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FACULTY OF ENGINEERING  
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**Project Report**  
Version 1

**CENG 407**  
Innovative System Design and Development I

**<201915>**  
**<A serious game to improve the specific fields of child  
intelligence>**

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## **Abstract**

Technology is developing day by day and its use to help learning is becoming more widespread. As technology developed and the use of technology in learning increased, the concept of Serious Games emerged. The use of games and simulations other than the pure entertainment purpose is called Serious Games. Serious games can be used as a tool to educate people at any age. One of the advantages of serious games is that learners can experience different situations that cannot be found in the real world. “Mind Garden” is a digital platform which contains different kind of serious games to develop children’s set of mental skills to create positive impacts for their education life. We aim to create an entertaining yet instructive environment to keep children’s attention in both education and entertainment. In this report, we explained why we plan to create “Mind Garden”, what are the software requirements and how we plan to design our software.

## **Key words:**

Serious games, mobile games, educational games, child intelligence

## **Özet:**

Teknoloji gün geçtikçe gelişiyor ve öğrenmeye yardımcı olmak için kullanımı giderek yaygınlaşıyor. Teknoloji geliştikçe ve teknolojinin öğrenmede kullanımı arttıkça, Ciddi Oyunlar kavramı ortaya çıktı. Oyunların ve simülasyonların salt eğlence amacı dışındaki kullanımına “Ciddi Oyunlar” denir. Ciddi oyunlar her yaşta insanı eğitmek için bir araç olarak kullanılabilir. Ciddi oyunların avantajlarından biri, öğrencilerin gerçek dünyada bulunamayan farklı durumları deneyimleyebilmeleridir. “Mind Garden”, çocukların eğitim yaşamları için olumlu etkiler yaratmak amacıyla zihinsel becerilerini geliştirmek için farklı türlerde ciddi oyunlar içeren dijital bir platformdur. Çocukların dikkatini hem eğitimde hem de eğlencede tutmak için eğlenceli ama öğretici bir ortam yaratmayı amaçlıyoruz. Bu raporda neden “Mind Garden” yaratmayı planladığımızı, yazılım gerekliliklerini ve yazılımımızı nasıl tasarlamayı planladığımızı açıkladık.

## **Anahtar Kelimeler:**

Ciddi oyunlar, mobil oyunlar, eğitici oyunlar, çocuk zekası

# **1. Introduction**

## **1.1 Motivation**

We are a group of senior students in the computer engineering department who are excited in the gaming sector. As a group, we have taken the course of "innovative game design" for a more immeasurable understanding of the gaming field. We aimed to combine the fields of education and gaming technologies in this project. We have chosen the Unity Game Engine for that purpose. For learning the Unity Game Engine deeper, we have taken the courses from "Udemy" to understand the unity game engine quite well. Furthermore, we aimed to raise awareness about technology affects children's mindsets. As a result of the literature review, the improvement of child intelligence using smart devices is achievable. The main motivation behind this project is the improvement of child intelligence.

## **1.2 Problem Statement**

The main problem of this project is harmful technology usage in kindergarten age children. As we mentioned in the literature review, every kindergarten-aged children has their smart devices in their house. Playing that smart devices could harm the mindset of kindergarten-aged children. Furthermore, playing not inspected games for children could lead to serious harm in children's physiology too. The kindergarten-aged children should be raised carefully, and attention should be paid to the use of technology in this regard.

## **1.3 Related Work**

MentalUp is software that UCL and YTU approved, supported by TUBITAK and pedagogical certified product that developed by Yıldız Technical University Academicians [1]. Focuses on kindergarten children's mindset. It aims to help children develop their mental skills and discover their potential through fun brain exercises. Moreover, Kodable founded by Jon Mattingly on October 20th, 2011. Trusted by over %50 of US schools that able to teach programming and creativity with digital applications of the company [2]. Some of the applications have drag and drop programming, explore cod before understanding it, design games, create characters, etc. That trusted by educators and experts [2]. US school teachers are using applications of the company too.

## **1.4 Solution Statement**

As a result of the literature review, a serious game on mobile devices can be the solution. A serious game is a game produced for a primary purpose rather than pure entertainment. To avoid the harmful effects of games on kindergarten-aged children is developing an educating and entertaining serious game. The game has limits of the screen looking time to avoid wasting time of children. The environment of the game is educating and non-violent plus entertaining for a child. The sub-games inside the project is focused on improving specific fields of kindergarten-aged child mindset. The mascot will be used to make understanding the games smoothly for a child. As a result, the game will not be harmful to any children plus the game will be beneficial to any children.

