

## Acknowledgement

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## Abstract

Over the past decade, there has been a significant increase in the amount of time children spend using mobile phones. While technology continues to rapidly evolve and become an integral part of daily life, children's phone usage is predominantly devoted to playing games. Although children possess innate creativity and innovation, they are often consumed by the digital content presented to them. Therefore, it is essential to create an appropriate environment that enables children to fully utilize their creative and innovative potential through their favorite activity - playing games.

It has been determined that allowing children's time to be consumed in an unproductive manner will result in a catastrophic decline in our society's evolution as children today are the future of tomorrow [22]. Thus, it is imperative to leverage children's love for gaming and transform it into a medium that enables them to achieve the most.

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## Chapter One: Introduction

### 1 . 1 . Background

In recent years, there has been a significant shift in the way children interact with technology. Today's kids are growing up in an age where they have unprecedented access to information and resources, and they are able to use technology in ways that previous generations could only have dreamed of. Kids now start using the internet at a very young age for a range of tasks like playing games, watching movies, looking up information, sharing it with friends, and so on [1].

One of the most significant changes that technology has brought about is the way in which children learn. In the past, learning was primarily done in a classroom setting, with a teacher providing instruction and guidance. However, with the advent of mobile devices and the internet, children are now able to learn in a much more personalized and flexible way. They can access educational resources from anywhere, at any time, and at their own pace. This has opened up a whole new world of learning possibilities for children.

Gaming has emerged as one of the most popular ways for children to learn. Games are designed to be engaging and fun, and they often require players to use problem-solving skills, critical thinking, and creativity. This makes them an ideal learning environment for children. Games also have a powerful driving force that motivates players to compete and win, even if it means repeatedly playing the same game. This is why gaming has become such an integral part of every child's life.

In light of these trends, our aim is to create a mobile educational application that can help children learn in a fun and engaging way. We want to create an app that is easy to use, accessible from anywhere, and filled with resources that can be used at the child's own pace. Our app will be designed to be interactive and engaging, with features that encourage children to explore and learn.

We believe that our app will be a valuable resource for parents and educators who are looking for new and innovative ways to help children learn. By combining the power of technology with the fun and engaging world of gaming, we hope to create an app that will inspire children to learn and grow.

### 1 . 2 . Problem Statements

There are two issues with mobile learning for kids. First, there aren't many educational apps designed specifically for them. This means they don't have access to apps that meet their needs and interests. Second, some educational apps from other countries don't have reward systems. Rewards motivate kids to use the app and complete tasks, so this can make mobile learning less effective.

## 1 . 3 . Project Objectives

Our main goal is to create the first mobile educational software for children in the Arab world. We believe that this app will provide children with a fun and engaging way to develop their cognitive, innovative, and creative skills.

To achieve this objective, we will be designing an app that is both simple and enjoyable for children to use. Our app will feature intuitive controls, engaging graphics, and interactive content that will keep children motivated and excited about learning. By making learning fun and enjoyable, we hope to inspire children to explore new ideas, develop their creativity, and build their problem-solving skills.

## 1 . 4 . Project Scope

Our educational application is primarily designed for children between the ages of 5 and 12, as well as their parents. However, we believe that the scope of our app is not limited to just these users. In fact, anyone who is interested in learning and developing their cognitive, innovative, and creative skills can benefit from our app.

## 1 . 5 . Project Limitation

The time frame for this study was constrained because it began in October 2022 and ended in July 2023.

### 1.5.1 Minimum device requirement

- **Platform:** Android 4.1 or above.
- **Memory:** 4GB RAM
- **Storage:** 200MB Available

### 1.5.2 Database

In order to make our mobile educational application as accessible as possible, we have decided to use a cloud-based database. This will allow us to store all of our educational content in one central location, which can be accessed from anywhere with an internet connection.

Another benefit of using a cloud-based database is that it will increase the ease of access for users. Because the app will be connected to the cloud, users will be able to access their educational content from any device with an internet connection. This means that children can continue their learning even when they are away from their primary device.

## Chapter Two: Literature review

### 2 . 1 . Problem Description

Smart mobile device usage is increasing rapidly among young children due to the novel characteristics of these devices and the rapid development of apps targeting these age groups.

Many researchers have pointed out that mobile devices are the preferred learning technological tool for young children, due to the advantages of this technology relative to other older ways of learning, these include a user-friendly touchable interface and interactive displays that stimulate multiple sensory systems and provide instant responses to input [4].

Unlike traditional learning ways such as school which demand fine skills and self-study to get the most benefit, which often proves difficult for young children.

We found that the most effective way to learn a child is by gaming because gaming lets children practice what they know, and also what they don't. It allows them to experiment through trial and error, find solutions to problems, work out the best strategies, and build new confidence and skills, specific games will be designed for each age range [5].

This chapter will give a brief on our project and show the games that we choose and the categories we'll be including in the app. It will also go through the rationale behind our choice of this teaching strategy.

### 2 . 2 . Data Gathering

Our objective is to gather information to better understand your preferences and requirements for a game-based learning application for kids. We want to ensure that the application provides an engaging and effective learning experience so we interviewed some parents and their children to help us understand more about what we exactly must do to benefit the children.

We asked them a bunch of questions to narrow the answers and be more specific questions like;

- What subjects or topics do you believe are important for children to learn through games?
- Do you prefer a structured learning approach with clear objectives or a more open-ended, exploratory experience?
- What kind of devices do you envision children using to access the application (e.g., smartphones, tablets, computers)?
- What specific learning goals or skills would you like the application to address?
- What types of games do you think would be most effective for children's learning?
- Are there any specific game mechanics or features that you believe would be engaging and promote learning?
- How important is it for the games to provide feedback and progress tracking for children and parents?

After gathering the information from the data gathering session, the next steps will be analyzing and synthesizing the collected data to identify common themes, patterns, and preferences expressed by the participants. This analysis will help in shaping the development and design of the game-based learning application for kids.

## 2 . 3 . Literature Review

### 2.2.1. Benefits of children education

Firstly, before we start this chapter, we have to know why education for children is one of the rights that every child should have, and how we are obliged to upgrade the educational process all over the time to fit the new children's minds and also make the educational process it keeps up with the now times.

A good education process for children brings their self-esteem, better career prospects, improved health, and a better understanding of the surrounding world and the people that live in it, it's a significant resource to end the cycle of poverty and to bring brilliant minds to light in order to change and develop people's livelihood in this world in which we live [6].

Receiving education through the traditional method has become a thing of the past nowadays. All countries put children's education as the priority for them because they know the importance of having a future generation aware and aware of the development in which we live [7], so they are now competing to develop the method of education and make it easier, better, and more developed.

So, we must adapt to this new era and participate in it and make our own mark.

### 2.2.2. The mobile educational apps

Learning in its wider perspective could be seen as a continuous process of enriching human knowledge, of which focus has now completely shifted to eLearning. Due to mobile phones and the various feature-oriented applications, students can learn at their pace and take their time at understanding things, as everything is just a click away " Thus, in these modern times, students are more inclined to use a mobile phone, or smartphone as it is more widely known, for all purposes. Furthermore, a student may access any piece of knowledge from anywhere in the world, putting the world at their fingertips. This lessens the likelihood of going to a library and looking up the information because a mobile phone may be used for a variety of similar tasks. However, "mobile apps" are what make the information readily available. As a result, each mobile app has a special feature that provides a certain set of services. " [8].

mobile learning is the fastest-evolving learning technology and has ample opportunities in the global learning technology industry. If the app is designed very well [9], it will definitely fulfill the purpose of learning and discovery.

In accordance with this context, we have aimed to design an educational app named Bubble. The proposed app aims at teaching and self-learning for children in preschool and in school, even any child who does not even have any previous knowledge.

### **2.2.3. The important role of using mobile apps in education**

mobile applications have gradually brought about some crucial changes in the education industry, as most individual educators are getting in touch with the app stores, to get mobile apps for imparting knowledge, and this is because the educational apps offer a lot of benefits.

Thus, mobile apps have progressively become the most interactive and constructive way to attract students to study and enhance their productivity.

Therefore, some of the key benefits of adopting mobile educational apps include the following:

**Interactive learning:** Gone are the days, when the only option for the students to read books, was by visiting the library (the traditional setting). On the other hand, the innovative gadgets of today make it easy for students to practice their lessons in an effective and interactive way. These become readily possible through the use of apps on mobile gadgets and are available for all types of skill levels and aid learning using various teaching methods, such as video tutorials, and even educational games [9].

These apps ensure interactive and effective learning, by transforming boring lessons and helping the students to visualize each and everything.

**Availability:** Unlike schools, mobile apps are available round the clock. Therefore, learning via apps is not time-bound learning; rather it is relaxed learning. Consequently, time-bound learning is not much effective, as children get distracted very easily and are not able to concentrate continuously for a long time.

Thus, educational apps work the best regarding this issue, as they are always available, and the students can study at their convenience [9].

**Portability:** Mobile devices could be said to be an important part of our everyday lives since they enable us to access a large variety of ubiquitous services, a reason why most persons will not leave their mobile phones at home while going somewhere [9].

Thus, using apps have become a part of the daily routine, whether one is watching a video on the way to work or playing games at lunch, one's phone is always with him/her. Therefore, the apps can be the constant companions for the students, that is, with the help of educational apps, learning will not be confined to the classroom alone, as the apps allow pupils to take their learning into their own hands and they can study and test themselves at any point in the day.

### **2.2.4. Design and its effects on the mobile educational apps**

There are many people living in our country. Most individuals in today's economic and technical progress own cellphones. In my nation, smartphone development has increased

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since around 2010. With the help of 3G and 4G networks, there are more than 900 million smartphone users worldwide, and the penetration rate of the Internet is close to 70%. About 99% of these 900 million netizens use their mobile phones to access the internet, which essentially means that every household in our nation owns a smartphone. As a result, there are always more smartphone applications available, with education apps serving as an example. The key issue at hand right now is how to satisfy entirely various sorts of netizens through interface design what we called in (UI/UX) [10].

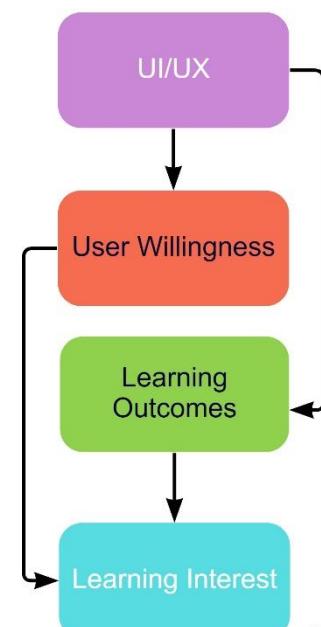
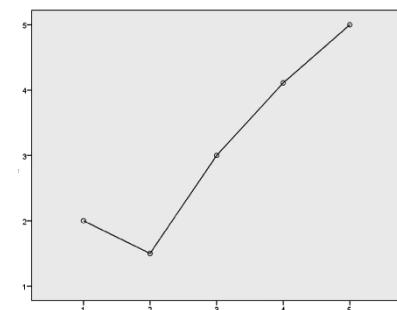
Designing for UI and UX is closely tied to the academic field of Human-Computer Interaction (HCI). For HCI research, practice, and teaching, user interface design is essential. Don Norman initially coined the phrase "user experience" (UX) [14], which aims to address the human experience from an emotional, affective, experiential, hedonic, and artistic perspective. The UX research and design processes respond, focusing on well-established work environments in the public and private spheres and elevating the user's element of emotion and experience. Based on this, the designers can cope with a complex, networked world of information and computer-mediated interactions and grasp the dynamics of socio-behavioral settings of HCI [13].

Interfaces (UI/UX) are the means through which consumers and digital products communicate. The layer of the UX that is visible is referred to as the UI. The user is encouraged to "share" her personal information with the service provider through the UI. The most important factors when discussing user interface and privacy are clearly telling users about the kind and volume of data that is gathered when they use the service [11].

The user requirements for educational APPs are more complex, and the APP interface must enable users to feel the exquisite product experience in terms of vision; otherwise, users won't have a favorable initial impression of the APP. The user's desire for engagement is quite strong in addition to their visual requirements. Users prefer to actively participate in learning and do not want to passively consume app content. User experience and emotional needs can only be met in this way [10].

Due to the relative range of educational aims and the dispersed nature of user wants, the education APP interface must be explicit about both its product goals and user needs. The effectiveness of educational APP products can only be ascertained when they are used by younger, older, mature, and adult populations. The user's demands are obviously to increase their professional level or learn material for fundamental education [10].

The design goals define which features are necessary for the interface interaction design of educational APPs. The interface interaction design components must incorporate video



material if the APP is built around the teaching style of live and recorded viewpoint. [10] The APP, however, is primarily built around a question bank, therefore the interface interaction design components should concentrate on the exercises and aid users in improving their learning outcomes through interactive design features like the in-depth justifications of incorrect questions.

As seen by the graph, more study reveals a general positive correlation between "User experience" and "User Willingness."

user experience : significantly influences whether a user is likely to use a product again, and this influence is favorably connected with learning outcomes.

User willingness : is significantly impacted by user-friendliness and entertainment, the User experience is greatly influenced by the way that content is presented, the interaction manner, and the design of the interface.

learning Outcomes : these are strongly influenced by user experience and user willingness, and user experience enhancement can also lead to greater user willingness.

We can easily understand how numerous aspects interact when we organize their connection into a map.

Research has shown that there is a strong positive correlation between user experience and user willingness. As seen in the graph, user experience significantly influences whether a user is likely to use a product again, and this influence is favorably connected with learning outcomes. User willingness, on the other hand, is significantly impacted by user-friendliness and entertainment.

In the context of educational applications, the user experience is greatly influenced by the way that content is presented, the interaction manner, and the design of the interface. Therefore, learning outcomes are strongly influenced by user experience and user willingness, and enhancing user experience can also lead to greater user willingness. Learning interest, in turn, is a result of all these previous factors.

When these aspects are organized into a map, it becomes clear how they interact. According to research, the user experience design of HCI craft education applications has a strong emphasis on appearance and interaction, in contrast to other types of apps. The aesthetics of color and graphics, which are frequently valued in other apps, are not as significant in educational applications. Instead, the major strategies to stimulate user interest in using educational applications again include designs that are fun and helpful to the user.

Improving the user experience can also increase the desire of users to use craft education applications again. Enhancements in these areas can be employed in practical design to raise learning effectiveness and interest. Therefore, it is important to consider both user experience and user willingness when designing educational applications, as they strongly impact learning outcomes and interest.

So we now have to choose the tool that we will use in designing our app UI, there are two options for the tools Sketch and Figma and in this part, we will simply compare them to make sure that we make the right choice.

Differences	Figma 	Sketch 
<b>Compatibility</b>	Web-browser	macOS operating system
<b>Pricing</b>	Free version, professional version and organisation version	One-time payment or pay per editor on Sketch Teams
<b>Styles</b>	Create styles for various elements, which can be mixed and matched with other sets of elements.	Has two types of styles: text or layer. the elements are established for each style.
<b>Symbols &amp; Components</b>	The components are streamlined; when the master one is edited, then every instance also updates.	Any modifications made in the Symbols Page automatically applies to every occurrence of that symbol.
<b>Vector Tools</b>	In Figma Vector Networks, the designer can work in different directions without having to split a path object.	When using Sketch's vector tool, designers need to combine and string points together.
<b>Plugins</b>	Introduced first plugins in 2019. Incentives developers to create more plugins.	Offers more 3rd-party plugins
<b>Prototyping</b>	Built-in integration with Principle; supports overlays when linking objects to other artboards.	Sketch supports almost every advanced prototyping app.
<b>Collaboration</b>	Cloud-based, it supports multiple designers to work and edit a document simultaneously.	Introduction of Sketch for Teams in July 2020.

Finally, we choose the Figma tool to use in designing the UI of our app due to the tool's benefits.

## 2.2.5. Advantages of the games

A special type of computer software that is both entertaining and instructive is called educational games. In addition to efficiently promoting student learning and problem-solving skills development [32], it may deftly blend knowledge with games, create authentic problem situations for learners, and drive learning motivation [5].

Several advantages of educational games that led us to pick this way of learning include:

- Increases A Child's Memory Capacity:  
Memory, one of the main cognitive functions, and Games often revolve around the utilization of memorization, children have to remember some aspects of the game in order to solve it [34].

- Helps With Fast Strategic Thinking & Problem-Solving:

Most games require children to think quickly [31]. Moreover, they must utilize their logic in order to think a couple of steps ahead in order to solve problems and complete levels. This is great because it is something that helps children later in life as they develop their logical thinking, their accuracy, and their ability to think with confidence and outside of the box.

- Skill-Building:

A lot of games contain new skills that the children didn't know before [33]. For example, learn the concepts of programming, and how to make software like games, Also learn the concepts of electric circuits.

According to this article [30], there is a serious game app called "Global Adventure" which is designed to promote children's knowledge, skills, attitudes and values of global competence in the game. The game has the best effect on the improvement of the skills of the child which achieves three-level skills development of perception, conformation, and production.

Overall games develop and improve children's global competence during the learning process [30], Therefore, it seems that the effectiveness of learning through games [29].

### **2.2.6. Using a reward system**

Rewarding is one of the factors that influence student learning outcomes, so it is crucial to have it, it's tough to create an effective and efficient learning environment for young learners, they feel bored so quickly and get distracted all the time easily. At this young age, most of those children just want to play physical or digital games they are not interested in getting knowledge in a direct way or in the traditional way of studying so, it is essential to make

the students feel comfortable and enjoy learning [15] by using a reward system to maximize the understanding for the learning content [17][18].

According to [16], in this article, A group of teachers did an experiment on some of their students about giving rewards to the students and determining the effectiveness of it in the quality of learning, they concluded at the end of the experiment that it is important that we as educators should continuously give rewards to the students due to the positive effect on student's learning capacity, the rewards can make the students study harder or it can make the students feel more excited during their studying session, its encouraging students and motivating them, also they observed that not all students were interested in the verbal rewards given they prefer to get a physical reward.

The research methods section in this article [17] contains a straightforward architecture that illustrates and discusses the general structure of the game reward model.

- Red box: the child begins to engage in play and begins to make crucial decisions, which will indicate that this child will pass this stage of play or not.
- Green box: This stage begins implicitly as soon as the child begins to play the game and continues till the game ends So, so the child gets the educational content indirectly.
- Yellow box: after the child finishes the game, he/she will get a reward as a motivation to make continuously play more games in the mobile app and gets more educational content.
- Dashed line: This is the application's default loop.



So, it is now very clear that the traditional way of teaching children is not a very good way to get them to want knowledge but that could be mitigated by changing the teaching environment to a game oriented environment but that also could lead to boredom and loss of interest so, it is we set a key objective in this project [17] to have a reward system in the educational app to get the best benefit of the process of learning.

### **2.2.7. suitable educational content for children**

Adaptive learning according to the ages of the children users who use the educational apps is a crucial step that we have to take care of it to build an effective mobile educational app [19] so, in this part we will explain why we have to use the adaptive learning method and how we will use it in our software.

It will not be fair if you provide the same educational content to all children of all ages. You do not know the mental and cognitive capacity for each generation, they face different and difficult challenges in relation to their ages in order to understand the given educational content [20]. Therefore, we must separate the content that is offered to children of young age and children who are older than them. Trying to provide the best educational content suitable for all ages

The adaptation engine acquires input data and produces the adaptation results. Input data into the adaptation engine is the learner's age. Output results of the adaptation engine are the adapted mobile educational content that suitable for this age [21]. There are several approaches in the field of mobile content adaptation for implementing adaptation engines, which include:

- 1) Adaptation rules, that is, when the child-types of his age ,content adaptation is derived from conditional structures of if/then/else statements, which are based on previous studies.

- 2) Adaptation algorithms, that is, when the child-types of his age, content adaptation is derived from different types of algorithms such as heuristic algorithms, similarity algorithms, and decision-based algorithms.

