TANGIGURU: TANGIBLE LEARNING SOLUTION FOR EARLY CHILDHOOD DEVELOPMENT

Project Id: 287

Project Proposal Report

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DECLARATION

We declare that this is our own work, and this proposal does not incorporate without acknowledgement any material previously submitted for a degree or diploma in any other university or institute of higher learning, and to the best of our knowledge and belief, it does not contain any material previously published or written by another person except where the acknowledgement is made in the text.

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The above candidates are carrying out research for the undergraduate Dissertation under my supervision.

Signature of the supervisor Date

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ABSTRACT

Due to various factors, online education has seen rapid expansion in the last few years. The outbreak of Covid-19 is one of the primary causes. In the case of younger students, particularly those ages between 4 and 7, the online platform could not provide them with the information they needed. As a result, they became hooked on smartphones and tablet computers. An interactive tangible learning kit with various activities is proposed for the children to learn things more interactively and improve their thinking ability and creativity while overcoming their addiction to electronic devices. Children can learn with minimal supervision using the proposed learning kit while receiving interactive guidance similar to that provided by on-site teachers. This Tangible Learning Kit will solve most remote teaching activities related to early childhood development. A significant component of our project is creating the UI/UX design for the web application and implementing the creative learning activities for its tangible kit. This section receives a great deal of attention in this paper. Early childhood development milestones and related literature will be used as a guide for these learning activities. Afterwards, the learning activities should be transformed into software applications that can interact with tangibles and console hardware so that children can learn with them. Children in the target age range of 4 to 7 years should be able to easily understand the user interface that is being developed for these learning activity applications. Furthermore, a mobile application will also be developed as a part of this research component to view the analytics of the learning activities of the child.

Keywords - Internet of tangible things, Creative learning, Childhood education, educational applications, Internet of tangible things

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1. INTRODUCTION

1.1.Background and Literature Survey

The rapid growth of technology in the twenty-first century has had a massive impact on children's learning models, methods, and forms. Because they were born and reared in a technologically driven society, today's children are termed digital natives. As a result, several countries have acknowledged the need of incorporating technology into education and have revised primary school curricula for early childhood education. Mobile phones, tablets, and laptops are [1]"gateways" into the digital world, but many of them are not necessarily appropriate for children, particularly young children, because they are often intended by adults and for adults. Thus, the design and development of interactive technologies for children should take into account factors of the child's development that affect their ability to learn and interact with the technology. In general, [1]Tangible User Interfaces may be the best bridge between physical form and digital information since they can blur the distinction. As a result, Tangible User Interfaces are one of the most natural methods for children to interact with technology, particularly technology that facilitates learning. Given that Tangible User Interfaces are a new field of study, the theoretical contributions of this original study are twofold: it provides a critical overview of the current state of research efforts in Tangible User Interfaces application in the learning and teaching process for young children, and it addresses knowledge gaps in the field that warrant further investigation.

Many people have investigated how technology might improve learning as children play. The role that technology can and should play in young children's education has sparked great controversy among scholars. Some argue that technology stifles a child's creativity and even vehemently oppose computers for young children, claiming that technology should be avoided until youngsters are[1] "mature enough." In contrast to these ideas, we truly think, along with numerous others whose work is referenced below, that technology should be utilized to supplement children's learning when appropriate.[1] Despite the contentious nature of the debate, several have successfully stepped into the field of digitally enhanced educational methods for young children. Several researches on the user interface for early childhood education using existing solutions have focused mostly on three aspects.Techniques for teaching children how to conduct learning activities, motivating them to complete tasks, and providing parents with evaluation on their child's development are all presented.

1.1.1.Techniques for teaching children how to conduct learning activities

When it comes to interfaces created particularly for children, we normally see a bright graphic with prominent buttons in front of our eyes. But, as is always the case with children, it is not that straightforward. [2]In reality, the kid need an interface that considers developmental features at each stage as well as the set of abilities that he has at various ages. Furthermore, as we shall see later, the idea of "kid" is a very relative phrase. [2]The amount of time youngsters spend on computers has quadrupled in the last decade. This project is ideal for studying not just studies on the children's interface, but also ideas on the child's complete psychological and

physical development. After all, they will assist us in understanding what the kid interface should be, correctly servicing all requirements and taking into consideration all of the child's potential. Jean Piaget was unquestionably one of the most significant specialists in the area of child psychology; he developed the theory of cognitive development, which defines the psychological developmental features of the child at various ages.For example, Piaget believed that the child learns the world exclusively through the creation and acquisition of individual experience, respectively, our task is to provide the child with such UX, where he can be the author of his story, but not the listener who passively perceives what the screen tells him.