## **2. Literature Review**

Nowadays, the use of simulations and serious games in learning and assessment is widespread. Serious games used for purposes other than mere entertainment. The starting point is the concept of the serious game itself, and what it means. Serious games are allowed learners to experience some situations that are impossible in the real world for different reasons like safety, cost, time, etc. However, they are also claimed to have positive impacts on the players' development of several different skills [3]. Although there is much theoretical support for the benefits of digital games in learning and education, there is mixed empirical support. In this report, we searched about how to improve the children's mental capabilities using games.

### **2.1 Introduction**

Serious games are becoming popular. As technology develops, we come across many solutions to our problems. Serious games are there to create an entertaining environment for children's education. The term itself nowadays recognizable by everybody, but there is no current solid definition of the concept. The problem with the education system is that it is not always fun, and it shouldn't, but this contradiction creates a dull environment for those who need the most children. Lack of attention they gave to education makes the concept not efficient and loses its purpose. We believe entertainment is a solution to this problem. In the 90s, the term "Edutainment" created by a blending technique using the terms "education" and "entertainment". Edutainment generally refers to any training that also entertains, while usually associated with educational purposes of video games. The primary target group was preschool- and young children, with a focus on reading, mathematics, and science [3]. It was the first attempt to bring entertainment to education. As shown in Figure 1, serious games participate in many areas because we can apply them to various problems and challenges. Not only education, but we can also use serious games in; healthcare, which can be applied as rehabilitation, a consultancy that can develop children for their business future by teaching them social and logistic dynamics.



**Figure 1. Types of games [4]**

We aim to create a series of serious games and collect them on one platform to improve children's mindsets. The reason for creating multiple games is to reach out to multiple attributes of a child mentality and improve them at the same time efficiently and enjoyable.

## **2.2 Children Learning Styles**

Learning new concepts can be annoying for children nowadays. To achieve this goal, we have to make learning fun for children. If the students are not interested in the presented content, they will not learn it. To reach the ultimate goal of child learning, it is essential to use a combination of teaching methods and keep up the interest of a child. For that purpose, child games and e-learning methods are a magnificently cheap and efficient way to do it [5]. Every child has different characteristics while studying. Some students participate in class, and others are quiet. An active child usually likes to participate in lectures, like answering the question, lead the other friends in the study group, etc. The quiet child usually tends to listen to the teacher in class and shy to participate in class.

**Table 1. Learning Styles**

<b>Auditory</b>	<b>Visual</b>	<b>Kinesthetic</b>
Discussion	Texts	Movement
Debate	Charts	Role-plays
Podcasts	Tables	Drama
Dictations	Graphs	Races and competitions
Jigsaw reading	Mind maps	Handling objects or props
Reading aloud	Graphic organizers	
Storytelling	Art	
Chain games/chant	Drawings	
Lectures	Pictures	
	Posters	
	Realia	
	Visualizations	

Learning style is sometimes described as the cognitive, affective, social, and physiological characteristics that serve as a relatively stable predictor of how learners interpret, communicate with, and react to the learning environment [5]. There are three types of learning styles that usually known widely. That is: auditory, visual, and kinesthetic. Those types of learning styles are classified based on how the learner best in learning something. Visual learners learn best when they see something, auditory learners tend to use listening and auditory-related areas to process information, and kinesthetic learners prefer to learn by activities that require physical interaction [6]. The best way for visual students is observation. A teacher's body language and facial expressions are important for understanding the quality of the lecture. Auditory learners are prone to verbal lectures which contain discussions, oral lessons, and interaction. Kinesthetic learners tend to interact physically with activities by moving, walking, touching, etc. [7].

Towards this information, we can make sure about serious games for children can reach all learner types, including kinesthetic, auditory and visual, by using visual effects, characteristics sounds, and touching keyboard, mouse, or screen.