### 2.2.8. Chosen Framework

choosing the right framework for software creation is one of the most important steps toward making good software due to the importance of the frameworks, it controls the application reliability and programming and testing efforts [23]. So, it will be important to choose the right framework wisely.

Every framework has its advantages and disadvantages, but there are still some core topics that we consider when we choose the framework for our software.

The following three factors were taken into account when selecting the framework for our software project:

- **Documentation:** Essential point as a good documentation means a better explanation on how everything works inside the framework and that will lead to a better implementation and use of the framework functionality.
- **Security:** Effective and reliable framework security is very important to any software because it protects the user's personal data and prevents it from being stolen [24].
- **Community Support:** the framework must have an active community of support. This is important to find a solution if we have any problems while implementing the software or we couldn't find it in the documentation[26].

The Educational Game Design Framework is focused on producing games that combine three main factors: game design, pedagogy and learning content and modeling, Here is a list of the frameworks that we will choose from [38].

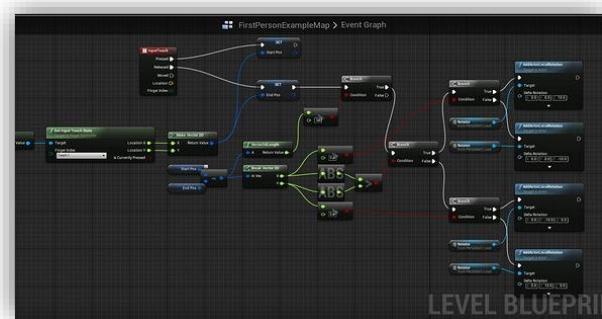
#### 1. Unity

It prides itself being a cross-platform game engine supported on Android, iOS and Linux. You can develop in a language of your choice consisting of C#, Boo or JS. It allows you to build game styles of 2D,3D, virtual reality and augmented reality. It's flexible and well documented. Unity is a popular development platform and has an excellent support service offering many tutorials and guides, also there is a free version [36].



## 2. Unreal Engine

Is a framework which requires no additional plug-ins. Unreal contains pre-built modular systems and customizable plug-ins. Its code is written in C++ and runs on over ten platforms. Similarly, it allows you to create virtual and augmented reality-style games [37].



## 3. libGDX

It is a free, open-source, cross-platform framework. Licensed under Apache 2 you can build 2D or 3D games using Java as well as using some C++ and C components. It allows you to create games using the same code base for Linux, macOS, Windows, HTML5, Android, iOS and Blackberry. Therefore as a developer, you can write, test and debug your application. There is ever-growing community support with many tutorials provided by them and third parties.



## 4. GODOT

An open-sourced and free cross-platform framework operating under the MIT license. GODOT allows for the construction of 2D and 3D games. Its games are built-in the C# or C++ language made for mobile, PC and web platforms. Similarly, it also has its own language if you choose to use GDScript. Currently, the platforms it supports are HTML5, iOS, macOS, Android, Windows, Blackberry 10 and many others. Alongside the code, GODOT features an animation system which has a range of original features [35].



Now our final choice fell on the duo Unity and Unreal Engine and now we will make a more accurate comparison for the final selection.

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	<b>Unity</b>	<b>Unreal</b>
<b>Graphics</b>	Physically-Based Rendering, Global Illumination, Volumetric lights after a plugin installed, Post Processing	Physically-Based Rendering, Global Illumination, Volumetric lights out of the box, Post Processing, Material Editor
<b>Unique Features</b>	Rich 2D support	AI, Network Support
<b>Target Audience</b>	Mostly indies, coders	AAA-game studios, indies, artists
<b>Coding</b>	C#, Prefab, Bolt	C++, Blueprints
<b>Community</b>	More than 200k members on the official subreddit	About 100k members on the official subreddit
<b>Performance</b>	Does not scale well, unlike Unreal Engine	Has support for distributed execution ( <a href="#">Incredibuild</a> )



1. Great for building simple mobile apps including AR/VR apps

2. Simpler and faster coding with c#

3. Impressive asset store

4. Polishing graphics take more time and work



1. Achieve the highest quality of graphics

2. Lightening the fast processing

3. All users group have access to the source code

4. Complex for small game

Finally, We chose Unity framework to implement our software project because of its huge benefits as:

- Easy to learn
- The engine is actively developing and getting more and more features each release.
- Huge range of supported platforms
- One of the biggest communities
- A lot of ready-to-use solutions and assets.

Also using the same code to many platforms, it reduces the cost and complexity of the app production while accelerating app development.

## 2.2.9. Previous work

In this section we will discuss past software's that are have a similarity with our software project.

### 1) prodigy

prodigy game is educational website for children containing various type of games like Mathematics and Language for kids, and they will described as follow:



- **Prodigy Math**  
is the engaging math platform It's curriculum-aligned, offering content from every major math topic from age 6 to 14 years, it contains some math battles and quizzes.
- **Prodigy Language**  
This learning program is focus on learning the kids the words and letters of a chosen language in simple and visually pleasing way.

**Some of the advantages of the prodigy website are as follows:**

- 1) Teacher's progress track  
Prodigy also provides multiple user accounts that are accessible to schools, teachers, and parents. Some of the key features for teachers include creating personalized assignments and Real-time tracking to identify each student's daily progress.
- 2) Games Variety  
Prodigy offers a variety of customized games that suit all children of all tastes.

**Some leading nonprofit organizations committed to helping children thrive describe some of the disadvantages of the prodigy website as follows:**

1) Selling memberships to kids.

Prodigy's push to sell Premium memberships is relentless and aimed at kids. In just 19 minutes of "studying," we saw 16 ads for membership and only 4 math problems. Ads take the form of videos and news feeds that showcase what Premium members can do those players without a membership cannot.

Premium memberships do not provide kids with access to a better learning tool. Instead, these memberships provide kids with bragging rights and digital goodies like cool hats and cute pets.

2) Distracts more than it teaches.

Too much onslaught of ads, and many of the in-game distractions are emotionally manipulative. Offers to rescue creatures, try new styles, chat with strangers, or try out new dance moves are hard for kids to resist. They focus on making the kid go shopping and character customization.

3) Teaches kids to be consumers, not learners.

Most of a child's attention is drawn not to the educational game but to their character's customization. In time considered independent learning, kids are buying and earning new accessories for their wizards and performing dance moves completely unrelated to the game's plot. Children spend the most time in the outdoor section there, children can spin wheels to get more stuff and there are shops constantly available throughout the game—a known real-world sales tactic.

## 2) ABCya

ABCya.com is a website that provides educational games and activities for school-aged children. The games on the website are organized into grade levels from pre-school to mid-school, as well as into subject categories such as letters, numbers, and holidays. Many of the games meet standards associated with the Common Core State Standards Initiative.



**Some of the advantages of the ABCya website are as follows:**

3) Hints System

how the games allow students to make mistakes and keep trying until they get the correct answer.

4) Reward System

games have incentives to get a certain amount of questions correct, which enables students to unlock certain features of the game.

Some leading nonprofit organizations committed to helping children thrive describe some of the disadvantages of the ABCya website as follows:

- 1) There's no progress tracking or learning support  
There's no support for kids who don't know what game to choose or how to get through a difficult game.
- 2) continuous dispersion  
If you don't pay the premium price for the ad-free version you will get bored of so many ads, it's even pretty easy for kids to click on the ads by mistake thinking they're clicking into a game. Each game has one or two banner ads.
- 3) Lack of the Arabic content  
This educational site does not provide support for educational content in the Arabic language for children. It is only available in the English language, which will lead to difficulty in learning for children in the Arab world

### 3) Scratch

Scratch is a programming language recommended for kids over the age of 8 that was created by the MIT Media Lab. For younger children, there is even an alternative version of Scratch. It's called ScratchJr and it can be used by kids aged 5-7 as it's even simpler and more intuitive.

**Some of the advantages of the Scratch website are as follows:**



- 1) Scratch allows students to develop 21st century skills through the use of technology.
- 2) Scratch can be used by people of all ages including students from elementary- high school ages, and adults in a variety of settings.
- 3) A major advantage of scratch is that it is a free program so people can access and utilize scratch for both personal and academic use.

Some leading nonprofit organizations committed to helping children thrive describe some of the disadvantages of the Scratch website as follows:

- 1) User lack of training when using scratch. This could be on behalf of the teacher and student.
- 2) Teachers cannot monitor what students are creating in scratch. Inappropriate material may be used by the student that the teacher would have no knowledge of until they view the final scratch project.
- 3) Students under the age of 13 will need to use the email address of their parent or guardian, some student's parent do not have email addresses which could be a barrier to when using scratch.

## 4) Childsplay

Childsplay is a collection of educational activities that are designed for young children. These activities can be used at home, in kindergartens, and in pre-schools. Childsplay provides a fun and safe way for young children to use the computer, while also teaching them important skills like math, letters of the alphabet, spelling, and eye-hand coordination.



The activities in Childsplay are designed to be engaging and interactive, with colorful graphics and intuitive controls that are easy for young children to use. By providing a fun and educational platform for young children to learn and explore, Childsplay can help to promote early childhood development and set children on a path towards lifelong learning

**Some of the advantages of the Childsplay software are as follows :**

- 1) memory activities that are fun to play and at the same time learn sounds, images, letters, and numbers.
- 2) train the child to use the mouse and keyboard in early age so he gets comfy using them in the future and help him type faster.
- 3) multilingual support to make it easy for any child to use it around the world and learn new languages if he wants
- 4) runs on Windows, MacOS, and Linux. So it's usable for every computer and the parent does not need to download a special operating system

**Some leading nonprofit organizations committed to helping children thrive describe some of the disadvantages of the childplay software as follows:**

- 1) The biggest problem is that the childplay software contain a non-educational games which can lead the kid to play these games more than the educational ones and obtain zero benefit from the games and get addicted to non-educational games they made these games so the kid can have some fun while using the app but it mislead the education way of the software
- 2) The interface is hard to use does not contain any words or even hints to use the app it only made of icons and not a good one either.

## 5) Gcompris

GCompris is an e-learning tool that provides training exercises for children both inside and outside the classroom. It is a free and open-source software that can be used on multiple platforms. GCompris offers a wide variety of activities for children aged 2 to 10, covering more than 100 pedagogical domains.

GCompris has been available for over twenty years and has become a popular educational resource for schools worldwide. Its activities are designed to be engaging and fun, while also promoting important skills like reading, writing, math, and problem-solving. With a focus on early childhood development, GCompris offers a valuable resource for parents, teachers, and educators who are looking for innovative ways to promote learning and growth in young children.



### Some of the advantages of the Gcompris software are as follows:

- 1- Currently GCompris offers more than 100 activities which make it's learning flexible and contain many information for the kids to learn
- 2- does not require an Internet connection, does not collect any data, and so strictly complies with the EU's General Data Protection Regulation which make your personal information secured and free of ads
- 3- grading functionality allows you to propose training exercises to pupils to practice mathematics, language, science and humanities.
- 4- Every game contain a manual to help the kid and the user to use the software

### Some leading nonprofit organizations committed to helping children thrive describe some of the disadvantages of the Gcompris software as follows:

- 1) GCompris currently does not support iOS which made it a problem because now days many people use IOS operating systems in their homes and they can not use the software
- 2) No ability to separate users / groups: As result you cannot set two different activity for your children which make it annoying for the kids

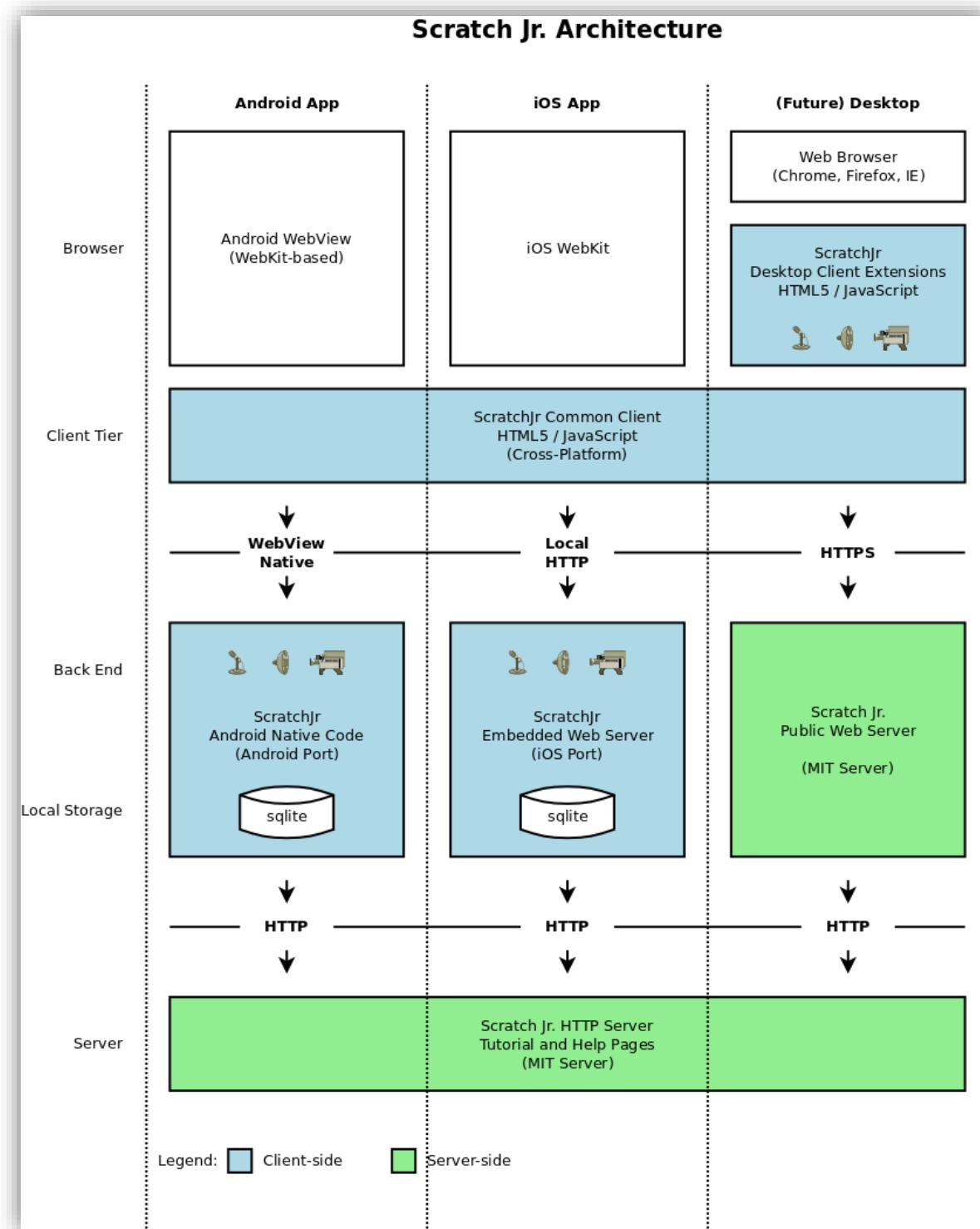
After all the data has been collected, this section is summarized in a simple comparison between all the features of all the sites mentioned

Point	prodigy	Childs Play	ABCya	Gcompris	Scratch	LUDOS
progress track	✓	-	-	✓	-	✓
Full Free	-	✓	-	-	✓	✓
presence of ads	✓	-	✓	-	-	-
Hints System	-	-	✓	-	-	-
Games Variety	✓	✓	✓	✓	-	✓
Reward System	-	-	✓	-	-	✓
Arabic content	-	-	-	-	-	-
Training quizzes	-	-	-	✓	✓	✓
Parent monitor	✓	-	-	-	-	✓
Programing content	-	-	-	-	✓	-
Logic circuits content	-	-	-	-	-	-
Good UI	✓	-	-	✓	✓	✓

## Previous System Model:

This Section will illustrate the software architecture of the other platforms that main goal is to provide educational games for children like our software.

1)



Our first software architecture is based on the ScratchJr platform, which is designed specifically for young children to help them develop 21st-century learning skills. ScratchJr is a simplified version of the popular Scratch language, which has been used by over 10 million people worldwide. While programming in Scratch requires basic reading skills, ScratchJr provides a simplified way to learn programming at a younger age, without any reading or mathematics required.

ScratchJr is available as a free app for iOS and Android, and our software architecture is split into two tiers. The first tier includes the user interface, which provides an intuitive and easy-to-use platform for young children to create their own programs and animations. The second tier includes the programming logic and database, which is responsible for storing and executing the programs created by the user.

### **Client tier**

This tier contains two layers:

The presentation layer: Contains the user interface where the end-user interacts with the application. Its main purpose is to display information to the user and collect information from the user. This top-level tier runs on the mobile app.

The presentation layer is developed using Android WebKit and IOS WebKit.

The Data layer: contains the database of the software, the type of the database is a local database to store the game assets and the player's progress.

The Data layer is developed using SQLite.

### **Server tier**

Contains the landing page that has tutorials and a help page.

The server tier is developed using HTML5 and Javascript and communicates with the Client tier using API calls, In the two tiers.

all communication goes through API calls.

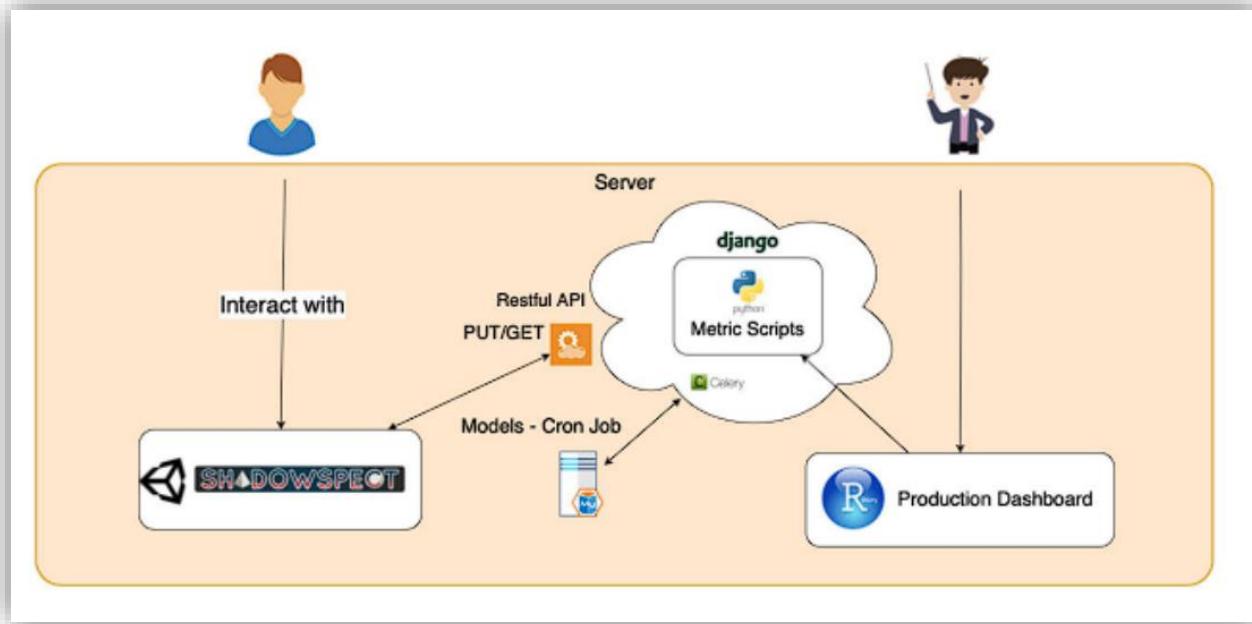
### **Benefits of software architecture.**

Here are some points of benefits that we took in the view of the ScratchJr Software Architecture

- Available for iOS, and Android.
- Local Storage.
- Landing page available.

2)

In Figure below we have a diagram which contains the different elements that make up the architecture:



**Shadowspect:** This module represents the geometry game that was developed for game-based assessment. The game has been built using Unity Engine and deployed as a web application hosted in a web server. This facilitates accessing the game from multiple devices and without having to install any software to do so. Also, the game was developed as lightweight as possible, since we need students using Chromebooks or similar low capacity computers in schools to be able to use it.