Like the sort of engagement that occurs when a youngster makes his or her own cartoon or game, gaining new information in the process. Children become users at a young age, even before they can read, talk, or recall. It's important to remember that when we speak about particular [2]UX characteristics, we're largely talking about utilizing touch-based applications, since children under the age of 12 typically interact with tablets and smartphones. And it is critical to recognize that a four-year gap in age indicates a completely different set of abilities for a kid; this is not an adult who can be readily [2]classified as belonging to one of the 25–45 age groups. NNGroup advises at least two age groups for children: 3–5 and 6–8.

3–5 years- Even though a child's motor skills are still developing at this age, the primary role of [2]UX is played by large images, instant visual and audio feedback, an understanding of the user's complete lack of patience, the possibility of multiple clicks at the same time, and the inability to distinguish between different types of content, e.g. the ad banner from the game. A youngster can only concentrate on one item at a time, which explains why any navigational hierarchy is impossible.

6–8 years- At this age, most youngsters know how to read, therefore one of the most important abilities in interacting with interfaces has been acquired, although vocabulary is restricted.[2]The major UX goal here is to utilize the child's language while avoiding strange terminology.We can already ask somewhat more sophisticated questions with words, but these words must be intelligible.

Without a parent or a teacher, children need instruction in order to comprehend the learning activities. However, children from 4 to 7 years old are unable to comprehend textual instructions. Since a solution, several existing systems used icons and animations to deliver guidance, as visuals appeal to youngsters more than text-based instruction do.

One of the implemented alternative is shown [3]on the Today's Stories project's Diary Composer software's early user interface design. Because the user interface is designed for very young children (4-8 years old), visual engagement is prioritized above written interaction. The resultant environment is designed to be visually pleasant and appealing to children while also supporting easy, intuitive interaction via the use of appropriate interaction methods, appropriate metaphors to express system operations, and constant visual and audible feedback. In addition, the final system should be tailored to the children's demands, desires, and preferences, fostering self-expression and uniqueness. And also [3] had explained, "Convey available functionality in a highly visual form and do not rely on textual representations, in order for the system to be language independent and usable by younger children who cannot read," because "highly visual

menus and icons appear to be appealing to children and easy for them to understand and use" (Wilson, 1988).

However, some research implemented text-based instruction to teach children. [4]This paper designed and developed Knowledge Journey, a text-based instructions user interface for children. It used multimedia elements in the user interface design to make the appearance appealing to children and used font sizes greater than or equal to 14 pt. This interface is colorful and voice-enabled, with options for searching either through text input.

1.1.2. Motivating children to complete tasks

It is more important to provide learning feedback to children in order to motivate them. In such a situation, children would be more willing to take risks and learn from their mistakes. [5]The need for auditory and visual feedback is discussed in some implemented solutions. This research paper demonstrated that a physical learning environment engages all senses and supports overall child development because the child receives direct feedback from [6]TUIs while completing the task. Younger children (ages 4–6) prefer more intuitive feedback, such as visual cues and meaningful sound.

In [7]research paper described followings.Another factor observed in the feedback given to the interactive toy. When the child fails to complete the activity correctly, the LEDs in the bear's chest turn green, having the e ect of turning on and symbolically representing the bear being annoyed. The children, on the other hand, did not understand the symbolic representation of the incorrect response. As a result, the negative response was omitted in the second interaction with them, leaving only the positive response. They realized that if the LEDs did not light up, it meant that something was wrong. [7]Case study 2 involved auditory therapy with children aged 3–5 years old who had cochlear implants. These children are just starting to learn how to speak. The feedback mechanisms and the type of interaction can vary depending on the user.

[3]And also following facts have been mentioned in this research paper. making of the presentation and interaction appealing to children by making all the components of the user interface (inter)active and by providing feedback to indicate 'successful' interaction steps (Norman, 1988; Cooper, 1995) through animation (Baecker, Small,1990) and audio effects (Mountford, Gaver, 1990) that, on the one hand, facilitate the

comprehension of the concepts, and on the other hand, promote and support exploratory styles of interaction. Create a 'forgiving' environment where there is no 'incorrect' or 'wrong' input and where active support and [3]guidance is offered whenever needed (Cooper's "Don’t make the user look stupid” and “Make errors impossible” design principles (Cooper, 1995)).and also [1]This article discusses the conception and implementation of the Voxar Puzzle, a platform for games in which children can use real objects to interact with a digital puzzle and receive real-time feedback on their interactions.