### **2.3 Children and Games**

We live in a digital world. Consumer research firm NPD Group (2009) reported that households with children aged 4 to 14 owned an average of 11 electronic devices [8]. In this digital world, it is significant to use technology efficiently for a purpose. Digital games can be a good case for that purpose. In educational child games, we are aiming for improving child intelligence since every child has their digital device, we are trying to achieve that digital devices are helpful for their mindset. Digital game-based learning has been used to teach, train, and raise students' awareness. In schools, it is employed as an adjunct to traditional methodologies to teach mathematics, science, engineering, history, and languages [9]. Digital games are faster than traditional teaching methods because of the internet usability and game



experiences of early 21. Century children. Furthermore, visual effects are an essential issue in the learning phase, too, just looking at diagrams and objects is not funny for the children. Game animations make understanding easy and able to develop 3-D thinking ability. Also, children likely to keep their attention while playing games, and that improves learning because they are not getting distracted [10]. One way to motivate children is to use creativity and innovation associated with the gamification of learning. Considering the importance and value of computer technologies to gaming culture, reflecting the attractiveness of gaming programs to educational programs will enable the student to participate more effectively in teaching-learning activities. If a game well designed and effectively structured, using gamification activities to support accounting courses is not only a viable alternative but also provides opportunities to elaborate on specific issues. As a result, teachable moments can be triggered by playing games.

## 2.4 Digital Game-Base Learning (DGBL) and Video Games

There are a number of interpretations of the game concept. The following description was developed by way of a critical examination of a variety of theses as to the essence of game-playing: To play a game is to engage in activity directed toward bringing about a specific state of affairs, using only means permitted by specific rules, where the means permitted by the rules are more limited in scope than they would be in the absence of the rules, and where the sole reason for accepting such limitation is to make possible such activity [11]. Many people play games for fulfilling pure purposes in their lives, such as; relaxation, enjoyment, preventing boredom, challenge, competitiveness, etc. These purposes could affect one's cognitive, behavioral, social, and affective skills indirectly. To create a strong effect directly through a digital platform, one of the best methods to do it is DGBL. Digital games, an interactive technology within the multimedia learning environment, could foster the learning process effectively and interestingly, especially among young learners [12]. DGBL is a concept that uses the game as a tool to express training content; it is all about exploiting the influence of computer games to captivate and involve end users for a specific purpose, such as the development of new knowledge and skills. [13]. DGBL is an evolving sector of education. Some of its advantages are:

- **Increases Student Engagement:** Becoming stronger in various courses creates more engagement in different subjects to get achievements. So that by one strong course, other courses have a high potential to grow.
- **Provides Instant and Healthy Feedback:** Data is easy to gather and compare with the help of technology. Nowadays most software applications use Data Science to create sub-systems that have purposes small but effective such as recommendation, testing efficiency, etc. With the help of this feedback, it becomes much easier to develop any subject.
- **Easy Access to Applications:** Not only game and education, but most of the aspects of life is also digital. Everything is reachable in the network. Different kinds of serious games, DGBL platforms are now accessible through the internet.

It contains open to question drawbacks, but also there are indisputable benefits of DGBL. Now that it becomes more and more successful, it is essential to give attention and separate from the concept "video games".

## **2.5 Similar Applications**

### **MentalUp**

MentalUp is a software that UCL and YTU approved, supported by TUBITAK and pedagogical certified product that developed by Yıldız Technical University Academicians [1]. Focuses on kindergarten children's mindset. It aims to help children develop their mental skills and discover their potential through fun brain exercises. It has more than 100 brain exercises for children. Also, MentalUp demands that playable for all kinds of children. It has daily exercise programs, performance tracking, reports for parents, etc. You can use it from many platforms, both on the computer, on the phone, on the tablet.

### **TocaBoca**

TocaBoca is a software that PRIVO: COPPA Safe Harbor Certified [15]. Differently from MentalUp, TocaBoca focuses on children's fun in games education and mindset development is the second phase for TocaBoca. The main goal for the company makes fun games for kids and keep children away from harmful games. The company claims that "Give them the freedom to play in ways that only they can dream up. There are no rules, no boundaries and no "right" or "wrong" way to do anything. There's just the undeniable, power of play. The thread that runs through everything we do is keeping the kids' perspective." The main goals for them are creativity, quality, innovation, and inclusion.

### **Kodable**

Kodable founded by Jon Mattingly on October 20th, 2011. Trusted by over %50 of US schools that able to teach programming and creativity with digital applications of the company [2]. Some of the applications have drag and drop programming, explore cod before understanding it, design games, create characters, etc. That trusted by educators and experts. US school teachers are using applications of the company too. Kodable educates children to code anywhere with fun games and provides teachers K-5 coding curriculum.