**Server backend with Django:** The main backend of the server has been built using the Django framework based on Python. Shadowspect communicates with this Django server using a RESTful API. Django also communicates with a MySQL database where all the necessary models have been defined. One of the challenges is keeping the metrics data up to date to make this a real-time dashboard. To do so, we use Celery, a task queue implementation for Python web applications used to asynchronously execute work outside the HTTP request-response cycle [54], so that we can schedule a cron job to execute the Python scripts every ten minutes and keep the metric's output updated.

**Analytics processing:** Each one of the metrics that we have defined is a separate function that computes the required data output as defined in a Python script. These functions are called by the cron job that updates the data, the Python scripts directly import data from the MySQL database, computes the metric, and stores the metric output in the MySQL database, so that is directly accessible without delay.

**Dashboard:** We have developed the dashboard using Shiny's R framework, and we have deployed it on ShinyApps web server. This brings a good number of benefits, such as that the

entire deployment pipeline is very easy as it does not need any hardware or configuration of the system. ShinyApps is also secure-by-design with each application using its own protected environment, and access is always SSL encrypted. Finally, the resources allocated to the dashboard are scalable and we do not need to worry about balancing backend resources based on the system's current workload.

**Users:** We have two kinds of users. On the one side, we have the students, that interact with Shadowspect generating the trace data with their interaction with the game. On the other side, we have the teachers, that are using Shadowspect in their classes and are the ones that can access the Shiny dashboard production environment to visualize what their students are doing.

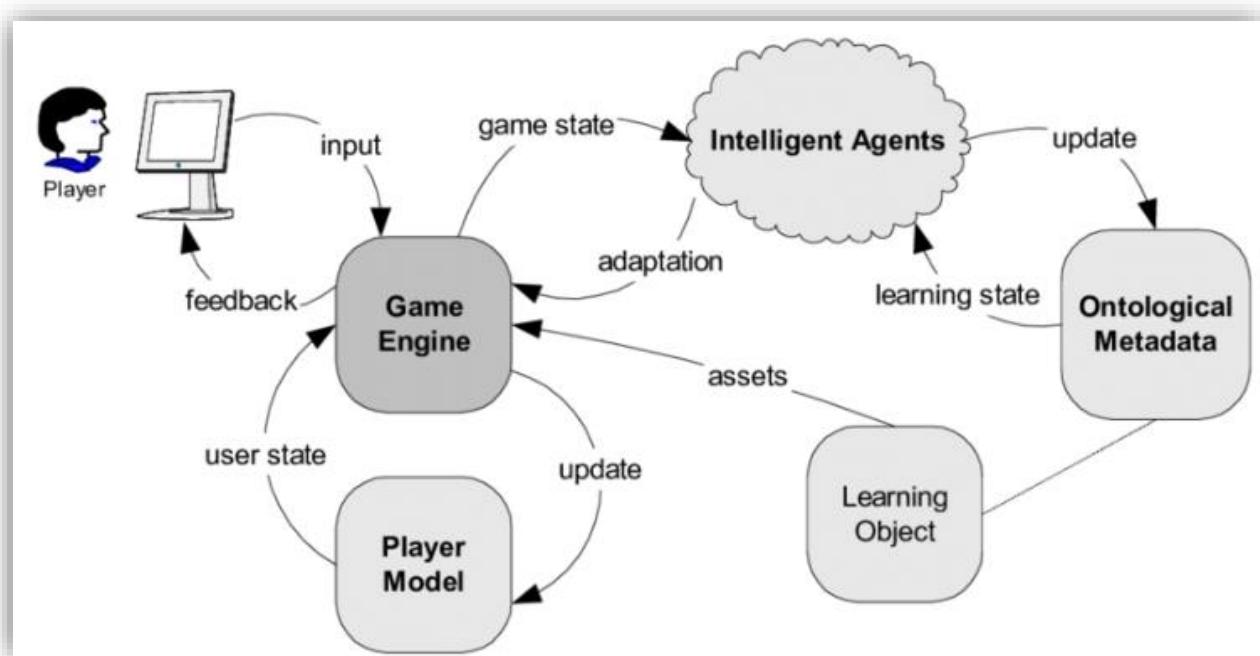
### **Benefits of the software architecture.**

Here are some points of benefits that we took in the view of the Software Architecture

- accessing the game from multiple devices.
- Local & online Storage.
- real-time dashboard.

3)

In Figure below we have a diagram which contains the different elements that make up the architecture:



Game engine: This module represents the intermediate point between the user and the database and the system engine.

The game has been built and deployed as a desktop application hosted locally on the user machine. This facilitates the processing process. Also, the game was developed as lightweight as possible, since we need students using low-end computers to be able to use it.

Player model: The main backend of the user has been built using the .Net framework based on Python. game engine communicates with this database using local communication traffic to get and save all the user status.

Learning object: The main backend of the software has been built using the .Net framework based on Python. game engine communicates with this database using local communication traffic also all the necessary models have been defined there. One of the challenges is keeping the metrics data up to date to make this a real-time dashboard. To do so, we use ontological meta data database to save the important data of the user to prevent it from being lost.

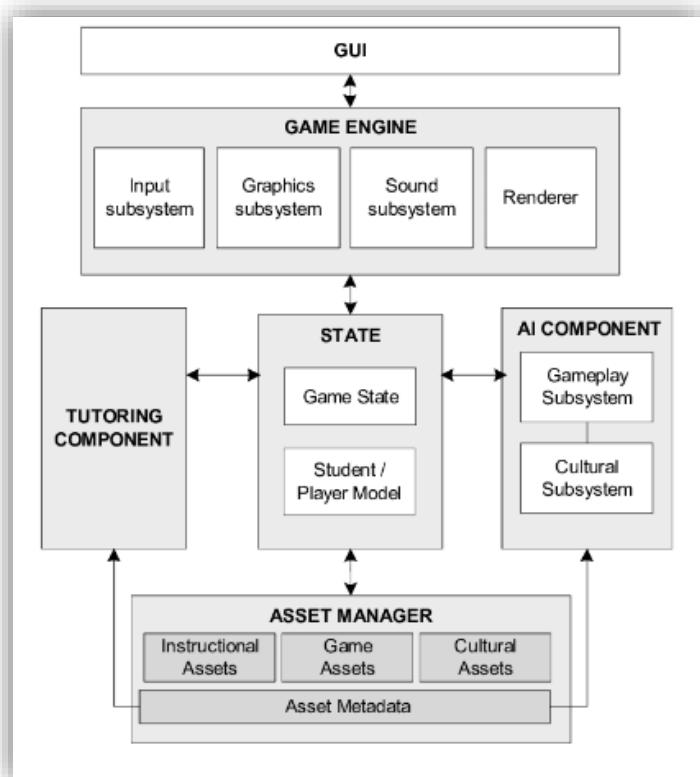
Player: We have one kind of user. On the one side, we have the students, that interact with game engine generating the trace data with their interaction with the game.

#### **Benefits of the software architecture.**

Here are some points of benefits that we took in the view of the Software Architecture

- locally installed in one device.
- Local Storage.
- fast processing.

4)



In Figure above we have a diagram which contains the different elements that make up the architecture:

GUI: This is the part that works as the client layer that interacts with the users, We have one kind of user. On the one side, we have the students, that interact with the GUI that interact with the game engine generating the trace data with their interaction with the game.

Game engine: The core functionality typically provided by a game engine may include a rendering engine for the graphics, sound, scripting, and animation, its work as a connection point between the front end and the back end of the software.

State: This is the part that works as the connection point between the game engine and the AI components and the database part.

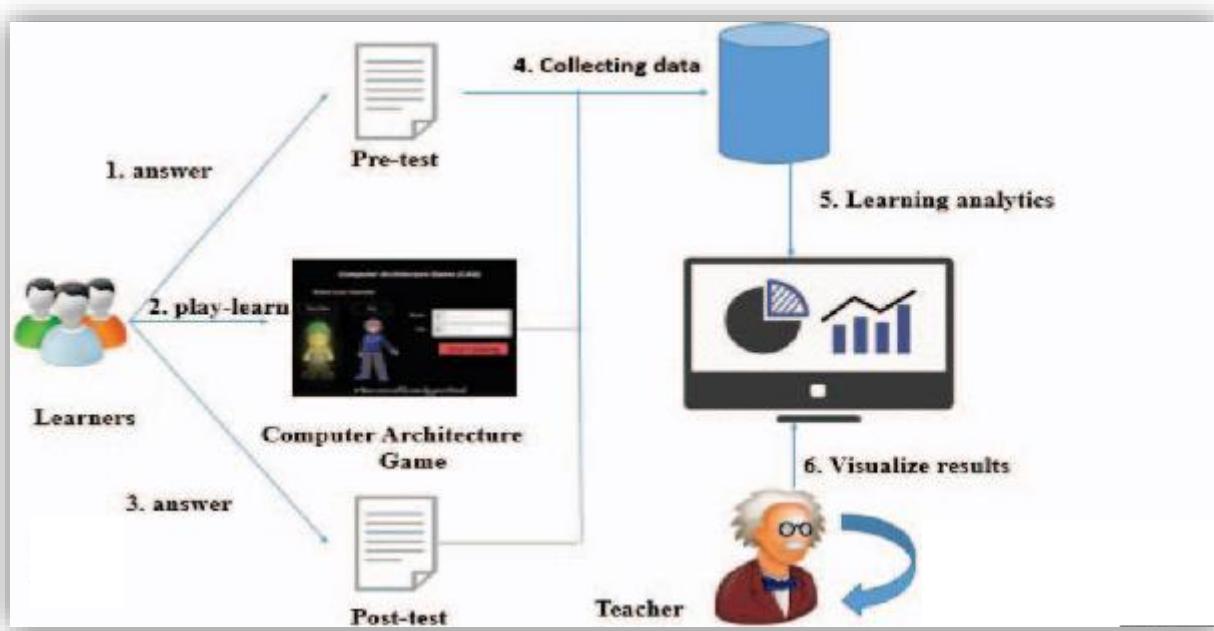
Asset manager: The main backend of the software it stores the software's important information like the game assets and the game sounds and the player status.

AI components: Serious game AI functionalities include player modelling (real-time facial emotion recognition, automated difficulty adaptation, stealth assessment), natural language processing (sentiment analysis and essay scoring on free texts)

### **Benefits of the software architecture.**

Here are some points of benefits that we took in the view of the Software Architecture

- locally installed in one device.
  - Local Storage.
  - AI components.
- 5)



In Figure above we have a diagram which contains the different elements that make up the architecture:

GUI: This is the part that works as the client layer that interacts with the users, We have one kind of user. On the one side, we have the students, that interact with the GUI that interact with the game engine generating the trace data with their interaction with the game.

Computer architecture game: The core functionality typically provided by a game engine may include a rendering engine for the graphics, sound, scripting, and animation, its work as a connection point between the front end and the back end of the software.

Also contain the computational part of the software and after getting the results from analyzing the tests that the user passed it this component send the result back to be saved in the database of the software.

Database: The main backend of the software it stores the software's important information like the game assets and the game sounds and the player status.

Users: We have two kinds of users. On the one side, we have the students, that interact with database generating the trace data with their interaction with the game. On the other side, we have the teachers, that are using database in their classes and are the ones that can access the Shiny dashboard production environment to visualize what their students are doing.

### **Benefits of the software architecture.**

Here are some points of benefits that we took in the view of the Software Architecture

- two kinds of users.
- Local Storage.
- learn analysis.

### **2.3. conclusion**

Given that children are attracted to using mobile devices frequently, integrating the most recent mobile technologies with educational contexts offers them a beneficial learning experience.

Mobile-based learning which is embedded with the newest technology allows for collaborative peer learning and fruitful and meaningful learning experiences, in contrast to traditional classroom learning [28].

In order to provide kids with the best learning experience possible, we will provide them a suitable environment for them by making it as interactive and attractive as possible.

## Chapter Three: System Analysis

### 3 . 1 . System Analysis

This section describes the final outline of our software project by detect the software methods and chosen framework.

From analyzing all the previously gathered data, we finally found the following:

#### 3. 1 . 1 Requirements

##### 1) User Requirements

###### **Functional Requirements:**

- 1) Parents Shall be able to make an account.
- 2) All users Shall be able to Login with his/her account.
- 3) All users Shall be able to logout from the app.
- 4) All users Shall be able to track his/her achievements.
- 5) All users Shall be able to track his/her progress of the game.
- 6) All users Shall be able to collect points from passing the levels.
- 7) All users Shall be able to spend his/her points on buying games or avatars.
- 8) All users Shall be able to play games.

##### 1) System Requirements

###### **Functional Requirements:**

- 1) users of the system shall login to the application with their username and password.
- 2) each level of the game that user pass, he/she will get a reward in form of points.
- 3) users can spend their points in the app.
- 4) calculate the progress of the user.
- 5) collect achievements.

###### **Non-Functional Requirements:**

- 1) Performance
  - the system shall response in few seconds and it has more than one throughput
- 2) Usability
  - the system has only one view, user view which can play games
- 3) Security :
  - Transaction data must be transmitted in encrypted form.
  - No one can have the same username of any other user each one has his own.
  - The system send message if you enter a uses username.
- 4) Supportability :
  - The system application will run start from android 6 and above also on iOS 10 and above

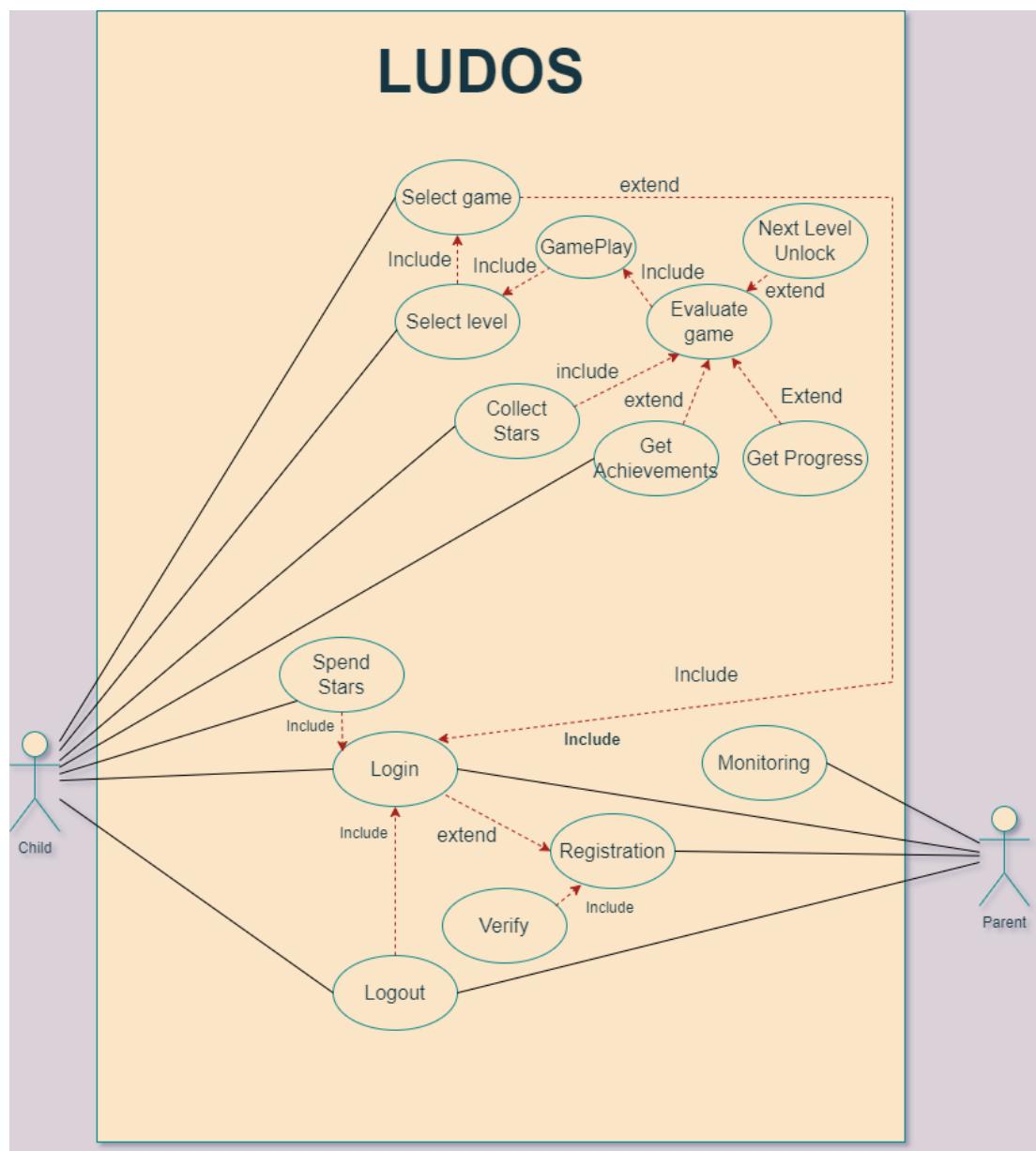
### 3 . 1 . 2 UML Diagrams

In this section, we will describe our software system with different types of diagrams like (Use case diagram, Database diagram, Activity diagram, Flowchart diagram, Package diagram, and Sequence diagram)

and this representation will help us to describe our software system well and make us understand our requirements and also take the best decisions will system implementation and testing.

In the following few pages, we will represent our system with the UML diagrams that have been mentioned previously and we will try to explain some of the diagrams with some UML tables that have much details of the diagrams.