1.1.3. Providing parents with evaluation on their child's development

This research paper have mentioned the importance of provide a feedback to parents during early childhood development,[8]The importance of early childhood education in people's lives cannot be overstated. When a child reaches the age of two, he or she begins their schooling. It builds the basis upon which the child's learning is built. The primary goal of this research paper is to comprehend the importance and purpose of early childhood education. The early childhood stage is critical, and parents at home and teachers at school must pay close attention to their children. They will be able to provide effective knowledge to them regarding academic concepts, play activities, arts and crafts, health, physical exercises, sports, games, the environment, communication, good manners, and etiquettes when they are able to impart [8]efficient knowledge to them regarding academic concepts, play activities, arts and crafts, health, physical exercises, sports, games, communication, good manners, and etiquettes

1.2. Research Gap

When compared to existing tangible learning solutions, the majority of them are focused on narrow learning domains. such as swiping, tapping and scrolling, or double clicking and paging through the images. Historically, children were unable to learn without external supervision and guidance. Only one of the facts mentioned previously is included. According to the research papers that are studied, the majority of currently available products. The majority of user interfaces are not child-friendly; some are only suitable for users with a very small age gap; and some products lack a feedback mechanism and progress tracking method. The majority of implemented solutions are device-dependent. Parents must assist children in comprehending task instructions. Additionally, there is no feedback for children after they complete tasks, and there are no methods for monitoring the child's progress. TangiGuru can be used to fill in those gaps.

Table 1

Existing researches	Guidance	Evaluation	Analytics
1.A Tangible Approach to Interactive Wearable Creation for Children.	✗	✓	✗
2.Supporting Cultural Learning through a Lukasa-Inspired Tangible Tabletop Museum Exhibit	✓	✗	✗
3.Designing the User Interface of an Interactive Software Environment for Children	✗	✓	✗
4.A comparison of desktop and physical interactive environments	✗	✓	✗
5.Tangible Technologies for Childhood Education	✓	✓	✗
6.Tangible Learning Solution for Early Childhood Development.(TangiGuru)	✓	✓	✓

As illustrated in the table, while numerous studies have been conducted in this domain, none of them have addressed all of the requirements for a complete tangible learning solution with automated guidance, evaluation, and analytics, as we proposed in this research.

1.3. Research Problem

Children in their younger years need guided learning. Because of the Covid epidemic in early 2020, the majority of the world's education has been delivered online. These remote online classes are always virtual and are either unattended or barely monitored. It is hard to have youngsters concentrate on a digital screen for longer lengths of time without them being addicted at such a young age. As a result, such approaches are mostly useless for children in their early infancy. [5]Furthermore, this virtual online education leads to physical and mental health problems, particularly addiction. Students may develop bad posture and visual problems as their screen usage increases. Children are easily distracted by other undesired programs on the electronic devices they use for online education, such as smartphones.[9]

Traditional educational toys address some of the issues stated above, but they depend heavily on human supervision and instruction. Furthermore, such toys have a restricted scope of learning, thus a diverse range of toys is necessary to fulfill all of the essential learning objectives in early childhood education. Because these young children are already living in a technologically dominated world, it is critical that they be properly adapted to technology. As a result, neither conventional educational toys nor smart mobile gadgets meet them.[10]

As previously stated, these are the primary typical issues. To address these issues, we proposed TangiGuru. Our endeavor The primary research question will be how to develop an interactive tangible learning solution for children's early childhood development. To Numerous research questions will arise as a result of concentrating on the primary research problem.

- How to develop an interactive, child-friendly UI/UX which is easily understandable for children?
- How to develop the learning activities suitable for required learning outcomes in early childhood development?

2. OBJECTIVES

2.1.Main Objective

As an alternative to current remote learning solutions and traditional educational toys, we propose an interactive physical learning solution to address the issues that have arisen. There are issues in integrating tangibles with an embedded system. One of our major goals is Development of child-friendly UI/UX and interactive learning activities for early childhood development.

An interesting and entertaining design will be used to create tangibles that will make their learning experience pleasant and exciting. When it comes to learning, it is more probable that youngsters would play a game for children than than looking at a laptop or smartphone and conventional educational toys. As a consequence, it is best to teach this method to young children over the internet rather than in person.

Children may engage in a variety of learning exercises relating to primary mathematical concepts, color identification, similarity recognition, word construction, and many other topics via the use of this tactile learning solution. In order to achieve this result, it is hoped that the child's social, emotional, and physical development would be enhanced by these activities.Because this needs just minimum direction and monitoring, parents or instructors may still keep track of their children's development via the use of the mobile application that is being developed in conjunction with the tangible learning kit.

2.2.Specific Objectives

- The specific objective listed below must be accomplished in order to achieve the overall objective.

2.2.1.Development of the learning activities suitable for required learning outcomes.

This solution is aimed at children aged 4 to 7. While the human brain develops and changes throughout life, the most rapid growth period for brain, critical thinking, creativity, motivation, and environmental skills occurs between the ages of 4 and 7 years. As a result, we proposed activities to supplement them. My contribution to the project is to consider these facts and create activities that can be done with a kit and cubes.