## **3. Software Requirements Specification**

### **3.1 Introduction**

#### **3.1.1 Purpose**

The purpose of this document is to describe the serious game called "Mind Garden". We aim to create a platform which contains different kind of serious games to address many mental skills of children to improve it. The name "Mind Garden" we came up with is simple yet an effective way to express ourselves for our future users because we want to choose a specific object which is recognizable for children, and in our opinion, it is an excellent way to create a game concept using plants. This document mainly focuses on the requirements of the project containing; software functionalities identified constraints and performance requirements. Moreover, this document explains how users interact with the game's user interface.

### 3.1.2 Scope of Project

Within the formal education, for most people, being a student is not entertaining. Entertainment is not an aspect of education, but it can be useful to employ in educational settings. Education is a significant and essential part of our lives. It is preparing for our future, choosing our proficiency. This problem could destroy an outstanding amount of potential for lots of people. This problem creates an unhappy environment in working places and decreases the quality and productivity of life and working spaces.

Using serious games, we are not only making education entertaining, but we also accustom students for licensed education by understanding which learning the student prone. So it is an excellent way to boost the mental skills of children. Creating one serious game to address children's attention is nearly impossible, so in our game, we are creating a game platform that contains different types of serious games. So, the purpose of "Mind Garden" is preparing children for education in every way possible. These games will dedicate what is the best learning style of our users, improve their other learning styles, boost their mental skills, and prepare them for education. It will be a standalone application. The innovative side of our application is that it is endless. Game developers could always come up with more types and more designs of serious games that could be implemented on our platform. The ability to add more types and more designs of serious games could increase relevancy to our application and address more users and developers. So it is a never stopping platform. The planned actor is a player. There will be an NPC (Non-Played Character) as a mascot to make users feel familiar with the game. It is there for teaching rules of games, explaining interfaces, objects, and creating a primary yet friendly relationship. Rewarding system of our game is connected to this NPC. After finishing tasks there will be a reward for our players to decorate the game mascot. This feature encourages players to play the game and decreases the possibility of boredom. Our game will contain four games that address different types of concepts using different types of learning methods. Obtained scores will be collected as data and create solutions for detected problems. Moreover, there will be a time limit for accessing the game. After reaching this limit, for daily, the player cannot access the game. This feature is important for averting game addiction.

### 3.1.3 Glossary

**Table 2. Glossary of SRS**

<b>Term</b>	<b>Definition</b>
Player	A person who plays the game.
Unity3D	Cross-platform game engine developed by Unity Technologies.
Serious Game	A game designed for a primary purpose other than pure entertainment.
NPC (Non-player Character):	Characters in the game who cannot be controlled by the player.
Standalone application	Applications that are able to operate independently of other hardware or software.
Software Requirements Specification	A document that completely describes all of the functions of a proposed system and the constraints under which it must operate. For example, this document.
Game Engine	A software-development environment designed for developers to build video games.

### **3.1.4 Overview of the Document**

The second part of this document describes the functionalities of "Mind Garden." It contains an informal requirements description. For technical requirement specification, there is a Requirement Specification chapter.

Requirement Specification chapter contains detailed information about the functionality of "Mind Garden". It contains technical terms about the game, so it is written mostly for software developers and game designers/developers.

To sum up, both sections explain and describe the functionalities of the product. The difference is there to address different audiences.

## **3.2 Overall Description**

### **3.2.1 Product Perspective**

Mind Garden is a game platform that contains multiple serious games for improving the mental skills of children, determining which learning style is suitable for children, and creating a healthy, entertaining environment for children to prepare their mindset for education in a positive way. The game will have two paths to follow. The routine mode includes a set of games that the user must spare time to play it. Games will be played consecutively. These routines will measure daily improvement, and a graph will be generated according to the data. Training mode enables the user to play whatever game he/she wants to play. The process will not affect the graph, and it is an excellent way to train and improve players' talent for specific games. Games have different objectives and play styles, so they address different types of mental skills. The main aspects of our games are mathematics, grammar, science, and memory. These aspects are the foundations of most of the proficiency.