#### Use case diagram:



**Use case Tables:**

- Registration

<b>Use case id</b>	1
<b>Use case name</b>	Registration
<b>Actors</b>	Parent
<b>Precondition</b>	Parent must have valid email to register with.
<b>Post condition</b>	parent registration occurred, and user must verify its account
<b>Input data</b>	Email , password, username
<b>Description</b>	User open the website and if he/she is a new user, he opens registration page. user will enter the username, email and password, then the user press register, after that once verification process runs successfully, user registration is done, and user will be redirect to the login page. Also If the verification process failed, a message will appear to the user with the error while verification, user must try register again.
<b>Comments &amp; exceptions</b>	

- Login

<b>Use case id</b>	3
<b>Use case name</b>	Login
<b>Actors</b>	Parent/Child
<b>Precondition</b>	User already created an account
<b>Post condition</b>	Logged in the application.
<b>Input data</b>	Username, Password
<b>Description</b>	Users open the application/website, then go to the login page, user enters the username and password and then press the login button, if login success, user redirect to home page, if login failed, a message will appear for the failed and ask the user to try again.
<b>Comments &amp; exceptions</b>	

- Logout

<b>Use case id</b>	4
<b>Use case name</b>	Logout
<b>Actors</b>	Parent/child
<b>Precondition</b>	User must be logged in firstly in the application
<b>Post condition</b>	Logout from the application
<b>Input data</b>	-
<b>Description</b>	Users open the application/website, then go to the settings page, then Press on logout button.
<b>Comments &amp; exceptions</b>	

- Select game

<b>Use case id</b>	7
<b>Use case name</b>	select game
<b>Actors</b>	child
<b>Precondition</b>	-
<b>Post condition</b>	select level
<b>Input data</b>	-
<b>Description</b>	user can select the game in the appropriate games that open for him
<b>Comments &amp; exceptions</b>	

- Select level

<b>Use case id</b>	8
<b>Use case name</b>	select level
<b>Actors</b>	child
<b>Precondition</b>	Select game
<b>Post condition</b>	play game
<b>Input data</b>	-
<b>Description</b>	every game contains a bunch o levels just the first level will be open in every new game the user unlock
<b>Comments &amp; exceptions</b>	

- Play game

<b>Use case id</b>	9
<b>Use case name</b>	play game
<b>Actors</b>	Child
<b>Precondition</b>	Select level
<b>Post condition</b>	Evaluate score
<b>Input data</b>	-
<b>Description</b>	once you select the level the game will be started
<b>Comments &amp; exceptions</b>	

- Evaluate game

<b>Use case id</b>	10
<b>Use case name</b>	evaluate game
<b>Actors</b>	child
<b>Precondition</b>	Playing any level at any game
<b>Post condition</b>	open next level
<b>Input data</b>	-
<b>Description</b>	after finishing the game in a specific time, the app will calculate the points you collect or the achievement you will get and your progress in the game
<b>Comments &amp; exceptions</b>	

- Next level unlock

<b>Use case id</b>	11
<b>Use case name</b>	Next level unlock
<b>Actors</b>	child
<b>Precondition</b>	Playing and win the level
<b>Post condition</b>	Evaluate game
<b>Input data</b>	-
<b>Description</b>	you finished the level with a win, after the game calculates the points, the next level will be unlocked
<b>Comments &amp; exceptions</b>	

- Collect points

Use case id	12
Use case name	collect points
Actors	child
Precondition	finish level
Post condition	Evaluate game
Input data	-
Description	after finishing every level, you will get points depending on the time you finish the level.
Comments & exceptions	

- Get achievement

Use case id	13
Use case name	get achievement
Actors	child
Precondition	win the game
Post condition	Evaluate game
Input data	-
Description	--
Comments & exceptions	

- spend points

Use case id	16
Use case name	spend points
Actors	child
Precondition	User already created an account and play games
Post condition	buy an avatar
Input data	-
Description	If you have an account and play any game that means you have collect points, to spend it you have to go to the shop and buy what you can buy
Comments & exceptions	

**Use Case Scenario tables:**

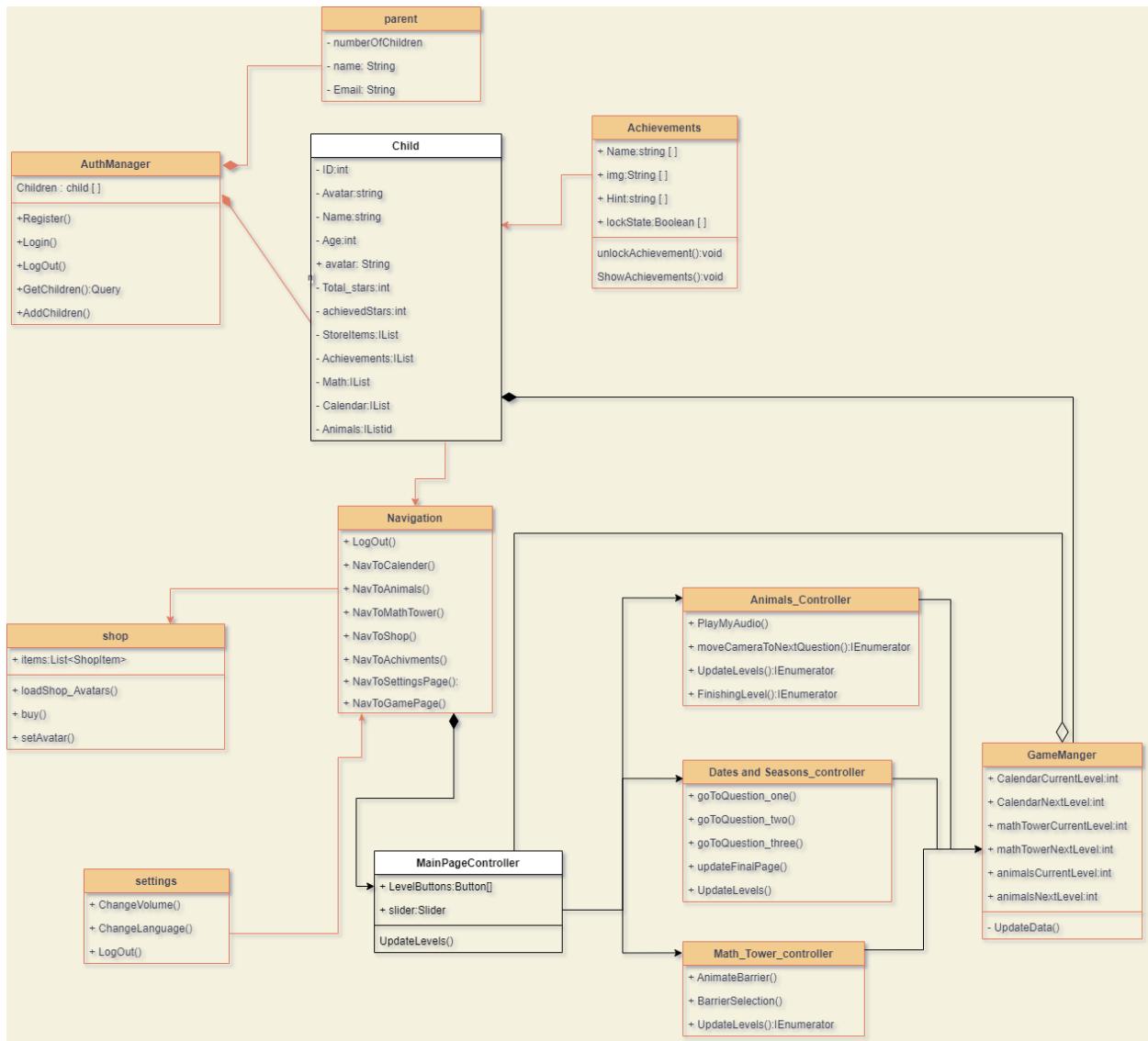
- Registration

Scenario id	1.1
Scenario name	Success User Registration
Target use case	User Registration
Scenario events	Users register with valid Email and the verify the account so user registration happen successfully

Scenario id	1.2
Scenario name	Fail User Registration
Target use case	User Registration
Scenario events	Users register with invalid Email so user registration happen unsuccessfully

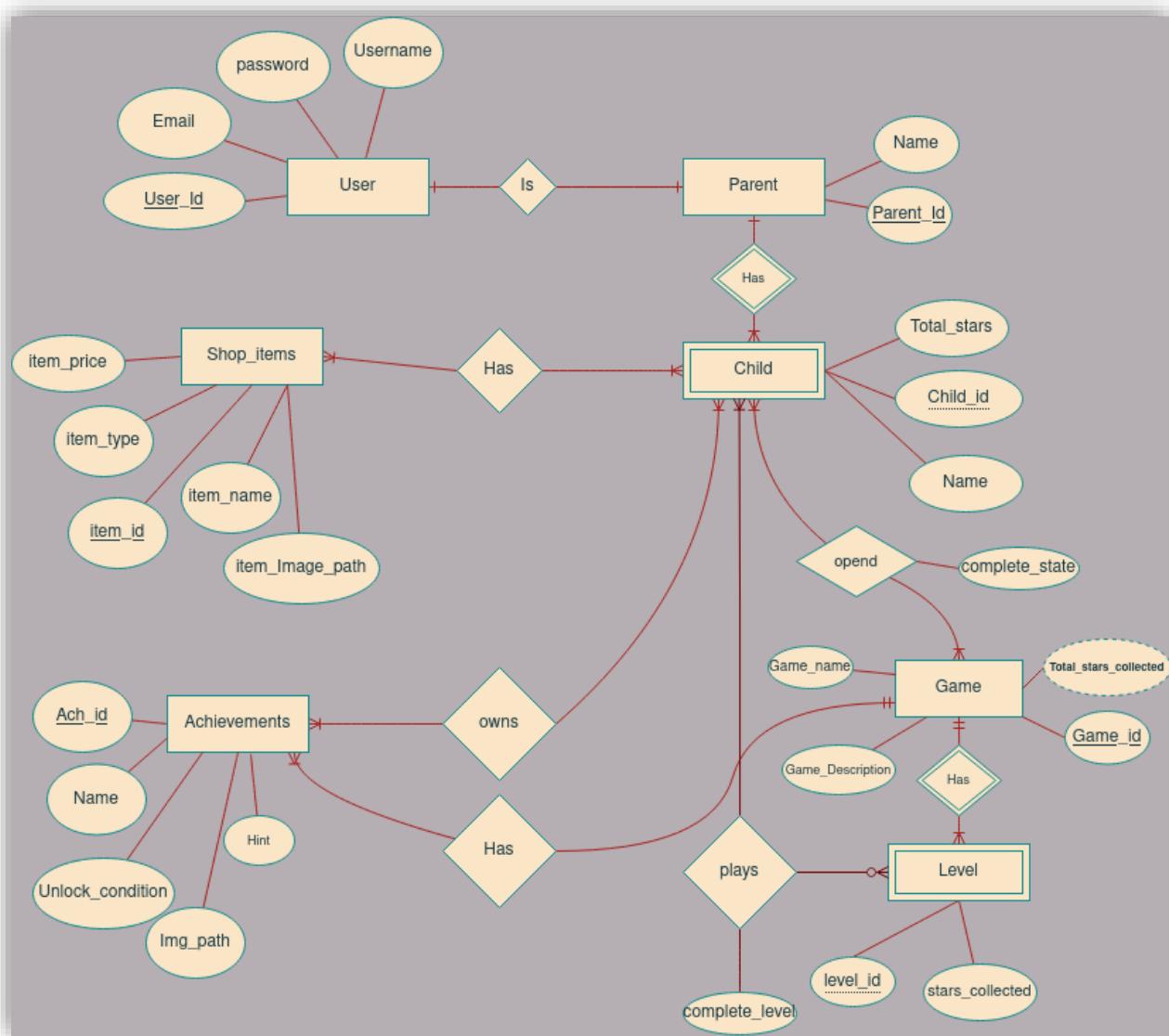
Scenario id	1.3
Scenario name	Allows the child to select a level to play in the selected game.
Target use case	Game play
Scenario events	<ol style="list-style-type: none"> <li>1. The child selects the "Select Level" option from the game menu.</li> <li>2. The system retrieves the child's progress in the game.</li> <li>3. The system displays a list of levels available for the child to play.</li> <li>4. The child selects a level to play.</li> <li>5. The system loads the selected level and the child is able to play the game.</li> </ol>

## Class diagram:

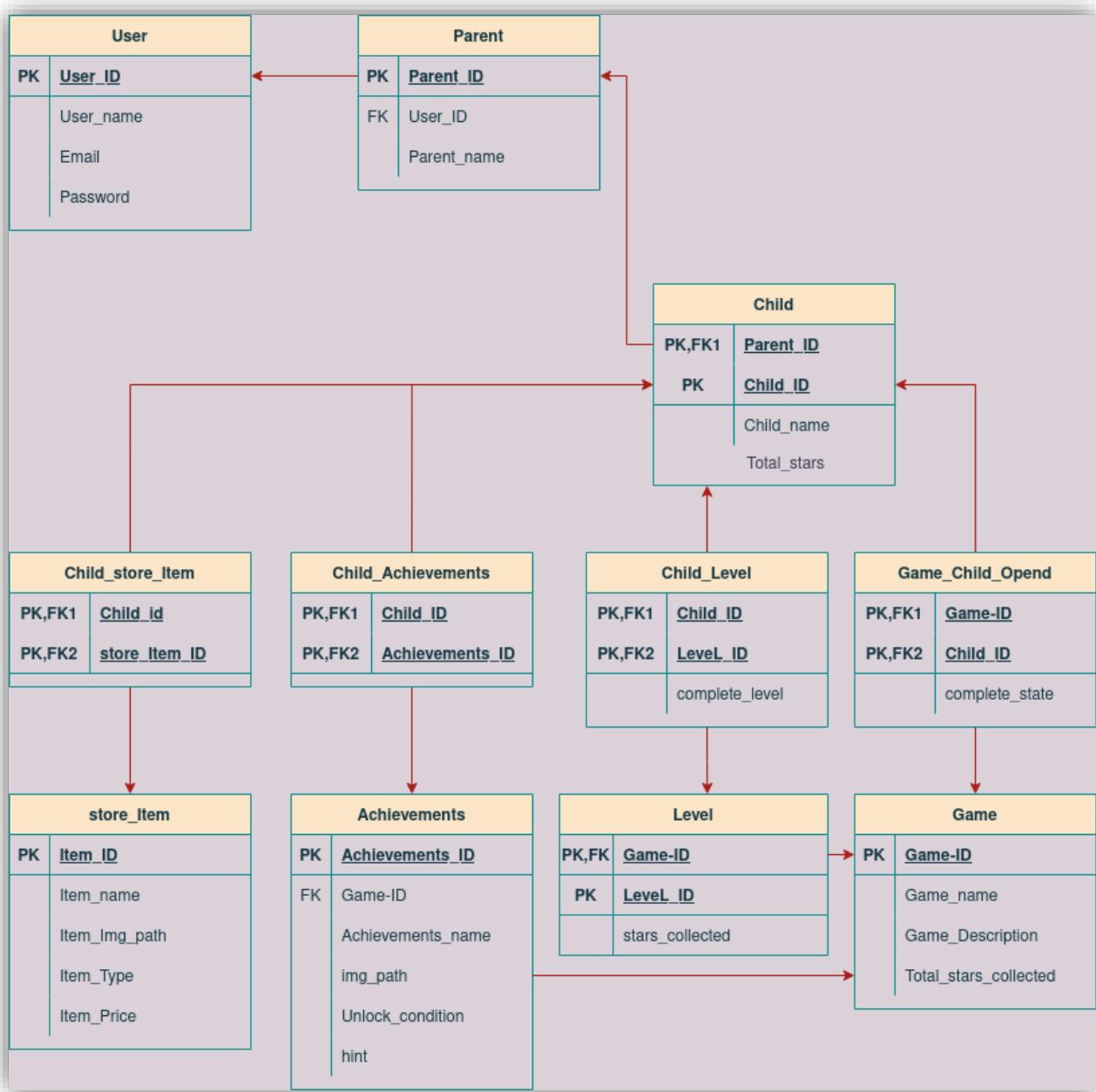


## Database Diagram:

### ERD



## Schema



### Description:

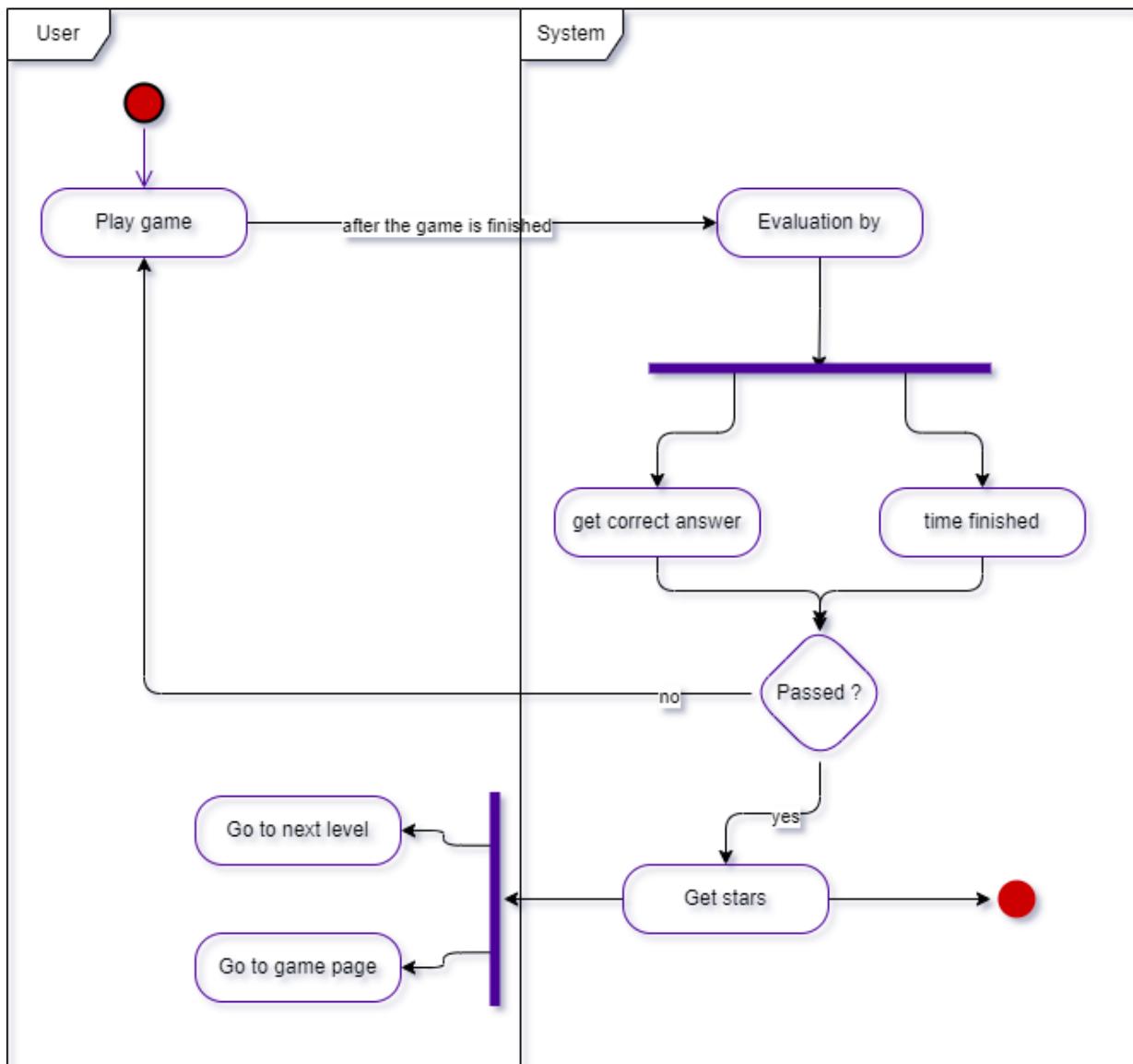
- Proposed entities (User, Parent, Child, Game, Level, Achievements, Shop\_item) that belong to the system
- Proposed attributes, it shows in each table.