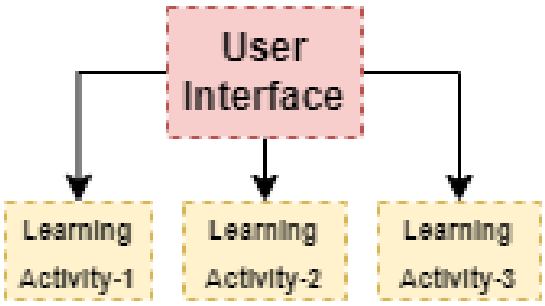

Figure 1 Structure of UI

2.2.2. UI/UX design for the web application.

The next objective is to develop guidelines with user interface which should be understandable and children friendly since that aged child are not familiar with letters and numbers.

2.2.3. Implement the mobile application.

Last objective is to develop a mobile app for parents which has ability to track the progress of children and will provide overall performance of the child.

3. METHODOLOGY

In the project proposal, we have proposed Interactive Tangible Learning Kit for younger ages which can be overcome the problems existing remote learning solutions and traditional educational toys.

This chapter of this project proposal describes how we will be conducting this proposed

project. The project will be conducted as the three major objectives to be assigned among each member of the team to work on. Each of these objectives develops one or more new features or functions to the proposing project. The three major objectives are,

- Developing Tangible Components with Interactive Features.
- Developing Intermediary Platform for Communication among Tangibles and Learning Activities
- Developing Learning Activities aligned with Early Childhood Development Milestones and Related Literature

These objectives will also be the three main procedures we will conduct this project.

3.1. Overview Diagram

The following System diagram shows how the proposed project system works and the main components.