### **3.2.2 Development Methodology**

During the development process, we have planned to use Scrum, which is an agile software development methodology. Our game contains sub-games that are fast-moving development projects. Scrum is efficient for creating fast-moving development projects. Also, observing individual effort is easy. This feature enables us to determine problems like distribution of tasks, possible discord in compliance. Scrum divides main work into sprints, which mean tasks that have a period to finish. Every sprint includes its planning, building, testing, and reviewing. Every sprint belongs to a different game. There are three main roles in the scrum, which are product owner, scrum master, and development team. The product owner builds a list of requirements for the product. Scrum Master is responsible for managing the development team and process. The development team includes developer members who work on the product, according to sprints. The development team should have a meeting every day to give information about finished, ongoing, and uninitiated features which planned in sprints. With scrum we can:

- Manage events in case of any problems in the planned events.
- Meetings ensure constant feedback about product to create awareness about the current position.
- Building quality products is possible at the scheduled time.
- Planning phase is more flexible to ensure avoiding any clash.

**Table 3. Scrum Table**

<b>Sprint 1</b>	<b>Sprint 2</b>	<b>Sprint 3</b>	<b>Sprint 4</b>
2D Modeling	2D Modeling	GUI Design	GUI Design
Coding	Coding	2D Mascot Modeling	Coding
Unit Testing	Unit Testing	Sound Recording	Unit Testing
Integration Testing	Integration Testing	Sound Editing	Animation
Deployment	Deployment	Video Editing	Acceptance Testing
Meeting	Meeting	Creating Survey	Verification Testing
Documentation	Documentation	Documentation	Agile Retrospective
Agile Retrospective	Agile Retrospective	Agile Retrospective	Release

Scrum Table includes four sprints. In every sprint, we have a set of tasks. We have four states for our tasks and we declare 3 week time period for each sprint. “Uninitiated” means that the state does not have any progress. “Ongoing” means that the state has a process but not finished. “Finished” means that the state is complete and ready for testing. “Pitfall” means that the state has problems, and the current task manager cannot deal with it.

### **3.2.3 User Characteristics**

#### **3.2.3.1 Player**

The player must have fundamental knowledge about portable mobile devices (tablets, smartphones). The player must not look screen closer than thirty centimeters. The player must not have anxiety and epilepsy problems caused by screen changes and sounds. The player must have fundamental knowledge about reading and writing to play primary school applications. The player must be at least four years old or higher.

### **3.3 Requirements Specification**

#### **3.3.1 External Interface Requirements**

##### **3.3.1.1 *User interfaces***

The user interface will be worked on the Android operating system.

##### **3.3.1.2 *Hardware interfaces***

Android OS 4.1 or later; ARMv7 CPU with NEON support or Atom CPU; OpenGL ES 2.0 or later [15].

##### **3.3.1.3 *Software interfaces***

There are no external requirements for the software interface.

##### **3.3.1.4 *Communications interfaces***

There are no external requirements for communication interfaces.

