which our last colleague, Dulat Amirkhanov, implemented. Moreover, user profiles, authorization, and authentication were also developed by him.

Project Execution

The project has encountered several challenges during the last two semesters, mostly related to back-end and front-end development, and integration between them. To overcome these obstacles the required preventive measures and actions were implemented.

During the development phase, a serious issue arose in the back-end part, regarding the functionality of the Docker container. Despite the successful deployment of the container, obtaining a constant and reliable connection to the database proved problematic. To address this issue, the following actions were taken:

1. To detect and prevent any database connection issues, a complete evaluation of the Docker container setup and configuration was performed
2. Various tools have been integrated to monitor and analyze the performance and behavior of the container and database connection. These tools have made it possible to monitor database performance in real-time.

Front-end development has had its own set of challenges, primarily due to the dynamic nature of Swift updates and compatibility issues between different versions of MacOS and iOS. Additionally, ensuring that game development satisfies the target audience of children aged 5-12 has become a major challenge. The following approaches were taken in order to address these issues:

1. To maintain compatibility with the most recent Swift versions, constant updates and optimizations were performed to the Swift code. Different testing procedures were implemented to identify and fix any compatibility problems that arose from Swift updates.
2. A determined effort was made to create games that were intuitive, engaging, and appropriate for children aged 5–12. To improve accessibility and engagement, we used user-friendly interfaces, basic gameplay mechanics, and visually appealing designs.

Differences between the expected and actual results were also caused by integration problems between the front-end and back-end components. In spite of these obstacles, proactive steps were done to fix integration problems and guarantee smooth communication between the two parts.

Evaluation

Three main aspects of the app evaluation are app speed and responsiveness, design elements, and ease of use. After completing the app development, we ran and used it to measure the response and loading times. The app responds quickly to any commands, and the gaming process goes smoothly. In the fall, our team mainly focused on the design development to make it simple, elegant, and robust. It was shown to the advisors multiple times, and based on their feedback, it was modified and crafted.

In addition, one of the significant app criteria is ease of use. From the beginning, we thought of making the app simply understandable and user-friendly since Movable Alipbi is specifically designed for children aged 5-12. As a result, we have an app with easily accessible icons, clear and concise text, intuitive and engaging UI, and interactive games that balance education and entertainment.

Last but not least, the team conducted an evaluation of the project to determine whether it solved handwriting issues the following way. Since the app's targeted audience is 5-12 aged children, we invited 4 kids aged 6-8 to conduct testing of three developed games ("Cupcake", "Submarine", "Balloons"). Every child was asked to play the game and reach the maximum score. After testing the games, they were asked the following questions to receive their feedback on the experience.

Question 1 - What was the easiest game?

Question 2 - What game did you enjoy the most?

Question 3 - Would you prefer to play these games at home?

Based on their answers to the survey questions, it can be noticed that the easiest game appears to be "Cupcake" since it is easily understandable. While the hardest one was "Ballon" due to the difficulty with pressure control and lack of understanding of the instructions to put proper pressure. The answers to the Question 2 varied. Most liked game appears to be "Cupcake" as kids enjoyed its design and had no confusion with its understanding. Collecting the stars while avoiding obstacles was told to be enjoyable, thus "Submarine" is rated as the most liked too. According to Question 3, kids would prefer to sometimes play the games if they had such an opportunity.

Moreover, we asked kids to rate the games based on the level of difficulty from 1 to 10, where 1 is extremely easy and 10 is very difficult. The evaluation levels of kids per each game can be seen in the table below.

	Kid 1	Kid 2	Kid 3	Kid 4
Cupcake	1	1	1	1
Submarine	7	2	1	5
Balloon	5	2	1	1

Table 1. Complexity level of games (range 1-10)

Another part of the evaluation is timing. The team recorded each kid’s time spent to achieve the highest score in every game, the results of which can be seen in Figure 1. According to the figure, it can be seen that the least time-consuming game is “Cupcake”, which took 15 seconds to complete on average, as the game process is easily understandable. The results for the “Ballon” game are varied. Only one child could successfully finish the game in less than 13 seconds, while others did it in around 20 seconds. Whereas the most time-consuming game appears to be “Submarine”. It is worth noting that more time was spent not because of the game’s difficulty level, but rather its own duration to successfully collect all the stars.

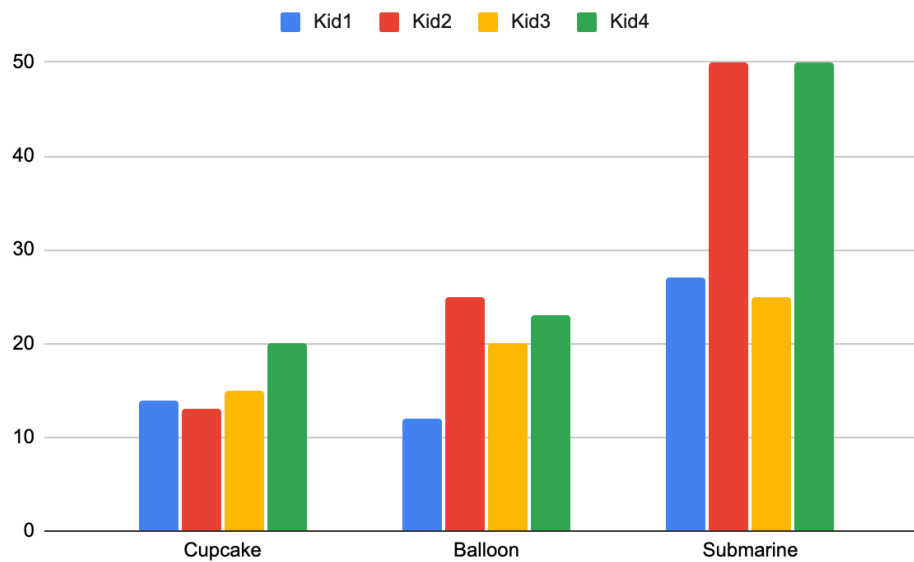


Figure 1. Time Analysis of Game Performance: 3 Games Played by 4 Children

Based on the evaluation conducted among four kids, it can be stated that the easiest game in terms of understanding and performance is “Cupcake”. “Submarine” appears to be the most enjoyable one due to its process and motivation to collect the stars, whereas the “Balloon” game is considered as the hardest since it requires pressure application. Overall, based on the kids’ feedback, it can be concluded that the game is user-friendly and suitable for the targeted audience (kids aged 5-12).

Conclusion and possible future work

Movable Alipbi has demonstrated significant potential in improving children's handwriting skills through its innovative use of technology and user-centered design. The project's success in integrating Stylus's features to improve three aspects of handwriting and personalized learning games presents a transformative approach to educational tools for children with dysgraphia.

Future work that can be done to further expand the product level is considered in the following ways. The app can be extended to other tablet and mobile platforms to reach a broader audience. A new feature that allows for real-time collaboration among peers, teachers, and parents, fostering a supportive learning environment, might be enabled. In addition, the app's scope can be further expanded to another level by including other aspects of learning disabilities, providing a comprehensive educational tool for various learning challenges. These enhancements will ensure that Movable Alipbi continues to evolve and meet the diverse needs of its users, potentially setting a new standard for educational applications in the field of learning disabilities.

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