**Tables:**

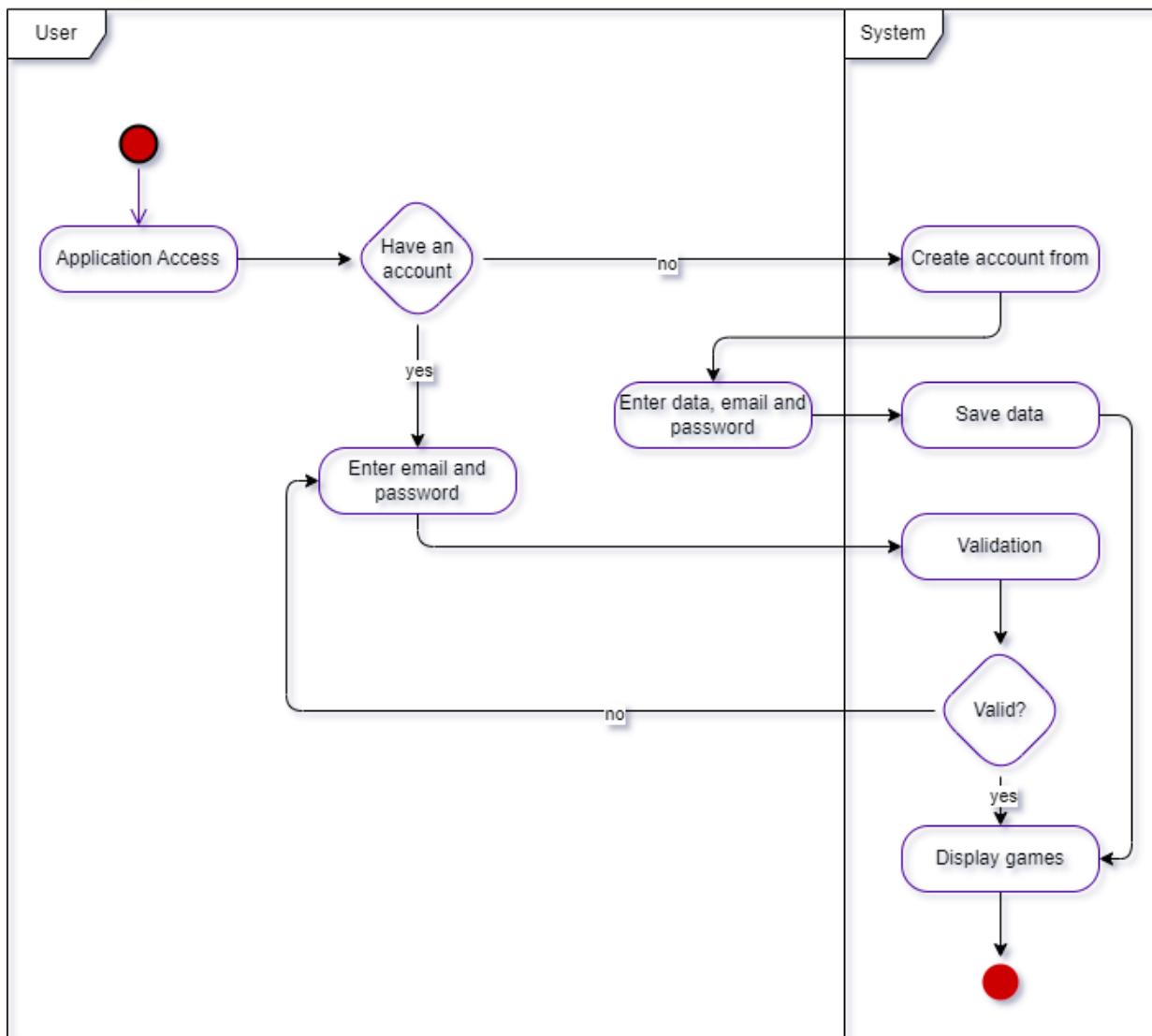
- User
  - User\_id
  - User\_Username
  - User\_Email
  - User\_Password
- Parent
  - Parent\_id
  - Parent\_name
- Child
  - Child\_id
  - Child\_name
- Game
  - Game\_id
  - Game\_name
  - Game\_describtion
  - Game\_completed
  - Game\_Total\_Star\_completed
- Achievements
  - Achievements\_id
  - Achievements\_name
  - Achievements\_Hint
  - Achievements\_Target
  - Achievements\_Image\_path
- Level
  - Level\_id
  - Level\_Stars\_Collected
  - Level\_Complete\_State
- Shop\_item
  - item\_id
  - item\_name
  - item\_Price
  - item\_Type
  - item\_Image\_path

**Activity diagram:**

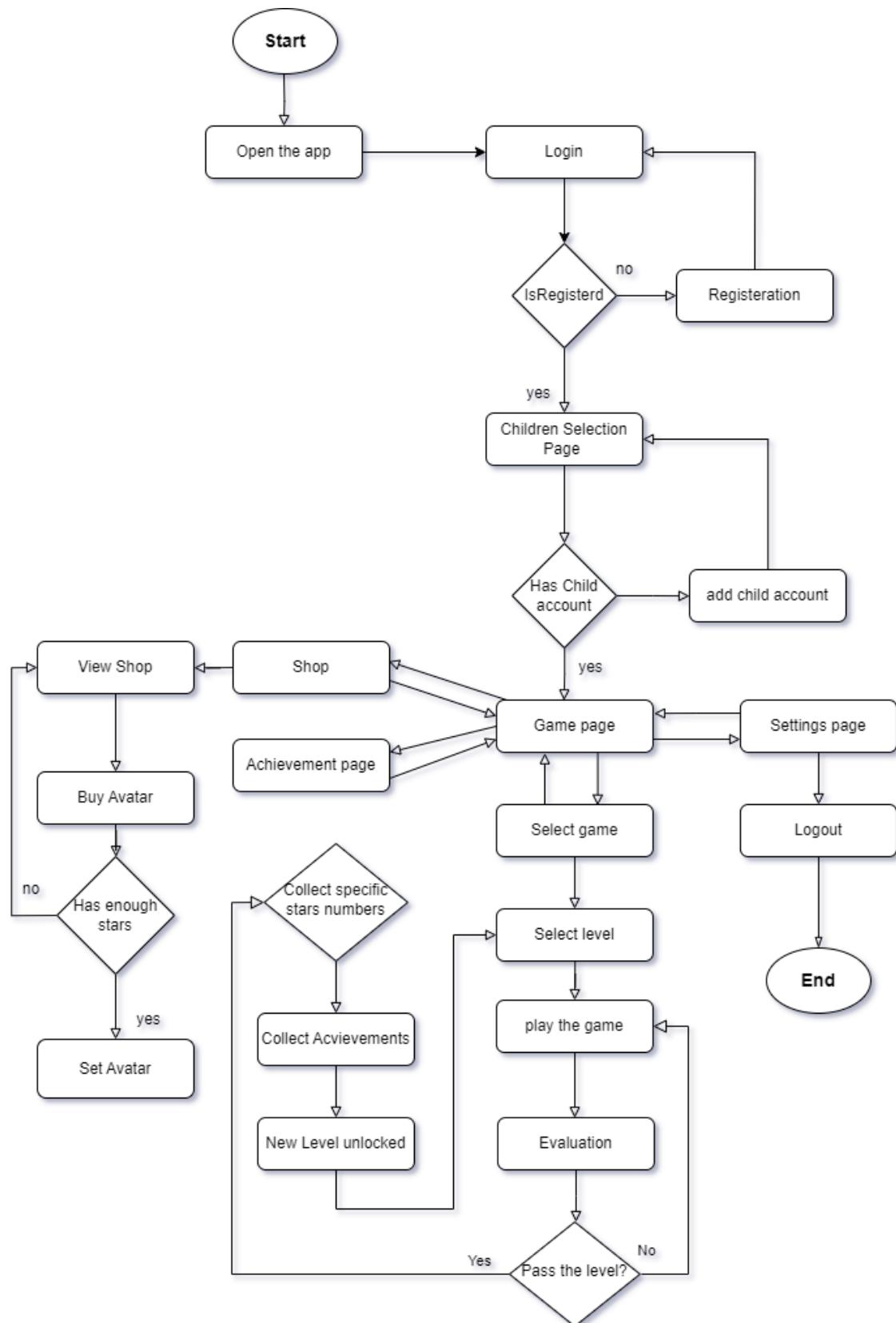
## # Evaluate Game



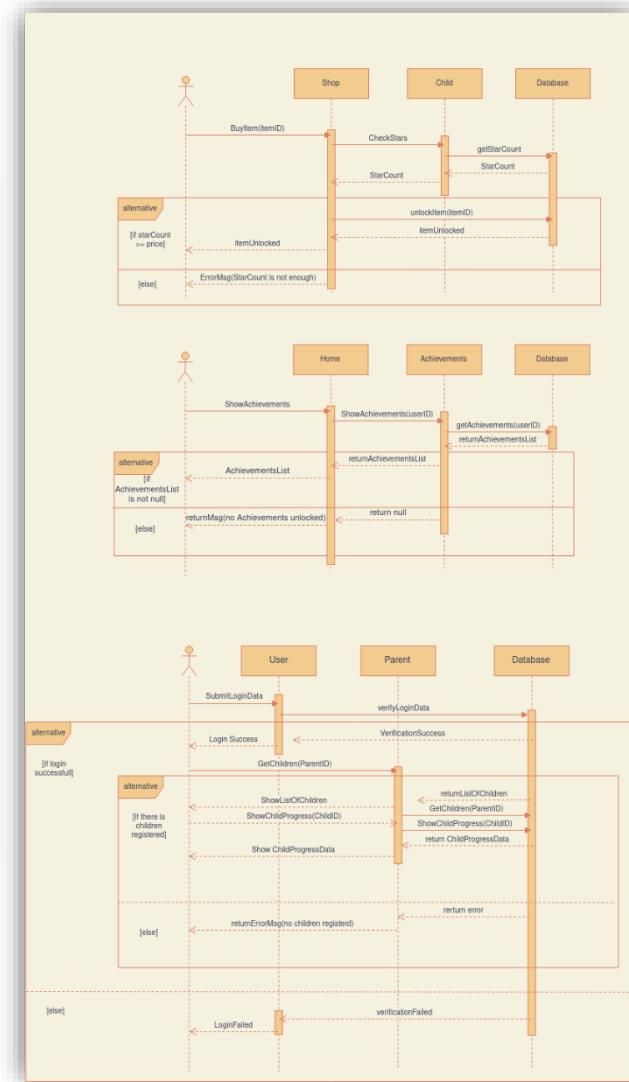
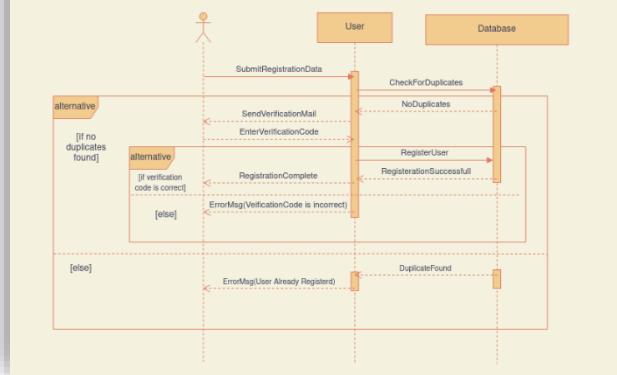
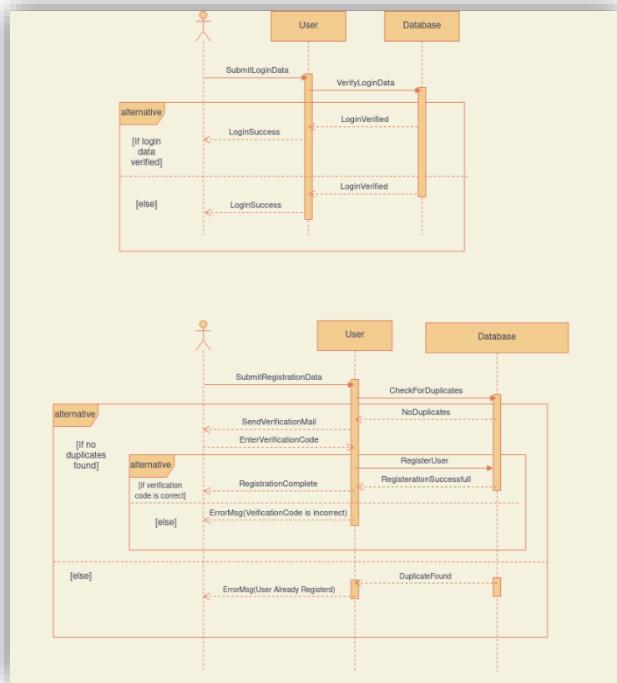
## # Login



## Software Flow Chart:



## Sequence diagram:



### 3 . 2 . System Model

This Section will illustrate the meaning of software architecture and how it improves the productivity and quality of the software, also we will describe the points that we took in view to make software architecture for our project.

#### **Software Architecture meaning**

The design stage in software development is a process by which the conceptual model obtained in the requirements stage is transformed into another model which is capable of being implemented. The software architecture of a computing system is the overall structure of the system which comprises software components and the interactions among them[39].

#### **Benefits of software architecture.**

By now we must have understood that good software architecture is extremely important for our software project. So here are some points of benefits that we took in view to make our software architecture[40].

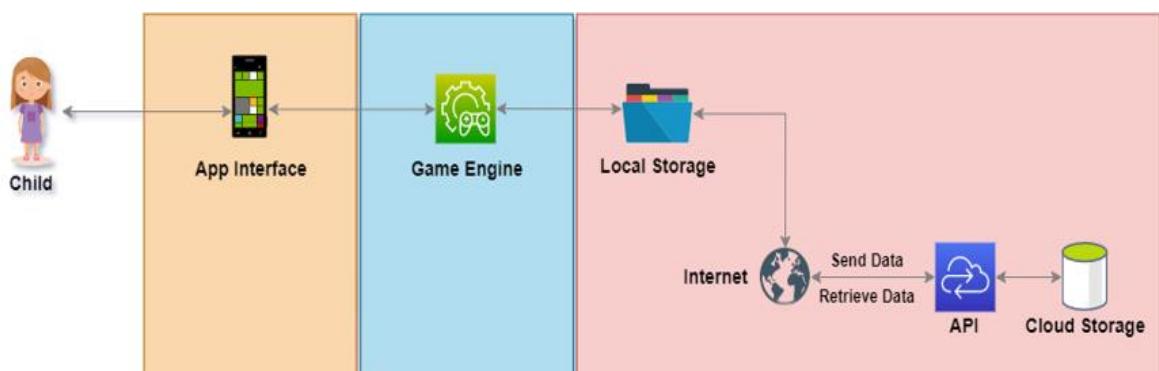
- It creates a solid foundation for our software.
- Increases performance of the platform.
- Providing a big-picture vision of the software.
- Better code maintainability.
- Helps manage complexity.
- risk management.

#### **Our Educational Game Architecture**

According to the requirements that we chose our software should provide four main functionalities:

- Providing hints to the players in the Arabic language.
- Representing the learning content with appropriate elements.
- Providing quizzes to the players to test their understanding.
- Giving players rewards to keep them motivated.

#### **Our Architecture**



**Our software architecture is split into three tiers.**

### Presentation tier

The presentation tier is the user interface and communication layer of the application, where the end-user interacts with the application. Its main purpose is to display information to and collect information from the user. This top-level tier runs on our web browsers and mobile app.

Web presentation tiers are developed using HTML, CSS, and JavaScript, and mobile presentation tiers are developed using Unity.

### Application tier

The application tier, also known as the logic tier or middle tier, is the heart of the application. In this tier, information collected in the presentation tier is processed.

The application tier can also add, delete or modify data in the data tier.

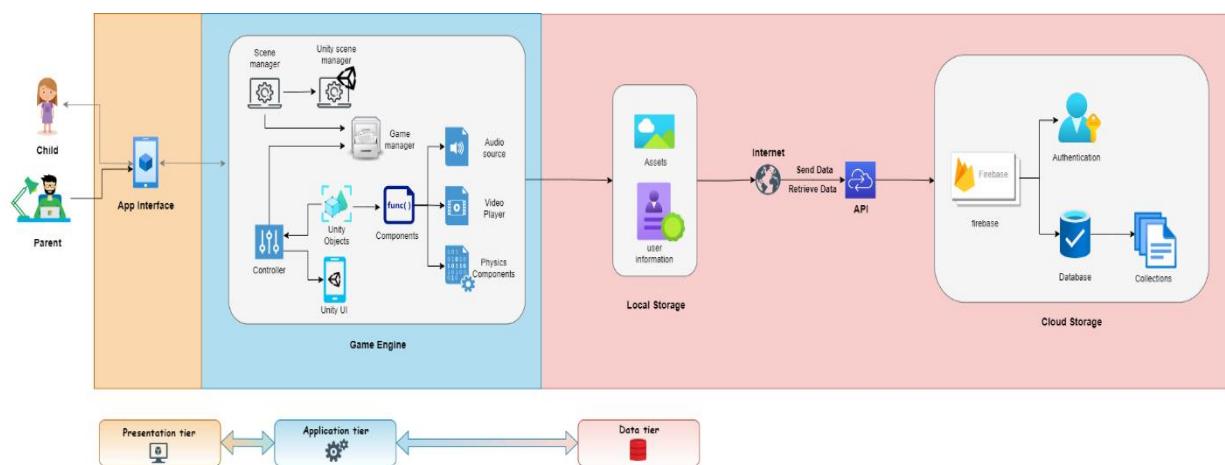
The application tier is developed using Unity and communicates with the data tier using API calls.

### Data tier

The data tier, sometimes called database tier, data access tier, or back-end, is where the information processed by the application is stored and managed.

In our software we used two types of databases first is a local database to store the game assets and the player progress, and the second is a cloud database to store the account information and the progress of the player

In the three-tiers, all communication goes through the application tier. The presentation tier and the data tier cannot communicate directly with one another.



## Our Architecture:

After all the data has been collected, this section is summarized and illustrated in a simple comparison between all the architectures of all the educational software mentioned before. also we will describe the points that we took in view to make software architecture for our project.

Point	[1]	[2]	[3]	[4]	[5]	LUDOS
Local storage	✓	-	✓	✓	✓	✓
Online storage	-	✓	-	-	-	✓
AI	-	-	✓	✓	-	-
Report generation	-	✓	-	-	✓	-
Locally installed	✓	-	✓	✓	✓	✓
Fast processing	✓	-	✓	✓	✓	✓
API	-	✓	-	-	-	✓
Two types of users	-	✓	-	-	-	✓
Online access	-	✓	-	-	-	✓

## Chapter Four: System Design

### 3 . 1 . System GUI

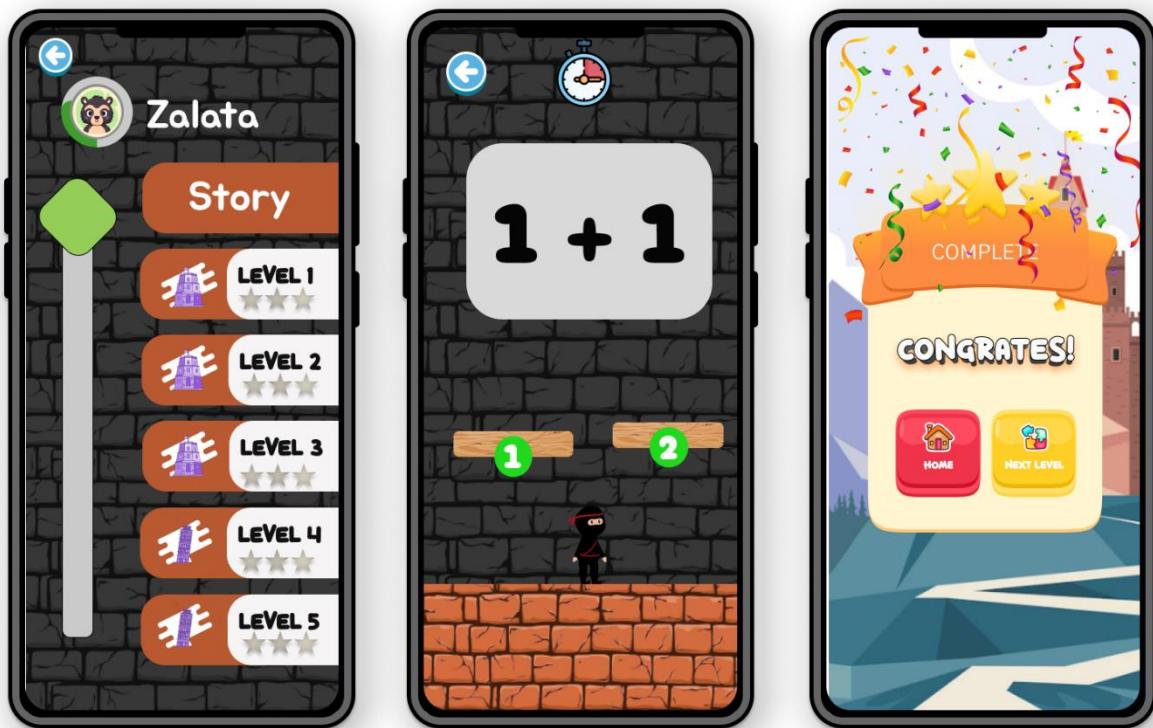
#### 3 . 1 . 1 Mobile Application



## # Animals



## # Math tower



## # Date & Seasons



### 3 . 2 . Games Manuals

<b>Math Tower</b>	<b>Description</b>	<b>Game Structure</b>	
	Math learning game designed to teach young children numbers and simple mathematical operations. It features several mini-levels that children and pre-K kids will love to play, and the more they play the better their math skills will become!	<b>levels</b>	<b>5</b>
		<b>points</b>	<b>3 per level</b>
	<b>outcomes</b>	<b>achievements</b>	<b>1</b>
		<b>User flow</b>	When the user opens the game he/she will find a bunch of levels which curriculum has been divided on it in a correct way to get the best learning. when the user start the level he/she will notice that the screen is divided to two sections, The first layer will be on the top of the screen and contains the navigations and the progress & Time information, The second section lay in the middle of the screen and contains the game information like the questions that will be displayed to the user. There will be Animate scenes and characters which will help the user to pass the level successfully.