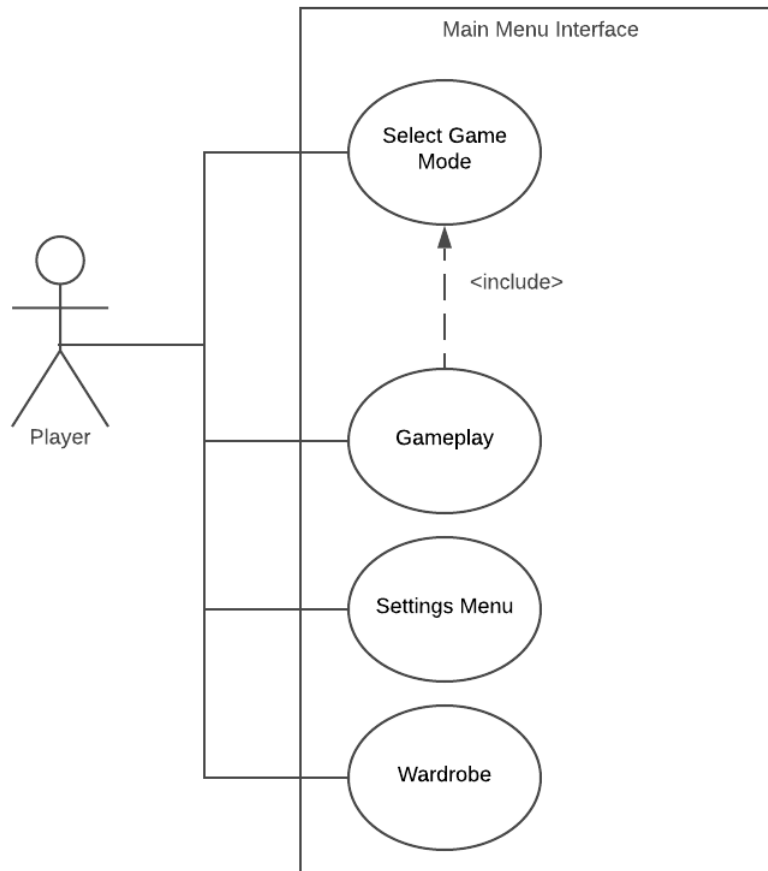
#### **3.3.2 Functional Requirements**

##### **3.3.2.1 *Main Menu Interface Use case***

##### **Use Case:**

- Select Game Mode
- Login / Register
- Settings Menu
- Gameplay

**Diagram:**



**Figure 2. Main Menu Interface Use Case Diagram**

**Brief Description:**

The use case diagram of the main menu is shown in Figure 1. The player can use the “Select Game Mode”, “Settings Menu”, “Wardrobe” functions in the main menu. As a player opens the game, he/she will encounter with the main menu. If the player opens the game for the first time, the player has to give basic information first. If the player has existing information, the player can access the game. After access to the game, the player can use select game mode function to select a preferred game mode to play. Game settings can be changed by using the “Settings Menu” button. The player can adjust the look of the mascot using the “Wardrobe” button.

### **Initial Step by Step Description:**

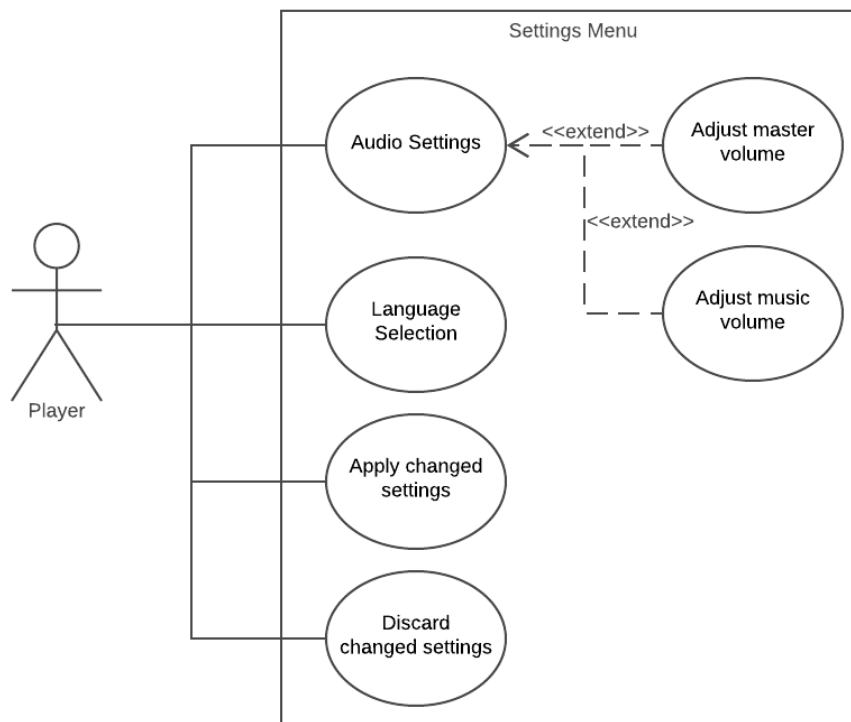
1. Player can start the system. If there is no initial information about the player, the player must enter initial information.
2. If the player selects, select game mode button player can select which game mode he/she wants to play.
3. If the player selects the settings menu button player is directed to the settings menu.
4. Player can select the wardrobe button to design the mascot.