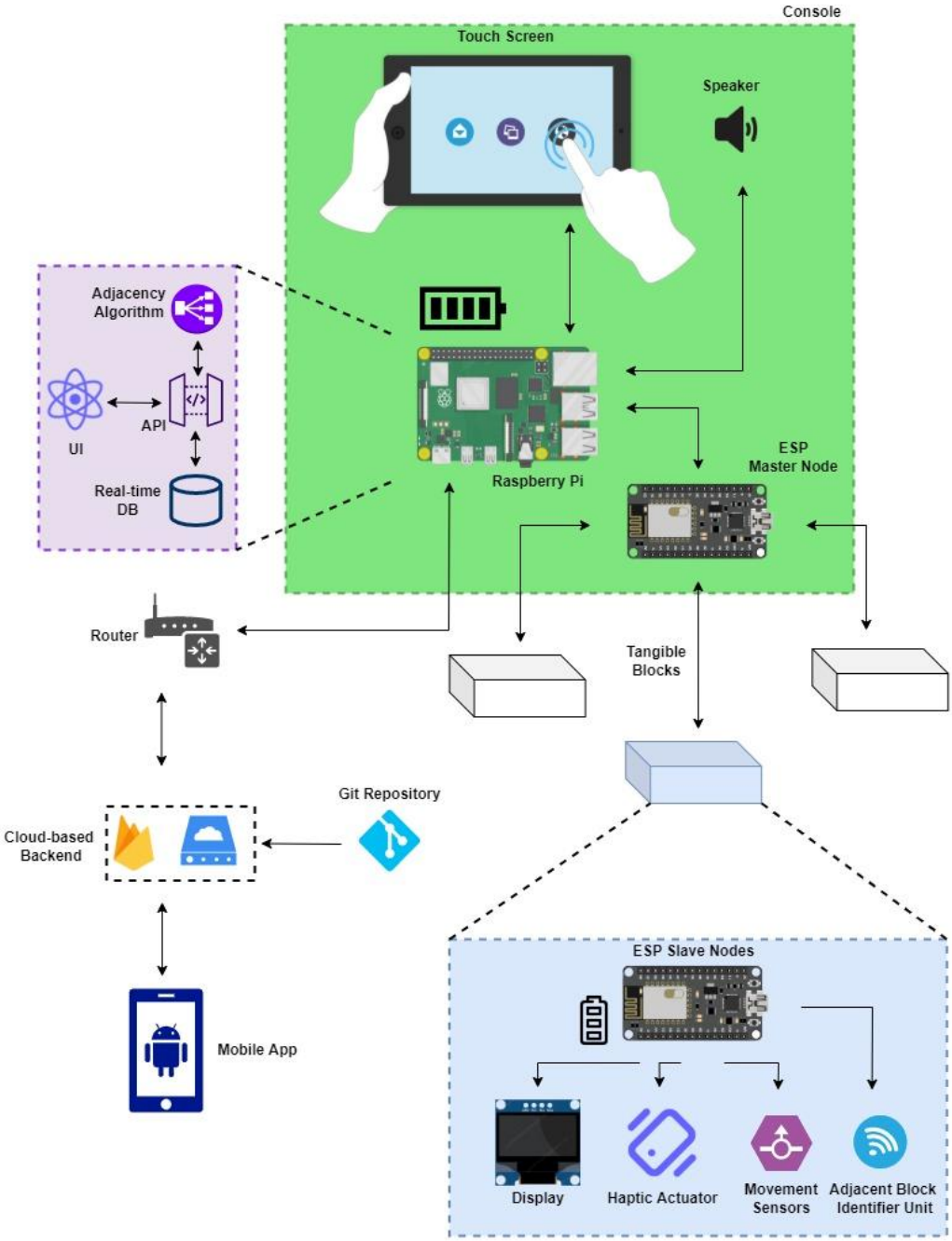

Figure 2 : System Overview diagram

3.2. Developing Learning Activities aligned with Early Childhood Development Milestones and Related Literature

We have planned to implement the interactive, child-friendly UI/UX in this procedure, which is easily understandable for children. And the Creative learning activities suitable for required learning outcomes in early childhood development. And also, Implement the mobile application to view the statistics of the child and control.

After developing the learning activities, the activities should be transformed into software applications that can interactively work with tangibles and console hardware where the child can interactively learn with. Development of these learning activity applications includes developing a child-friendly user interface that should be easily understood by children in the target age range of 4 to 7 years. Furthermore, a mobile application will also be developed as part of this research component to view the analytics of the child's learning activities.