Animals	Description	Game Structure	
	In this game, the main task is to determine the type of animals as soon as possible. With each level, the game will become more and more challenging.	levels	5
		points	3 per level
	outcomes	achievements	1
		User flow	<p>When the user opens the game, he/she will find a bunch of levels in which our curriculum has been divided in a way that we think is efficient and great in order to get the best learning experience from it.</p> <p>when the user start the level he/she will notice that the screen is divided to two sections, The first layer will be at the top of the screen and contains the navigations and the progress &amp; Time information, The second section lays in the middle of the screen and contains the game information like the questions that will be displayed to the user.</p> <p>The 5 levels of the game will represent learning of the different animals.</p> <p>There will be Animate scenes and characters which will help the user to pass the level successfully.</p>

<b>Date/Seasons</b>	<b>Description</b>	<b>Game Structure</b>	
	In this game child will learn to read the time he will start with easy numbers then he will be able to read more hard stuff and learning the right pronounce .	<b>levels</b>	<b>9</b>
		<b>points</b>	<b>3 per level</b>
	<b>outcomes</b>	<b>achievements</b>	<b>1</b>
		<p>If the user start the level they are taken to an introductory screen that explains the objective of the game and also learn them a lesson.</p> <p>The user is then presented with a series of challenges, each corresponding to a different season. For example, the challenge may be to identify the season based on a question about the weather.</p> <p>If the user successfully completes a challenge, they are rewarded with points and can advance to the next challenge. If they fail a challenge, they are allowed to retry the challenge or go back to the main menu.</p>	
		<b>User flow</b>	

## Chapter Five: System Implementation

### 4 . 1 . User interface implementation

#### Login Page

The login page is the first screen that users see when they launch the application. It is designed to be simple and user-friendly, with a clear and concise layout that allows users to log in quickly and easily. The login page consists of two main elements: the login form and the login button. The login form includes two input fields for the user's email address and password, with clear labels to indicate the required information.

- The purpose of the `LoginAsync()` method is to handle the user login process by taking in their email and password and using Firebase authentication to sign them in.
- The method uses `IEnumerator` to run the login process asynchronously, which means the program can continue running while the login process completes in the background.
- To handle login errors, the code uses a switch statement to check for different types of error codes. If any errors occur, the code inside the `if (LoginTask.Exception != null)` block is executed. This code checks for the type of error and displays a warning message to the user using the `warningLoginText` element.
- If the login process is successful, the code inside the `else` block is executed. This code hides the login panel, displays a loading screen, retrieves information about the user from Firebase, opens the select player screen, and logs a message to the console indicating that the user has successfully logged in.





The screenshot shows a mobile application interface with three circular icons at the top left. The main area displays a block of C# code. The code handles a login button's click event, performing an asynchronous Firebase authentication attempt. If successful, it logs the user in and displays their information. If unsuccessful, it shows an error message. The code uses Unity's UIManager and Firebase namespaces.

```
//Function for the login button
public void Login(string _email, string _password, Text _warningLoginText)
{
    //Call the login coroutine passing the email and password
    StartCoroutine(LoginAsync(_email, _password, _warningLoginText));
}

private IEnumerator LoginAsync(string _email, string _password, Text warningLoginText)
{
    //Call the Firebase FirebaseAuth signin function passing the email and password
    var LoginTask = FirebaseAuth.SignInWithEmailAndPasswordAsync(_email, _password);
    //Wait until the task completes
    yield return new WaitUntil(predicate: () => LoginTask.IsCompleted);

    if (LoginTask.Exception != null)
    {
        FirebaseException firebaseEx = LoginTask.Exception.GetBaseException() as FirebaseException;
        AuthError errorCode = (AuthError)firebaseEx.ErrorCode;

        string message = "Login Failed!";
        switch (errorCode)
        {
            /// Error Handling
            case AuthError.MissingEmail:
                message = "Missing Email";
                break;
            case AuthError.MissingPassword:
                message = "Missing Password";
                break;
        }

        warningLoginText.text = message;
    }
    else
    {
        UIManager.Instance.loginPanel.SetActive(false);
        UIManager.Instance.loadingScreen.SetActive(true);
        yield return new WaitForSeconds(2.2f);
        //firebaseUser is now logged in
        //Now get the result
        firebaseUser = LoginTask.Result;

        firebaseFirestore.Collection("parent").Document(firebaseUser.UserId).GetSnapshotAsync()
            .ContinueWithOnMainThread(task => { parent = task.Result.ConvertTo<Parent>(); });
        //firebaseAuth.StateChanged += AuthStateChanged;
        AuthStateChanged(this, null);
        UIManager.Instance.OpenSelectplayer();
        firebaseUser.DisplayName, firebaseUser.Email);
    }
}
```

## Shop Page

The shop UI allows users to purchase avatars using a specific number of stars. The UI displays a list of available avatars, along with their prices in stars. The user can then select an avatar to purchase by clicking on it.

When the user clicks on an avatar, the `buy()` method is called to handle the purchase. This method first gets the selected avatar's price and checks if the user has enough stars to buy it. If the user has enough stars, the method deducts the price from the user's total stars, adds the avatar to the user's list of purchased items, and updates the UI to reflect the purchase.

The UI also displays the user's total number of stars, which is updated whenever a purchase is made. In addition, the UI updates the appearance of the purchased avatar to indicate that it has been bought, such as by changing the "Buy" button to display "Set".

- The `buy()` method is used to handle the purchase of an item in the store. It first gets the selected item's parent object, then retrieves the price of the item from the price child object.
- If the user does not have enough stars to buy the item, the code displays an error message using the `_ShowAndroidToastMessage()` method.
- The `_ShowAndroidToastMessage()` method is used to display a toast message on an Android device. It uses the `AndroidJavaClass` to create an instance of the `Toast` class and call the `makeText()` and `show()` methods to display the message.





The screenshot shows a code editor window with a dark theme. At the top left are three colored window control buttons (red, yellow, green). The main area contains a C# script with syntax highlighting. The code defines a `buy()` method that interacts with Unity's EventSystems to get a selected game object, its price, and total stars. It checks if the item can be bought based on price and stars, then updates the UI and database. It also includes a private method `_ShowAndroidToastMessage` for displaying messages on Android.

```
private void buy()
{
    GameObject GO = UnityEngine.
        EventSystems.
        EventSystem.
        current.
        currentSelectedGameObject.
        transform.parent
        .gameObject;
    int price = int.Parse(GetChildWithName(GO, "price").
        GetComponentInChildren<Text>().text);

    if (!AuthManger.Instance.children.StoreItems.Contains(GO.name))
    {
        if (price <= AuthManger.Instance.children.Total_stars)
        {
            AuthManger.Instance.children.Total_stars -= price;

            stars.text = AuthManger.Instance.children.Total_stars.ToString();
            AuthManger.Instance.children.StoreItems.Add(GO.name);

            GetChildWithName(GO, "buy").GetComponentInChildren<Text>().text = "set";
            GetChildWithName(GO, "buy").GetComponent<Button>()
                .onClick.AddListener(() => sethandeler());

            GetChildWithName(GO, "price").SetActive(false);
        }
        else
        {
            //TODO error not enough stars
            _ShowAndroidToastMessage("Not enough stars");
        }
    }
}

private void _ShowAndroidToastMessage(string message)
{
    AndroidJavaClass unityPlayer = new
    AndroidJavaClass("com.unity3d.player.UnityPlayer");

    AndroidJavaObject unityActivity = unityPlayer.GetStatic<AndroidJavaObject>
    ("currentActivity");

    if (unityActivity != null)
    {
        AndroidJavaClass toastClass = new AndroidJavaClass("android.widget.Toast");
        unityActivity.Call("runOnUiThread", new AndroidJavaRunnable(() =>
        {
            AndroidJavaObject toastObject = toastClass.CallStatic<AndroidJavaObject>
            ("makeText", unityActivity, message, 0);
            toastObject.Call("show");
        }));
    }
}
```

## Achievements Page

The achievements page displays a list of 5 achievements that the user can earn by completing certain tasks. The achievements include:

- After playing one game level
- Passing the animal game
- Passing the math game
- Passing the calendar game
- Finishing all games

When the user completes the requirements for an achievement the button's change color from "Locked" to "Unlocked".

In addition to displaying the achievements, the UI also provides feedback to the user when an achievement is earned, such as by displaying a video. This feedback helps to motivate the user to continue playing and earning achievements.



```

void Start()
{
    UpdateUI();
}

public void UpdateUI()
{
    var achList = AuthManger.Instance.children.Achievements;
    for (int i = 0; i < achList.Count - 1; i++)
    {
        if (achList[i])
        {
            achievements[i].interactable = true;
        }
    }
}

private void CheckAndUnlockAchievement(string gameId ,int achievementIndex ,
int tStars)
{
    if (childData.getTotalStars(gameId) == tStars &&
!childData.CheckUnlocked(achievementIndex))
    {
        UnlockAchievement(achievementIndex);
    }
}
private void UnlockAchievement(int achievementIndex)
{
    childData.Achievements[achievementIndex] = true;
    achievementVideoPlayer.clip = Resources.Load<VideoClip>
($"achievementVideos/{achievementIndex}");
    achievementVideoPlayer.transform.parent.gameObject.SetActive(true);
    achievementVideoPlayer.loopPointReached += EndReached;
}
public bool isFirstGame()
{
    return achievedStars == 0;
}

public bool FinishedAllGames()
{
    return achievedStars >= 54;
}
public bool CheckUnlocked(int index)
{
    return Achievements[index];
}
return go(f, seed, [])
}

```

## Math game

The math game for kids is similar to the popular game Icy Tower, where the player must climb a tower by jumping from platform to platform. In this game, the player must solve math problems to progress through levels and climb the tower. The game includes multiple levels, each with different types of math problems and barriers. The game saves the player's progress and stars earned, allowing them to continue where they left off.

The UI consists of a tower with platforms, each with a math problem on the top of the screen. The player must solve the problem and then jump to the next platform. If the player jumps on the wrong platform, the user falls and blocks their progress. The player must then jump on the right platform and continue climbing.

- The MathTowerController script handles the logic for the game. It includes methods for animating the barriers, selecting the correct barrier, and removing the answer image from the platform.
- The MathTowerUiManager script handles the UI for the game, including updating the stars earned and progress towards completing the level. It also includes a method for finishing the level and updating the player's data.



```
public class MathTowerController : MonoBehaviour
{
    [SerializeField] private GameObject[] wrongBarrier;
    static bool[] completeStatus = { false, false, false, false, false };
    MathTowerUiManager uiManager;
    private int stars;
    Scene scene;

    private void Start()
    {
        uiManager = GameObject.Find("Canvas").GetComponent<MathTowerUiManager>();
        scene = SceneManager.GetActiveScene();
    }

    public void AnimateBarrier(GameObject barrier)
    {
        FirstBarrier(barrier);
        SecondBarrier(barrier);
        ThirdBarrier(barrier);
    }

    private void BarrierSelection(GameObject barrier)
    {
        if (barrier.name == "8")
        {
            if (scene.name == "Math-Level-1" || scene.name == "Math-Level-2" ||
            scene.name == "Math-Level-5")
            {
                stars++;
                barrier.GetComponent<Animator>().Play("ScalingToLeft");
            }
            else
            {
                barrier.GetComponent<Animator>().Play("ScalingToRight");
            }
            Destroy(wrongBarrier[2]);
            //StartCoroutine(uiManager.FinishingLevel());
            StartCoroutine(UpdateLevels());
        }
    }

    private void RemoveTheAnswerImage(GameObject barrier)
    {
        GameObject barrierChild = barrier.transform.GetChild(0).gameObject;
        barrierChild.SetActive(false);
    }

    IEnumerator UpdateLevels()
    {
        yield return StartCoroutine(uiManager.FinishingLevel());
        uiManager.UpdateStars(Timer.second, isActive:uiManager.isActive);
        if (!completeStatus[GameManager.instance.mathTowerCurrentLevel])
        {
            completeStatus[GameManager.instance.mathTowerCurrentLevel] = true;
            GameManager.instance.UpdateData(GameName:"math",level:
            GameManager.instance.mathTowerCurrentLevel, stars:stars);
        }
    }
}
```

## 4 . 2 . Database implementation

### Add child to the database

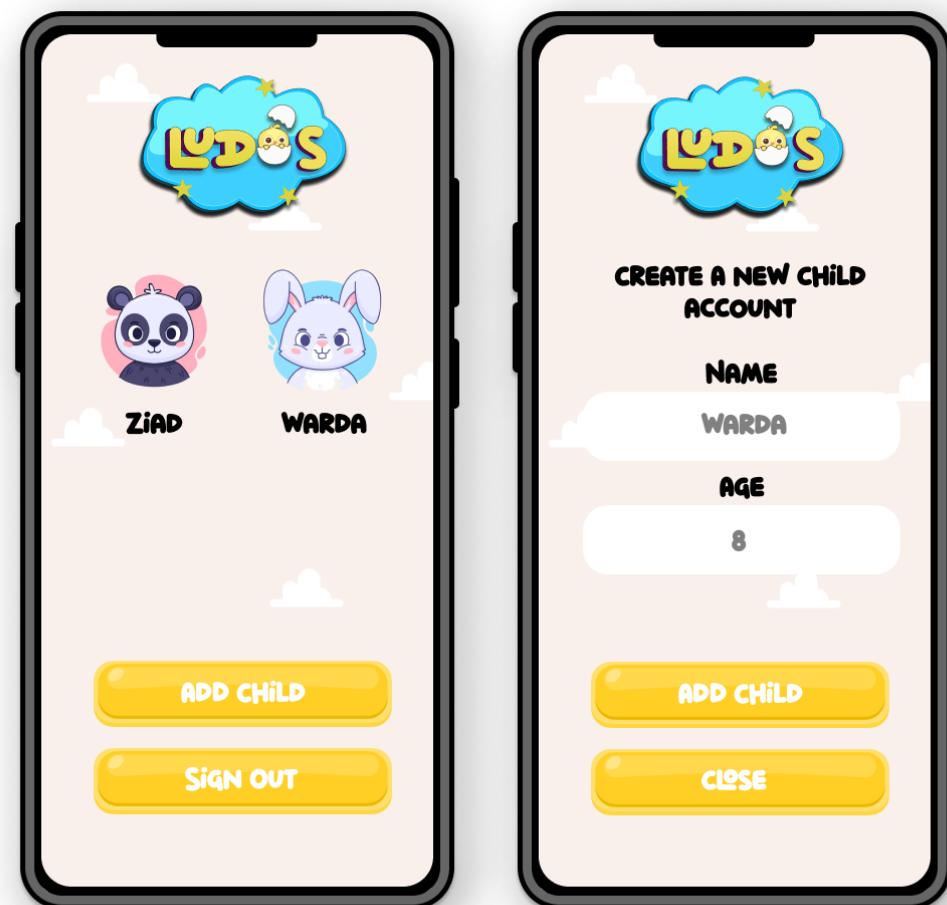
The AddChildren method is used to add a new child to the parent's account in the database. The method first increments the parent's number of children, and then creates a new Children object with the child's information, such as their name and age.

The method then uses the Firebase Firestore API to add the child to the database. It first updates the parent's document to reflect the new number of children, and then adds the child's document to the parent's collection of children.

The SetAsync method is used to add the parent and child documents to the database. This method returns a task that can be used to check if the operation was completed successfully.

If the operation is successful, the method logs a message indicating that the child was added successfully. If the operation fails, the method logs an error message.

The database stores information about the child's progress in various areas, such as math, calendar, and animals. This information is stored in ArrayLists, which can be easily updated as the child progresses.



```
//TODO shall we do method for parent : Async ,Delete ,Update still we dont need
username And email
public void AddChildren(string ChildName, int ChildAge)
{
    parent.NumberOfChildrens++; // update number of children for parent
    var parentnRef =
firebaseFirestore.Collection("parent").Document(firebaseUser.UserId);
    parentnRef.SetAsync(parent).ContinueWithOnMainThread(task =>
{
    if (task.IsCompleted)
    {
        //Debug.LogFormat("firebaseUser add data is successfully: {0}
({1})", firebaseUser.DisplayName, firebaseUser.Email);
        Debug.LogFormat("children {0} add successfully: ({1})",
children.Name, firebaseUser.Email);
    }
    else
    {
        Debug.LogFormat("children {0} add Failed: ({1})", children.Name,
firebaseUser.Email);
    }
});
//object Avatar set Default 1
// create child data
children = new Children(
    id: parent.NumberOfChildrens,
    avatar: "avatar1",
    name: ChildName,
    age: ChildAge,
    totalStars: 0,
    achievedStars: 0,
    achievements: new ArrayList(),
    storeItems: new ArrayList() { "avatar1" },
    math: new ArrayList(),
    calendar: new ArrayList(),
    animals: new ArrayList());

    var ChildrenRef =
firebaseFirestore.Collection("parent").Document(firebaseUser.UserId).Collection("ch
ildren")
    .Document(parent.NumberOfChildrens.ToString());
    ChildrenRef.SetAsync(children).ContinueWithOnMainThread(task =>
{
    if (task.IsCompleted)
    {
        //Debug.LogFormat("firebaseUser add data is successfully: {0}
({1})", firebaseUser.DisplayName, firebaseUser.Email);
        Debug.LogFormat("children {0} add successfully: ({1})",
children.Name, firebaseUser.Email);
    }
    else
    {
        Debug.LogFormat("children {0} add Failed: ({1})", children.Name,
firebaseUser.Email);
    }
});
}
```

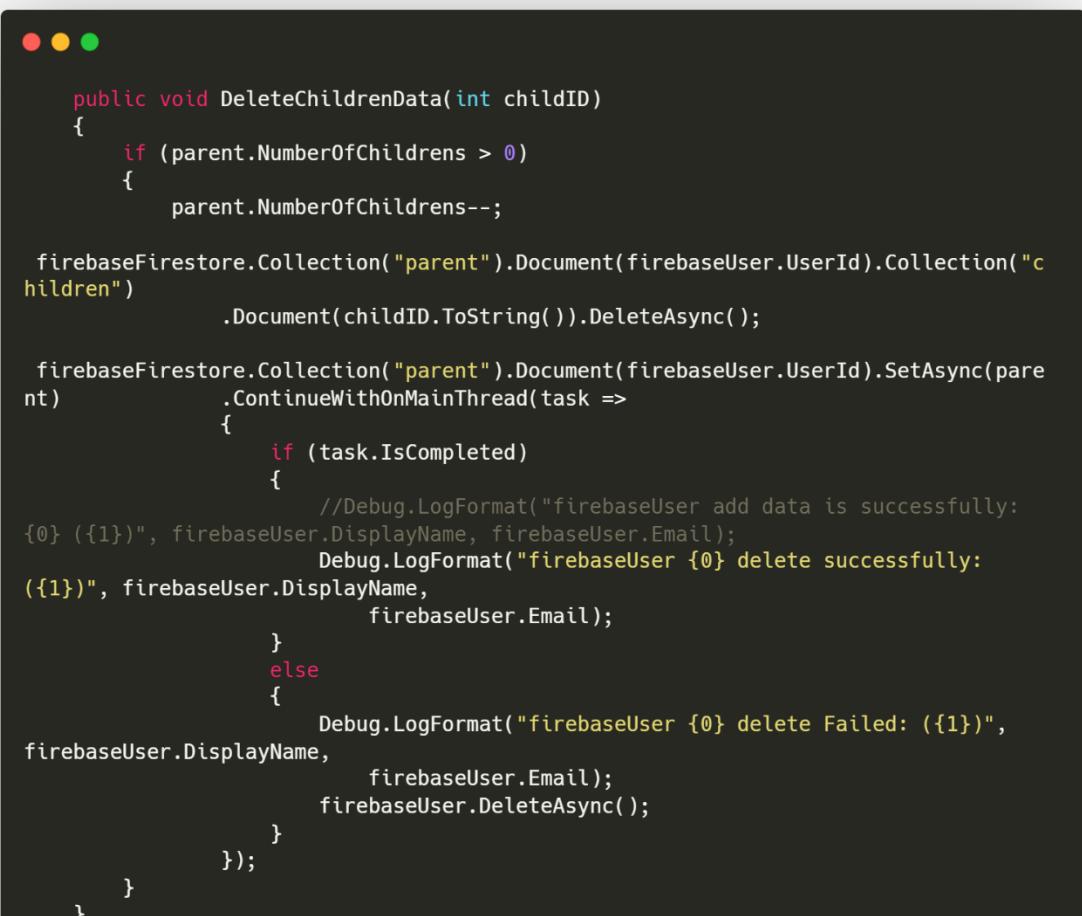
## Remove child from the database

The DeleteChildrenData method is used to delete a child's information from the parent's account in the database. The method first checks if the parent has any children. If the parent has at least one child, the method decrements the parent's number of children.