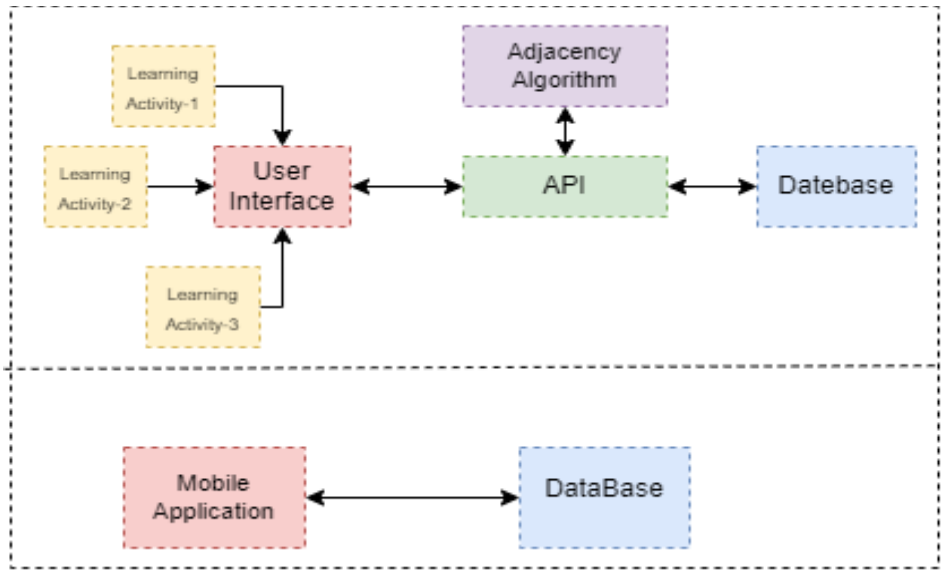

Figure 3 : System Overview diagram 2

3.3.User Interface

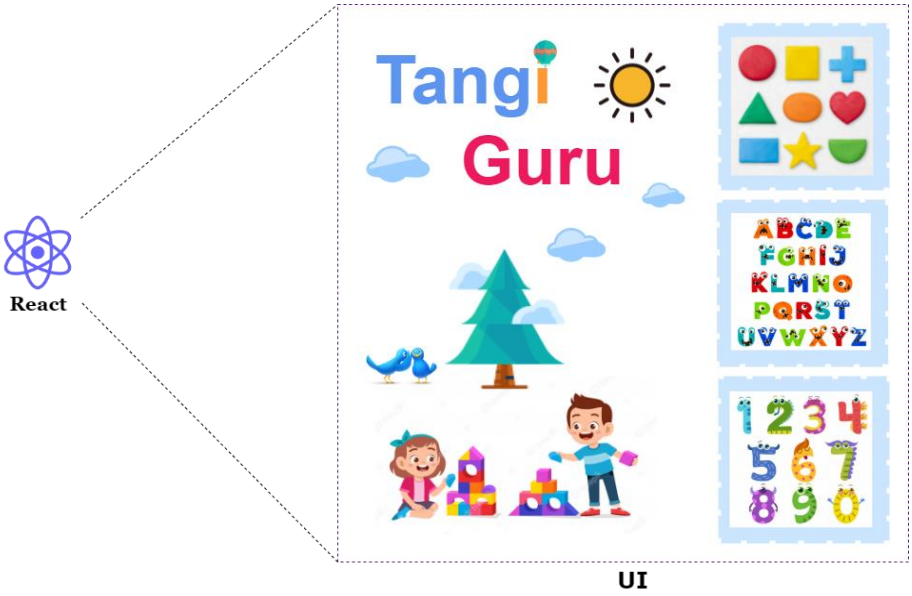

Figure 4 : User Interface

Figure 5 : Color Palette

When we are creating the user interface design specifically for the children, we have to focus on colors ,fonts size ,fonts style and something like a colorful picture with large buttons .specially color scheme is the main visual guide for most of their activities, attracting attention, creating moods and so on. As you can see, we intend to incorporate these color palettes into the user interface.The web application will be developed using React javascript library with use of Bootstrap CSS library.

3.4.Mobile Application

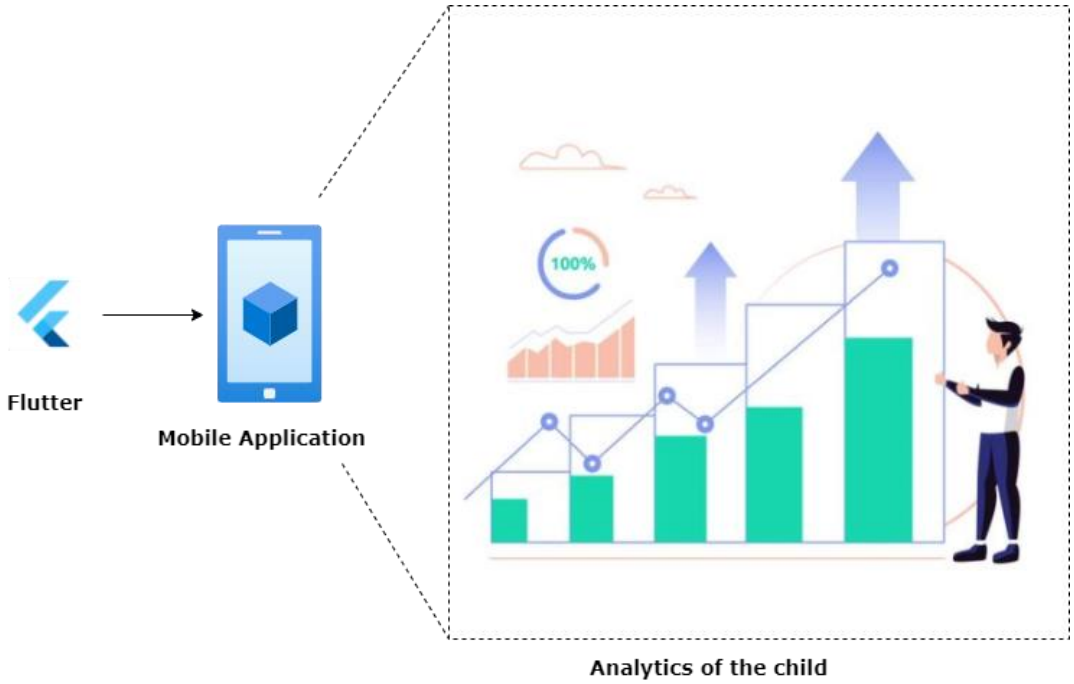

Figure 6 : Mobile Application Structure

I have planned to develop a mobile application for parents which has ability to track the progress of children and will provide overall performance of the child.Flutter will be used to develop the Android application. and Amazon DynamoDB database will be used stored data.

3.5.Learning Activities

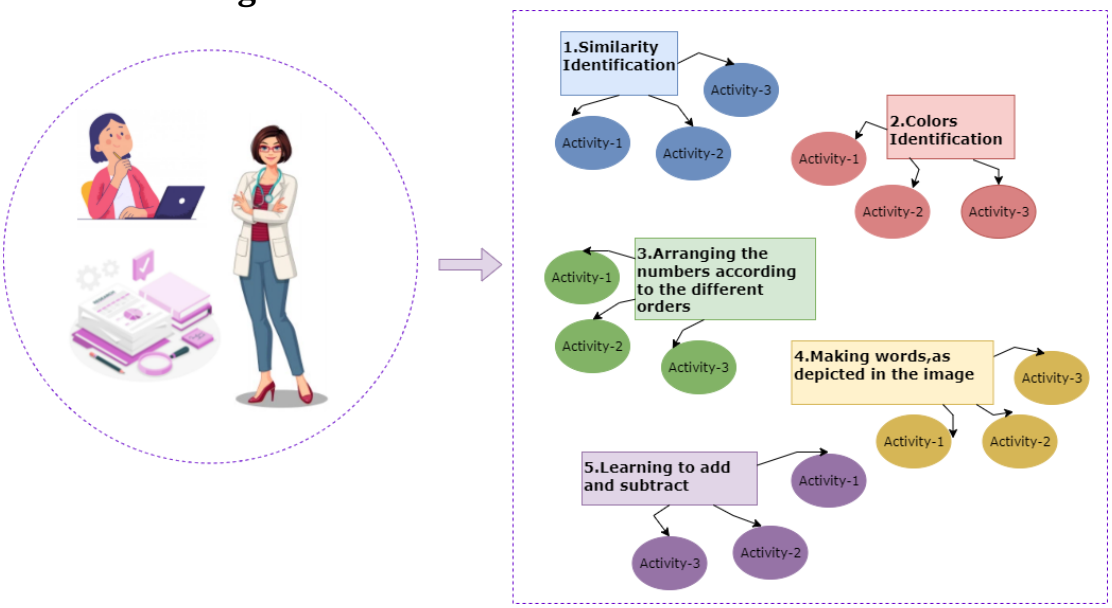

Figure 7 : Functionality Diagram

Under the supervision of a child psychology specialist, learning activities will be developed to address the learning outcomes of cognitive skills such as color identification, similarity identification, word formation, and number arrangement. Javascript will be used to create and implement the designed learning activities on the user interface. Moving on to the structure of my work, it consists of three major components: user interface, learning activities, and analytics.

4. DESCRIPTION OF PERSONNEL AND FACILITIES

Ms. Shashika Lokuliyana is in charge of this research. She works as a Senior Lecturer in Information Security, Computer Systems and Networking, and Computer Systems Engineering. She is currently assigned to the Faculty of Computing's Department of Information Systems Engineering at the Sri Lanka Institute of Information Technology (SLIIT) in Malabe, Sri Lanka.

This project is being co-supervised by Ms. Narmada Gamage. is an Assistant Lecturer at Sri Lanka Institute of Information Technology (SLIIT), Malabe, Sri Lanka, in the Department of Information Systems Engineering, Faculty of Computing.

As the external supervisor, Mr. Rajitha de Silva has joined this project. He is a PhD scholar at the University of Lincoln in Lincolnshire, England,UK

This research will be carried out by the three individuals mentioned below;

1). Manisha Ratnasuriya-: I am in charge of the parallel research component of building an interactive, child-friendly UI/UX that is easily understood by children, as well as related learning activities that are appropriate for required learning outcomes in early childhood development. These include developing the frontend software application, developing learning activities for children that are aligned with early childhood development milestones and related literature, Create a child-friendly UI/UX design for the web application. Implement the mobile application to view and control the child's statistics.

2). Cholitha Hettiarachchi –: He is responsible for the parallel research component of creating physical blocks with specific characteristics. This includes developing the interacting parts of the cubes and communication between blocks and the center console, developing the console casing with the required hardware, developing power management of the blocks and the con. He is in charge of developing a technology to identify adjacent blocks and acting as an intermediary for communication between blocks and applications. This includes creating an incoming API between blocks and application software, as well as implementing a mechanism to identify adjacent blocks. Implement system software for the console, as well as cloud servers to store user data and software updates sole, and develop the outgoing API between blocks and application software.

3). Lakisuru Semasinghe –: He is in charge of developing a technology to identify adjacent blocks and acting as an intermediary for communication between blocks and applications. This includes creating an incoming API between blocks and application software, as well as implementing a mechanism to identify adjacent blocks. Implement system software for the console, as well as cloud servers to store user data and software updates.

5. WORK BREAKDOWN STRUCTURE

It consists of the major elements, which is the user interface learning activities analytics.

And then the next level is to breakdown these parts into details, and the user interface basically consists of the design UI as familiar to kids, design UX as understandable for kids and implement authentication then comes to the learning activities, breaking down the learning actives chapter vice Develop learning activities to match with learning outcomes and Develop guidance for learning activities. And then, the analytics part will be broken down into developing a mobile app, implementing evaluation and analytics collection

, so these are the details of the actually contains of the software.