The method then uses the Firebase Firestore API to delete the child's document from the parent's collection of children. This is done using the DeleteAsync method, which returns a task that can be used to check if the operation was completed successfully.

After deleting the child's document, the method updates the parent's document to reflect the new number of children. This is done using the SetAsync method, which also returns a task that can be used to check if the operation was completed successfully.

If the operation is successful, the method logs a message indicating that the child was deleted successfully. If the operation fails, the method logs an error message and attempts to delete the parent's document using the DeleteAsync method.



```
public void DeleteChildrenData(int childID)
{
    if (parent.NumberOfChildrens > 0)
    {
        parent.NumberOfChildrens--;

        firebaseFirestore.Collection("parent").Document(firebaseUser.UserId).Collection("children")
            .Document(childID.ToString()).DeleteAsync();

        firebaseFirestore.Collection("parent").Document(firebaseUser.UserId).SetAsync(parent)
            .ContinueWithOnMainThread(task =>
        {
            if (task.IsCompleted)
            {
                //Debug.LogFormat("firebaseUser add data is successfully: {0} ({1})", firebaseUser.DisplayName, firebaseUser.Email);
                Debug.LogFormat("firebaseUser {0} delete successfully: {1}", firebaseUser.DisplayName,
                    firebaseUser.Email);
            }
            else
            {
                Debug.LogFormat("firebaseUser {0} delete Failed: ({1})", firebaseUser.DisplayName,
                    firebaseUser.Email);
                firebaseUser.DeleteAsync();
            }
        });
    }
}
```

#### 4 . 3 . Software implementation

##### Game manager

The MathGameUI script is attached to a UI canvas element that contains the level and stars text elements, as well as the play button. In the Start method, the UpdateUI method is called to update the text elements with the child's progress. The OnPlayClicked method is called when the child clicks the play button.

To update the child's progress in the math game, you could modify the GameManager script to include a method that updates the mathTowerCurrentLevel and mathTowerStars variables based on the child's progress, the OnPlayClicked method gets the child's performance in the game (e.g., the number of stars they earned) and then calls the UpdateData method of the AuthManager script to update the child's progress in the database. It then calls the UpdateMathProgress method of the GameManager script to update the child's progress locally, and then calls the UpdateUI method to update the UI with the new progress.



```
public class GameManager : MonoBehaviour
{
    public static GameManager instance;

    public int mathTowerCurrentLevel; // ----->>> LevelProgress
    public int mathTowerNextLevel; // ----->>> LevelProgress

    private void Start()
    {
        mathTowerNextLevel = AuthManger.Instance.children.Math.Count + 1;
        mathTowerStars = 0;
    }
    private void Awake()
    {
        if (instance == null)
        {
            instance = this;
            DontDestroyOnLoad(gameObject);
        }
        else
        {
            Destroy(this.gameObject);
        }
    }
    public void UpdateData(string GameName, int level, int stars)
    {
        if (stars <= 3)
        {
            switch (GameName)
            {
                case "math":
                case "Math":
                    if (AuthManger.Instance.children.Math.Count == level)
                    {
                        AuthManger.Instance.children.Math.Add(stars);
                        mathTowerNextLevel++;
                        AuthManger.Instance.children.Total_stars += stars;
                        AuthManger.Instance.children.achievedStars += stars;

                        AuthManger.Instance.SendChildrenData(AuthManger.Instance.children.ID);
                    }
                    else if
                        (System.Convert.ToInt32(AuthManger.Instance.children.Math[level]) < stars)
                    {
                        int temp = stars -
                        System.Convert.ToInt32(AuthManger.Instance.children.Math[level]);
                        AuthManger.Instance.children.Total_stars += temp;
                        AuthManger.Instance.children.achievedStars += temp;
                        AuthManger.Instance.children.Math[level] = stars;

                        AuthManger.Instance.SendChildrenData(AuthManger.Instance.children.ID);
                    }
                    break;
            }
        }
    }
}
```

## Game Navigation

The NavigationUI script is attached to a UI canvas element that contains the game page, settings page, achievements, shop, math tower, animals, calendar, and logout buttons. The Navigation script is also referenced in the script.

In the Start method, the button click events are subscribed to the corresponding navigation methods in the Navigation script.

When the user clicks on a button, the corresponding navigation method is called, which loads the appropriate scene using the SceneManager.LoadScene method.



```
● ● ●

public class Navigation : MonoBehaviour
{
    public void NavToGamePage()
    {
        SceneManager.LoadScene("GamesPage");
    }

    public void NavToSettingsPage()
    {
        SceneManager.LoadScene("SettingsPage");
    }

    public void NavToAchievements()
    {
        SceneManager.LoadScene("AchievementPage");
    }

    public void NavToShop()
    {
        SceneManager.LoadScene("ShopPage");
    }

    /// </MainPages>

    /// <Games>

    public void NavToMathTower()
    {
        SceneManager.LoadScene("Math-HomePage");
    }

    public void NavToAnimals()
    {
        SceneManager.LoadScene("Animals-HomePage");
    }
    public void NavToCalender()
    {
        SceneManager.LoadScene("Calendar-HomePage");
    }
    public void LogOut() {
        AuthManger.Instance.SendChildrenData(AuthManger.Instance.children.ID);
        AuthManger.Instance.LogOut();
    }
}
```

## Camera Movements

Assuming that you want to move the camera and the avatar to different positions when the user clicks on different buttons, you could create a UI with buttons that call the `moveToCalender`, `moveToSeasons`, and `moveToMainPage` methods of the `MainPageController` script.

The `MainPageUI` script is attached to a UI canvas element that contains the calender, seasons, and main page buttons. The `CameraLerp` script and the avatar transform are also referenced in the script.

In the `Start` method, the `OnCalenderButtonClicked`, `OnSeasonsButtonClicked`, and `On MainPageButtonClicked` methods are subscribed to the corresponding button click events.

In the button click event methods, the corresponding animation is played using the `AnimationController` script, and the camera and avatar positions are updated using the `LerpFromTo` methods of the `CameraLerp` script. The `pageAvatarPositions` array contains the camera and avatar positions for each page. The `StartCoroutine` method is used to start the `LerpFromTo` coroutine with the appropriate parameters.



```
public class CameraLerp : MonoBehaviour
{
    Transform mainCamPos;
    // Start is called before the first frame update
    void Start()
    {
        mainCamPos = gameObject.GetComponent<Transform>();
    }

    // Update is called once per frame

    public IEnumerator LerpFromTo(Vector3 pos2, float duration, float delay)
    {
        yield return new WaitForSeconds(delay);
        for (float t = 0f; t < duration; t += Time.deltaTime)
        {
            mainCamPos.position = Vector3.Lerp(mainCamPos.position, pos2, t / duration); yield return 0;
        }
        mainCamPos.position = pos2;
    }
    public IEnumerator LerpFromTo(string gameObjectName,Vector3 pos2, float duration, float delay)
    {
        Transform temp = GameObject.Find(gameObjectName).transform;
        yield return new WaitForSeconds(delay);
        for (float t = 0f; t < duration; t += Time.deltaTime)
        {
            temp.position = Vector3.Lerp(temp.position, pos2, t / duration);
            yield return 0;
        }
        temp.position = pos2;
    }
}

public class MainPageController : MonoBehaviour
{
    public void moveToCalender()
    {
        animationController.animate("UI1_enable", "Canvas");
        StartCoroutine(mainCam.LerpFromTo( page_avatarPositions[1, 0], 1f, 0.4f));
        StartCoroutine(LerpFromTo(Avatar.position, page_avatarPositions[1, 1], 1.05f, Avatar,0.3f));
    }
    public void moveToSeasons() {
        animationController.animate("UI2_enable", "Canvas");
        StartCoroutine(mainCam.LerpFromTo( page_avatarPositions[2, 0], 1.3f, 0.4f)); StartCoroutine(LerpFromTo(Avatar.position, page_avatarPositions[2, 1], 1.05f, Avatar,0.3f));
    }
    public void moveToMainPage() {
        StartCoroutine(mainCam.LerpFromTo(page_avatarPositions[0, 0], 1f, 0f));
        StartCoroutine(LerpFromTo(Avatar.position, page_avatarPositions[0, 1], 1.05f, Avatar,0));
    }
}
```

## Chapter Six: System Testing

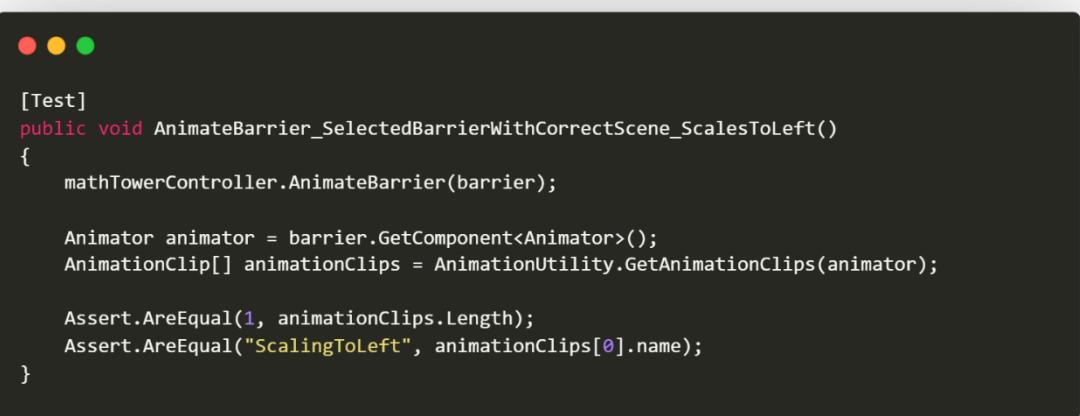
### 5 . 1 . Unit Testing

#### Barrier test

The first test, AnimateBarrier\_BARRIER8InMathLevel1Or2Or5\_ScalesToLeft, tests the behavior of the AnimateBarrier method when the barrier is in a specific math level. In this test, the Arrange step creates an instance of the MathTowerController class and a game object representing the barrier. The test then sets up the assumption that the scene name is "Math-Level-1" for this test.

In the Act step, the test calls the AnimateBarrier method with the barrier object as the parameter.

In the Assert step, the test checks that the barrier has an Animator component and that the current animation clip is "ScalingToLeft". The test then yields control back to the test runner.



```
[Test]
public void AnimateBarrier_SelectedBarrierWithCorrectScene_ScalesToLeft()
{
    mathTowerController.AnimateBarrier(barrier);

    Animator animator = barrier.GetComponent<Animator>();
    AnimationClip[] animationClips = AnimationUtility.GetAnimationClips(animator);

    Assert.AreEqual(1, animationClips.Length);
    Assert.AreEqual("ScalingToLeft", animationClips[0].name);
}
```

#### Disable barrier test

RemoveTheAnswerImage\_DisablesBarrierChildObject is a test for the RemoveTheAnswerImage method of the MathTowerController class. The purpose of this test is to verify that the RemoveTheAnswerImage method correctly disables the child object of a given barrier game object.

The test begins with the Arrange step, where it creates an instance of the MathTowerController class, a game object representing the barrier, and a child object of the barrier. The child object is initially set to be active.

In the Act step, the test calls the RemoveTheAnswerImage method with the barrier object as the parameter.

Finally, in the Assert step, the test checks that the child object of the barrier is no longer active. If the method is working correctly, the RemoveTheAnswerImage method should have disabled the child object.

```
[Test]
public void RemoveTheAnswerImage_DisablesBarrierChildGameObject()
{
    GameObject barrierChild = new GameObject();
    barrierChild.SetActive(true);
    barrierChild.transform.SetParent(barrier.transform);

    mathTowerController.RemoveTheAnswerImage(barrier);

    Assert.IsFalse(barrierChild.activeSelf);
}
```

## Tear Down test

In this case, the TearDown method is used to clean up any resources that were created during the test, in order to prepare for the next test.

In the TearDown method, any objects that were created during the test are destroyed. This is done to ensure that the tests are independent of each other and do not interfere with each other's results. In this specific example, the mathTowerController and barrier objects are destroyed to clean up after the tests.

By using the [TearDown] attribute, we can ensure that any setup or resources used during the test are properly cleaned up and disposed of after the test has finished running. This helps to prevent any memory leaks or other issues that can occur when resources are not properly managed.

```
[TearDown]
public void TearDown()
{
    // Clean up created objects
    Object.DestroyImmediate(mathTowerController.gameObject);
    Object.DestroyImmediate(barrier);
}
```

## 5 . 2 . Integration Testing

### Database Testing

<b>Test Case ID</b>	FB_001	<b>Test Case Description</b>	Test the Retrieving Data from Firebase										
<b>Created By</b>	Badri	<b>Test Scenario</b>	Retrieving Data from Firebase with ArrayList Struct										
<b>Description</b>													
Description: During development, we encountered an issue when retrieving data from a Firebase database using an ArrayList as a data structure. The issue was related to a foreach loop that was not correctly iterating over the child snapshots of the data. As a result, we changed the data structure from ArrayList to EList to fix the issue.													
Step	Step Details	Expected Results	Actual Results		<b>Status</b>								
1	Set up a Firebase database with test data.	The foreach loop should correctly iterate over the child snapshots of the data.	The foreach loop is not correctly iterating over the child snapshots of the data.		Fail								
2	Retrieve data from Firebase using an ArrayList												
3	Use a foreach loop to iterate over the child snapshots of the data.												
4	Observe that the foreach loop is not correctly iterating over the child snapshots of the data.												

### Solution

In order to address the issue with the foreach loop not correctly iterating over the child snapshots of the data when using an ArrayList as the data structure for retrieving data from a Firebase database, we revised the data structure to use an EList instead. An EList is a generic list data structure that is designed to work with a wider range of data types than an ArrayList, and is guaranteed to be type-safe and thread-safe. By changing the data structure to use an EList, we were able to ensure that the data types were consistent and that the foreach loop correctly iterated over the child snapshots of the data, ultimately resolving the issue with the data retrieval from Firebase.

## 5 . 3 . System Testing

### Valid Login

<b>Test Case ID</b>	LOGIN_001	<b>Test Case Description</b>	Test the Login feature in the mobile application				
<b>Created By</b>	Badri	<b>Test Scenario</b>	verify that a user can log in to the game successfully with valid credentials				
		<b>Prerequisites:</b>					
1	The game is installed and running on a compatible device.		1 email = badri@badri.com				
2	The user has created an account with valid credentials.		2 password = p@ssw0rd				
Step	Step Details	Expected Results	Actual Results		Status		
1	Launch the app	app should open	As Expected		Pass		
2	Navigate to the login	login page should be opened	As Expected		Pass		
3	Enter the user's valid	Data should be entered	As Expected		Pass		
4	Enter valid password.	Data should be entered	As Expected		Pass		
5	Click on the login button.	button should be clicked	As Expected		Pass		
6	Home page displayed	successfully logs in	As Expected		Pass		

### Invalid Login

<b>Test Case ID</b>	LOGIN_002	<b>Test Case Description</b>	Test the Login feature in the mobile application				
<b>Created By</b>	Badri	<b>Test Scenario</b>	verify that a user can log in to the game successfully with invalid				
		<b>Prerequisites:</b>					
1	The game is installed and running on a compatible device.		1 email = badri@badri				
			2 password = 123456				
Step	Step Details	Expected Results	Actual Results		Status		
1	Launch the app	app should open	As Expected		Pass		
2	Navigate to the login	login page should be opened	As Expected		Pass		
3	Enter the user's invalid	Data should be entered	As Expected		Pass		
4	Enter invalid password.	Data should be entered	As Expected		Pass		
5	Click on the login button.	button should be clicked	As Expected		Pass		
6	Displayed error message	Error message displayed	As Expected		Pass		

## Valid shop purchase

<b>Test Case ID</b>	Shop_001	<b>Test Case Description</b>	Test the shop feature in the mobile application										
<b>Created By</b>	Badri	<b>Test Scenario</b>	verify that the user can access and purchase items from the shop.										
<b>Prerequisites:</b>		<b>Test Data</b>											
1 The game is installed and running on a compatible device.		1 email = badri@badri.com 2 password = P@ssw@rd											
2 The user has logged in to the game successfully.													
Step	Step Details	Expected Results	<b>Actual Results</b>		<b>Status</b>								
1	Launch the app	app should open	As Expected		Pass								
2	Navigate to the shop	shop screen opened	As Expected		Pass								
3	Verify that the user can	The user can access and	As Expected		Pass								
4	Select an item to	item should be selected	As Expected		Pass								
5	Click on the purchase	button should be clicked	As Expected		Pass								
6	Verify that the item has	item should be purchased	As Expected		Pass								

## Valid achievements unlock

<b>Test Case ID</b>	ACH_001	<b>Test Case Description</b>	Test the achievements feature in the mobile application										
<b>Created By</b>	Badri	<b>Test Scenario</b>	verify that the game's achievements system works as intended.										
<b>Prerequisites:</b>		<b>Test Data</b>											
1 The game is installed and running on a compatible device.		1 email = badri@badri.com 2 password = P@ssw@rd											
2 The user has logged in to the game successfully.													
Step	Step Details	Expected Results	<b>Actual Results</b>		<b>Status</b>								
1	Launch the app	app should open	As Expected		Pass								
2	Navigate to the	achievements screen	As Expected		Pass								
3	Verify that the user can	The user can access the	As Expected		Pass								
4	Complete the	Completing the	As Expected		Pass								
5	Verify that the user	video should be displayed	As Expected		Pass								
6	Navigate back to the	The unlocked achievement	As Expected		Pass								

## Chapter Seven: Conclusion & Future Work

### 7 . 1 . Conclusion

In conclusion, the development and implementation of a game-based learning app has proven to be a highly effective and engaging tool for educational purposes. By combining the elements of gaming and learning, the app has successfully created a unique and impactful experience for children.

The interactive and immersive gameplay of the app has fostered a positive learning environment, encouraging active participation and knowledge retention. The incorporation of educational content into engaging challenges has effectively captured the attention and interest of children, making the learning process enjoyable and motivating.

Furthermore, the game-based learning app has demonstrated its potential to cater to diverse learning styles and preferences. Its dynamic and adaptive nature accommodates individual progress, allowing children to learn at their own pace. This personalized approach has enhanced the effectiveness of the learning experience, as users can focus on areas that require additional attention and reinforcement.

Moreover, the app has provided children with valuable opportunities to develop essential skills beyond the subject matter being taught. Critical thinking, problem-solving, collaboration, and decision-making skills have been nurtured through the app's challenging and thought-provoking gameplay.

In addition, the app's progress tracking and assessment features have enabled both children and families to monitor learning outcomes and identify areas for improvement. This feature has enhanced the effectiveness of the learning process, ensuring that children can receive targeted support and achieve their full potential.

Overall, the game-based learning app has revolutionized the way we approach education, harnessing the power of gaming to transform learning into a fun and engaging experience. Its ability to cater to diverse learning styles and promote the development of critical skills underscores its significance as a tool for educational advancement.

As technology continues to play an increasingly important role in education, the game-based learning app stands as a prime example of the potential to enhance learning outcomes and create a brighter future for learners worldwide. Its impact on the education sector is significant, and its continued development and implementation will undoubtedly pave the way for further advancements in educational technology.

### 7 . 2 . Future work

we're always looking to improve and add new features to enhance the user experience and make the kids have more fun and learn more from the application.