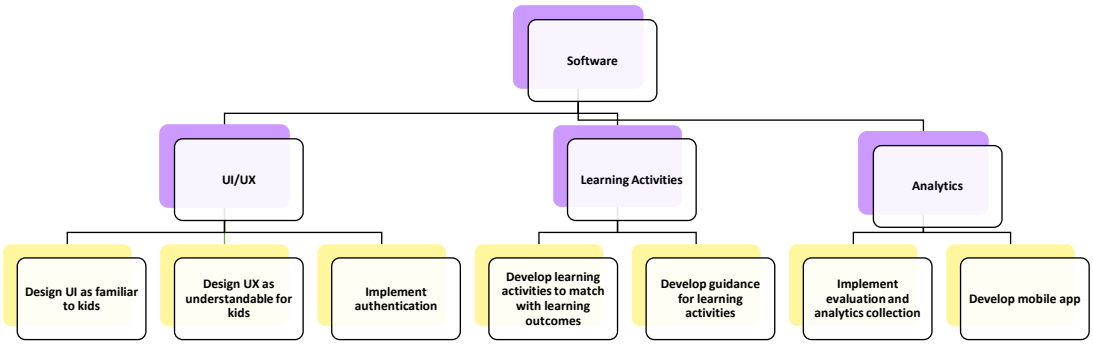

Figure 8 : Work Breakdown Structure

6. GANTT CHART

My Project implementation will be started in late February and is expected to complete by mid-September, while testing will be carried out from mid-August to the end of October. The proposing my component will be completed by December 2022

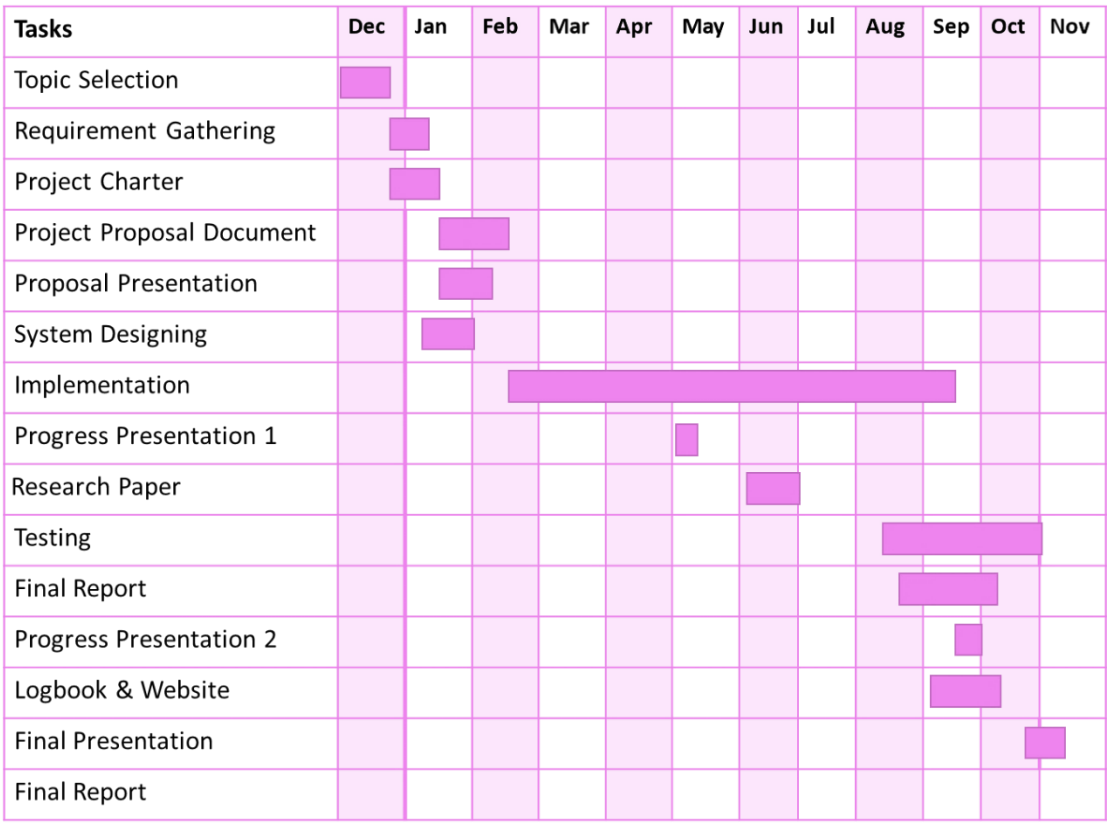

Figure 9 : Gantt Chart

7. BUDGET AND BUDGET JUSTIFICATION

The development of the tangible learning solution would necessitate a large number of electronic components; hence this research proposal is hardware dependent as well. Electronic components will therefore account for an overwhelming majority in this year's spending plan. All the prices listed here are in LKR (local currency). As a result of currency fluctuations, the following amounts may change.

Table 2

Component	**Amount (USD)**	**Amount (LKR)**

Yearly cost		
Domain name	11.00	2100.00
Total	**11.00**	**2100.00**

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