Our primary focus is to enhance children's learning experiences by incorporating a wide range of educational games into their routine. By introducing a diverse selection of games, we aim to ignite their curiosity, nurture their cognitive abilities, and facilitate continuous growth in knowledge. These

games will serve as powerful tools to make learning a fun and interactive journey for children of all ages.

### 7 . 2 . 1 . Games

#### ABC (First Game)

The "ABC" game is structured into five levels, and it covers all the English characters. The game employs interactive and engaging gameplay to teach children how to write each character correctly.

At the commencement of each level, a new character will be introduced, and children will learn how to write it through interactive exercises. The game will provide step-by-step instructions and guide children through the process of writing each character. Once children have learned how to write the character, they will be given the opportunity to practice it using interactive exercises.

The primary objective of this game is to teach children how to write English characters while providing them with a fun and engaging learning experience. By using interactive exercises and rewards, children will be motivated to continue learning and enhancing their skills.

Additionally, the "ABC" game has been fully developed and is currently awaiting integration with Firebase.



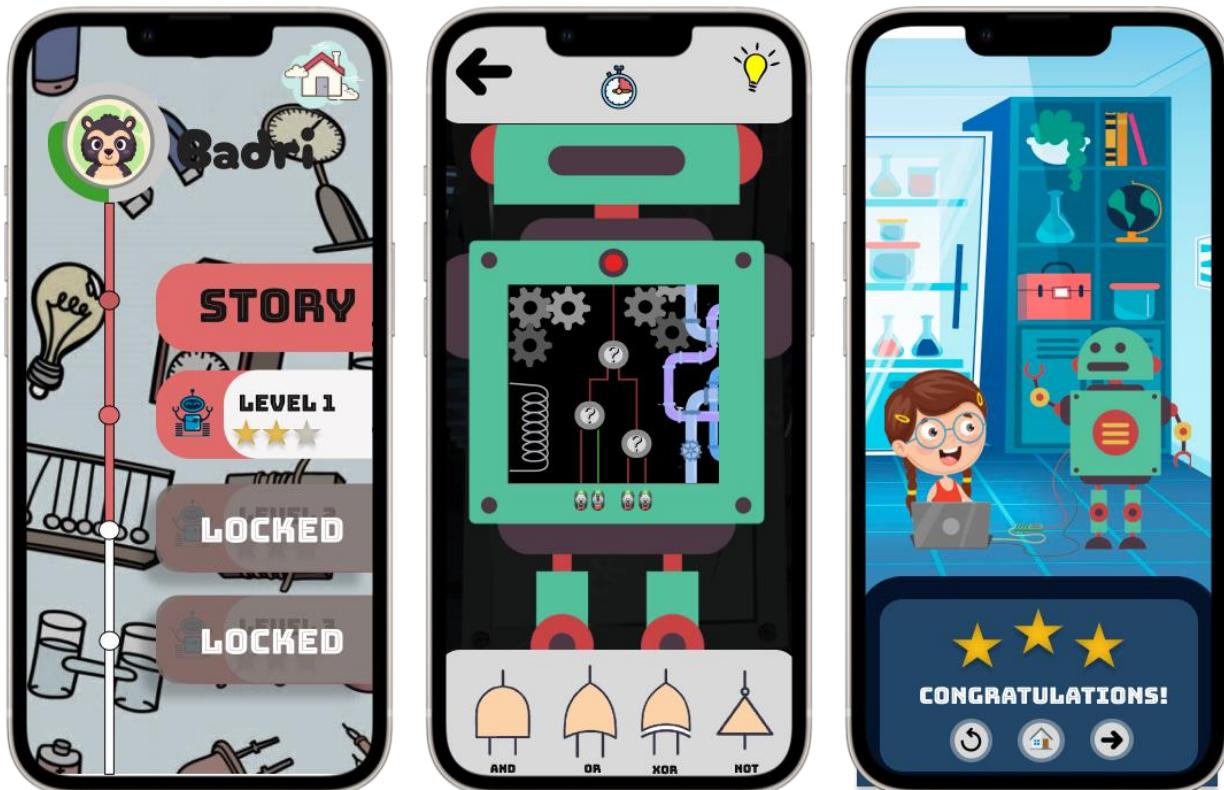
## Fix it (Second Game)

Our next step is to develop a new game for our app that will teach children about logic gates. The game, titled "Fix It," will be designed to attract children's attention and introduce them to the concept of logic gates in an engaging and interactive way.

To begin the game, a robot will be introduced to the children, which will talk and do some cool things to attract their interest. However, the robot will eventually become damaged and stop working. At this point, a girl character will appear to help the children fix the robot.

The girl character will teach the children about logic gates in detail, using animations and clear explanations to ensure that the children remain engaged throughout the game. Once the children have learned about logic gates, they will proceed to the gameplay, where they will use their new knowledge to fix the robot.

The "Fix It" game will be an immersive and interactive experience that aims to make learning about logic gates fun and enjoyable for children. By using a combination of clear explanations, engaging animations, and interactive gameplay, we hope to create a game that not only teaches children about an important topic but also helps to develop their critical thinking and problem-solving skills.



### Code cart (Third Game)

The main objective of the game is to engage and challenge children to move the car correctly by testing their problem-solving abilities. The game will be designed to provide children with an entertaining and engaging way to develop their problem-solving skills. By presenting them with complex challenges that demand creative thinking and innovative solutions, children will learn how to approach problems with a fresh perspective while cultivating their analytical abilities.

The game will be structured in a way that allows children to progress through increasingly difficult levels as they master each challenge. Each level will present a new problem that the children must solve, such as navigating through obstacles or finding the right path. To solve these problems, children will need to use their critical thinking and problem-solving skills to come up with innovative solutions.

To make the game more engaging, we plan to incorporate fun and interactive elements such as colorful graphics, sound effects, and animations. These elements will help to keep children motivated and focused on the game while also making the learning experience enjoyable and memorable.

The goal of the "car game" is to teach children how to become skilled problem solvers and enjoy learning about creative thinking and finding solutions to complex problems. We believe that problem-solving is a vital skill that can benefit children in all areas of life, from academic pursuits to professional careers and personal projects. By encouraging children to hone their problem-solving abilities while having fun, we hope to instill a lifelong love of learning in them.



## More Features

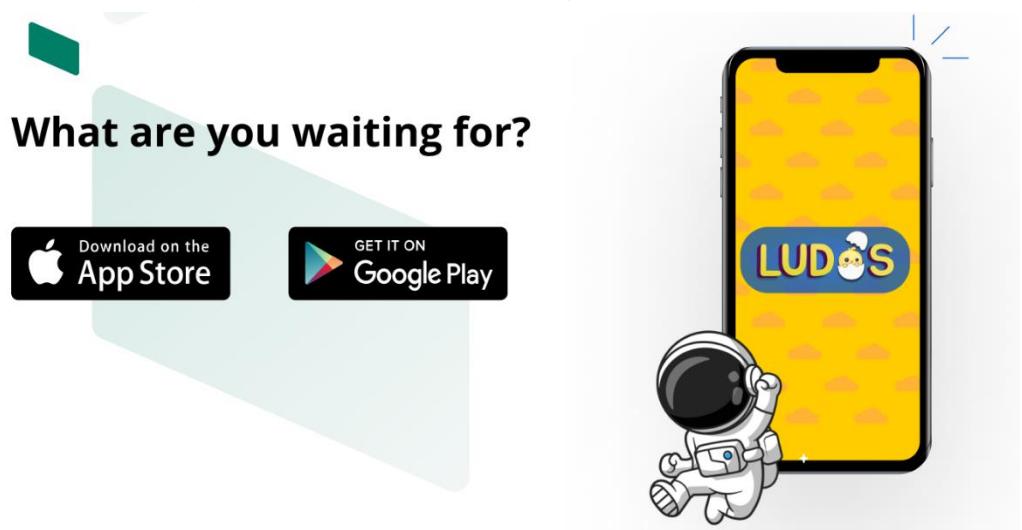
- Push notifications - This feature will be helpful for reminding users to play the game or use other services. It will provide a way to stay connected with the users and keep them engaged.
- Accessibility improvements - Ensuring that the app is accessible to all users, including those with disabilities, is a crucial aspect of creating an inclusive and effective educational tool.
- Dashboard - Adding a dashboard to the game will make it more competitive and engaging for kids. They can race to get the highest scores and learn better, which can motivate them to keep playing and learning.
- Personalization - Allowing users to personalize their experience in the app can make it more fun and engaging for them. Customizing the color scheme, creating a profile, or choosing their background images are some examples of personalization features.
- More content - Constantly adding new content to the app, such as new games, videos, articles, and categories, will keep the users interested and engaged. This feature will help to expand the learning opportunities available in the app.

## Website

As we expand our game collection, we understand the significance of providing parents with a seamless and informative experience. To accomplish this, we have plans to develop a dedicated website for the application, specifically designed to meet the needs of parents and facilitate their involvement in their children's learning journey.

The website will serve as a comprehensive platform where parents can access detailed information about the educational games offered. It will feature a user-friendly interface that allows for easy navigation, ensuring that parents can quickly find the information they need. Clear and concise descriptions of each game, along with their educational objectives and benefits, will be provided to assist parents in making informed decisions about their children's learning activities.

In addition, the website will provide parents with a monitoring system that enables them to track their children's progress within the games. Parents will have access to detailed reports that highlight their children's achievements, areas of improvement, and learning outcomes. This feature will allow parents to stay engaged and informed about their children's learning journey, and provide them with the necessary information to support their children's academic growth.



The image shows a screenshot of the Ludos app interface. At the top left is the Ludos logo. The top right features a user profile icon for "Zalata" with a dropdown arrow. The main header area has three navigation links: "Home", "Progress", and "Achievements". Below the header, a large green banner displays the text "Hello Zalata, Welcome Back". To the right of the banner is a cartoon illustration of a woman with dark hair, wearing a yellow polka-dot shirt and purple pants, standing with her arms outstretched. The background of the app interface is light blue with abstract green and white geometric shapes.

**Progress**

**Child one**

67%

[Add another one](#)

**Achivments**

**Child one**

**LUDOS**

## References

- [1] Mlumun, Yugh Sandra, et al. "Intellectual Impact of Mobile Educational Games on Secondary School Education in Nigeria: Case Study of Government Girls' College Makurdi." *American Journal of Information Science and Technology* 5.3 (2021): 48-59.
- [2] Narzikulovich, N. N. . (2022). Development of Physical Qualities of Preschool Children by Means of Mobile Games. *International Journal of Discoveries and Innovations in Applied Sciences*, 2(2), 45–48.
- [3] Yu, Z., Gao, M., & Wang, L. (2021). The effect of educational games on learning outcomes, student motivation, engagement and satisfaction. *Journal of Educational Computing Research*, 59(3), 522-546.
- [4] Papadakis, S., Alexandraki, F. & Zaranis, N. Mobile device use among preschool-aged children in Greece. *Educ Inf Technol* 27, 2717–2750 (2022).
- [5] Shufang Tan, Wendum Huang, Junjie Shang, Research Status and Trends of the Gamification Design for Visually Impaired People in Virtual Reality, *HCI in Games*, 10.1007/978-3-031-05637-6\_41, (637-651), (2022).
- [6] Gillett-Swan, J., Thelander, N. (2021). Child Rights Knowledge and Children's Education Rights. In: Gillett-Swan, J., Thelander, N. (eds) Children's Rights from International Educational Perspectives. *Transdisciplinary Perspectives in Educational Research*, vol 2. Springer, Cham.
- [7] Zheng, Y. (2021). New Ideas for College Physical Education Development Under the Background of “Internet+ Education”. In: Xu, Z., Parizi, R.M., Loyola-González, O., Zhang, X. (eds) *Cyber Security Intelligence and Analytics. CSIA 2021. Advances in Intelligent Systems and Computing*, vol 1343. Springer, Cham.
- [8] Al Abdullatif, Ahlam & Gameil, Azza. (2020). Exploring Students' Knowledge and Practice of Digital Citizenship in Higher Education. *International Journal of Emerging Technologies in Learning (iJET)*. 15. 122-142. 10.3991/ijet.v15i19.15611.
- [9] Mkpojiogu, Emmanuel & Hussain, Azham & Onah, Monday. (2021). Security Issues in the Use of Mobile Educational Apps: A Review. *International Journal of Interactive Mobile Technologies (iJIM)*. 15. 124-137. 10.3991/ijim.v15i06.20631.
- [10] Du, Y. (2021). Interactive Design Principles of Educational APP Interface. In: Sugumaran, V., Xu, Z., Zhou, H. (eds) *Application of Intelligent Systems in Multi-modal Information Analytics. MMIA 2021. Advances in Intelligent Systems and Computing*, vol 1385. Springer, Cham.
- [11] Parrilli, D.M., Hernández-Ramírez, R. (2022). Building a Privacy Oriented UI and UX Design: An Introduction to Its Foundations and Potential Developments. In: Martins, N.,

- Brandão, D. (eds) Advances in Design and Digital Communication II. DIGICOM 2021. Springer Series in Design and Innovation , vol 19. Springer, Cham.
- [12] Cao, H., Guo, J. (2020). Research on the User Experience of Educational App in the Context of "Intangible Cultural Heritage". In: Ahram, T., Falcão, C. (eds) Advances in Usability, User Experience, Wearable and Assistive Technology. AHFE 2020. Advances in Intelligent Systems and Computing, vol 1217. Springer, Cham.
- [13] Chang, WL., Lu, WH. (2021). Building Common Ground: Applying Mutual Learning in the UI/UX Education. In: Kurosu, M. (eds) Human-Computer Interaction. Theory, Methods and Tools. HCII 2021. Lecture Notes in Computer Science(), vol 12762. Springer, Cham.
- [14] Nielsen, J.: A 100-year view of user experience (by Jakob Nielsen). Accessed 11 Feb 2021
- [15] Ketut Sintia Kesuma Dewi, Padmadewi, N. N., & Dewi, K. S. (2022). An Analysis Analysis of Reward System Used in Blended Learning Strategy to Develop Students' Learning Motivation at North Bali Bilingual School. *Innovative Education Journal*, 1(1), 58–63.
- [16] Journal of Educational Research and EvaluationVolume 4, Number 3,Tahun 2020, pp. 307-314P-ISSN: 2597-422x E-ISSN: 2549-2675
- [17] Haryanto, Hanny, Ardiawan Bagus Harisa, and Indra Gamayanto. "Appreciative Learning for Immersive Reward System in Education Game Development." *Journal of Games, Game Art, and Gamification* 6.2 (2021): 32-38.
- [18] M. Morsidi, S. Tajuddin, R. K. Patchmuthu and S. H. S. Newaz, "Blockchain-based Reward System: a Means for Providing Incentive to Students for Teaching Feedback," 2021 *International Conference on Electronics, Communications and Information Technology (ICECIT)*, 2021, pp. 1-5, doi:
- [19] Zou, F., Cao, Y. (2020). Integrating Educational Content into Game: An Encapsulation Method. In: Shen, J., Chang, YC., Su, YS., Ogata, H. (eds) Cognitive Cities. IC3 2019. Communications in Computer and Information Science, vol 1227. Springer, Singapore.
- [20] Tan Kim Hua A Comparison of Online Learning Challenges Between Young Learners and Adult Learners in ESL Classes During the COVID-19 Pandemic, Vol. 12, No. 1, pp. 28-35, January 2022.
- [21] The Author(s) 2021 17 J. Ryoo, K. Winkelmann (eds.), Innovative Learning Environments in STEM Higher Education, SpringerBriefs in Statistics.
- [22] Bulut, D., Samur, Y. & Cömert, Z. The effect of educational game design process on students' creativity. *Smart Learn. Environ.* 9, 8 (2022).
- [23] Kearney, M., Burden, K., Schuck, S. (2020). Differentiating Mobile Learning Frameworks. In: Theorising and Implementing Mobile Learning. Springer, Singapore.
- [24] Mejía, J., Maciel, P., Muñoz, M., Quiñonez, Y. (2020). Frameworks to Develop Secure Mobile Applications: A Systematic Literature Review. In: Rocha, Á., Adeli, H., Reis, L., Costanzo, S., Orovic, I., Moreira, F. (eds) Trends and Innovations in Information Systems and Technologies. WorldCIST 2020. Advances in Intelligent Systems and Computing, vol 1160.

- [25] Santana Quintero, M., Duong, M., Smith, L. (2022). Developing an Ethical Framework for the Digital Documentation of Heritage Sites. In: Ch'ng, E., Chapman, H., Gaffney, V., Wilson, A.S. (eds) Visual Heritage: Digital Approaches in Heritage Science. Springer Series on Cultural Computing. Springer, Cham.
- [26] Murphy, B. M., Russell, K. L., Stillwell, C. C., Hawley, R., Scoggins, M., Hopkins, K. G., ... & Smith, R. F. (2022). Closing the gap on wicked urban stream restoration problems: A framework to integrate science and community values. *Freshwater Science*, 41(3), 000-000.
- [27] Rao, P. Srinivasa, et al. "DISTINCTION OF MOBILE FRAMEWORKS: FLUTTER VS NATIVE APPS.", Volume:04/Issue:06/June-2022.
- [28] Jayasinghe, M.J.W., Hennayaka, W.H.M.A.D.H., Fernando, M.P.M., Thilakarathne, K.N.U., Samarakoon, U., Kumari, S. (2022). **LEXISGURU: Mobile Application for Learning Basic Lexis in English** for Kids. In: Auer, M.E., Tsatsos, T. (eds) New Realities, Mobile Systems and Applications. IMCL 2021. Lecture Notes in Networks and Systems, vol 411. Springer, Cham.
- [29] Rocha, T., Barroso, J. (2021). PLAY for LEARNING: Serious Games to Assist Learning of Basic Didactic Concepts: A Pilot Study. In: Fang, X. (eds) HCI in Games: Serious and Immersive Games. HCII 2021. Lecture Notes in Computer Science(), vol 12790. Springer, Cham.
- [30] Wang, J. et al. (2021). A Study on Serious Game Practice to Improve Children's Global Competence. In: Fang, X. (eds) HCI in Games: Serious and Immersive Games. HCII 2021. Lecture Notes in Computer Science(), vol 12790. Springer, Cham.
- [31] Ergasheva, Madina Toyir Qizi. "THE BENEFITS OF TEACHING ENGLISH THROUGH GAMES." *Scientific progress* 2.7 (2021): 369-371.
- [32] Vuković, Predrag, and Anamarija Juras. "APPLICATION OF DIDACTIC GAMES IN MATHEMATICS TEACHING." *childhood* 17 (2022): 18.
- [33] Barr, Matthew, and Alicia Copeland-Stewart. "Playing video games during the COVID-19 pandemic and effects on players' well-being." *Games and Culture* 17.1 (2022): 122-139.
- [34] Abd-Alrazaq, Alaa, et al. "The effectiveness of serious games in improving memory among older adults with cognitive impairment: systematic review and meta-analysis." *JMIR serious games* 10.3 (2022): e35202.
- [35] Moving from Unity to Godot, 2020, ISBN : 978-1-4842-5907-8
- [36] Kishan Takoordyal, Beginning Unity Android Game Development, 2020, 978-1-4842-6002-9.
- [37] Beginning Unreal Engine 4 Blueprints Visual Scripting, 2021 ISBN : 978-1-4842-6395-2
- [38] Zagalo, N., Oliveira, A.P., Cardoso, P. (2021). Beats and Units Framework: A Story-Game Integration Framework for the Ideation Stage of Narrative Design of Serious Games. In: Mitchell, A., Vosmeer, M. (eds) Interactive Storytelling. ICIDS 2021. Lecture Notes in Computer Science(), vol 13138. Springer, Cham.
- [39] Entertainment for Education. Digital Techniques and Systems, 2010, Volume 6249  
ISBN : 978-3-642-14532-2 Wenfeng Hu

[40] (2008). Introduction to Software Architecture. In: Software Architecture. Advanced Topics in Science and Technology in China. Springer, Berlin, Heidelberg. [https://doi.org/10.1007/978-3-540-74343-9\\_1](https://doi.org/10.1007/978-3-540-74343-9_1)