#### **3.3.2.2 Settings Menu Use Case**

##### **Use Case:**

- Audio Settings
- Adjust master volume
- Adjust music volume
- Language Selection
- Apply Changed Settings
- Discard Changed Settings

##### **Diagram:**



**Figure 3. Settings Menu Use Case Diagram**



### **Brief Description:**

The use case diagram of the settings screen is shown in Figure 2. The player can change the “Audio Settings”, “Language Selection”, "Apply changed settings", "Discard changed settings" in various tabs respectively. In audio settings, tab users are permitted to change various volume settings. “Adjust master volume” function applied for changing the overall volume level of the game by moving along the volume slider. “Adjust music volume” function used for changing the background music of the game by moving along the volume slider. The player can change the language of the game by the "Language Selection" tab. The user can apply the changes by using the "Apply changed settings" tab, or the player can discard the changes by using the "Discard changed settings" tab.

### **Initial Step by Step Description:**

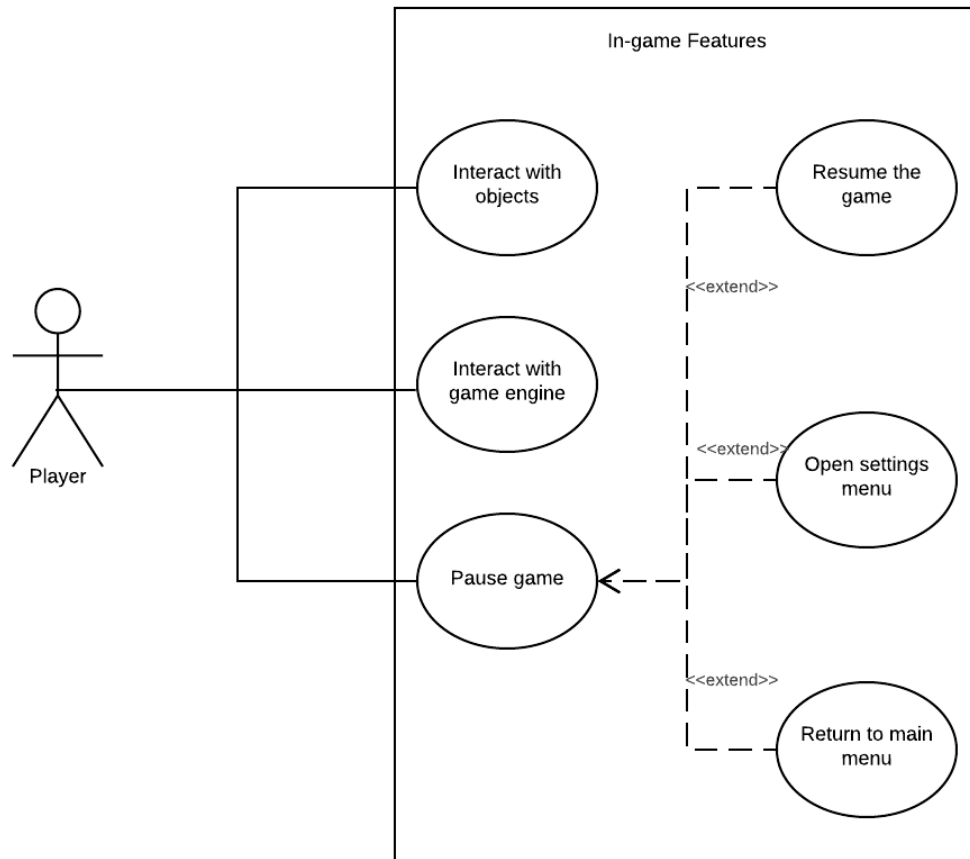
1. If the player selects, audio settings button player can adjust master volume and adjust the music volume.
2. If the player selects the language selection button, the player can choose one of the existing languages.
3. If the player selects apply changed settings button, all changes are saved.
4. If the player selects the discard changed settings button, all changes are discards.

#### ***3.3.2.3 In-Game Features Use Case***

### **Use Case:**

- Interact with Objects
- Interact with Game Engine
- Pause Game

### **Diagram:**



**Figure 4. In-game Features Use Case Diagram**

### **Brief Description:**

Figure 3 is in-game features use case diagram. In this diagram, when the player selects game mode to play, he/she interact with objects and game engine. When the player plays the game, he/she can pause at any time. If the player pauses the game, the game is stopped, and the pause game menu is displayed. Pause game menu includes resume the game, open settings menu, and return to main menu functions.

### **Initial Step by Step Description:**

1. When the player playing the game, he/she interact with game objects and game engine.
2. If the player selects the pause game button pause game menu is shown up.
  - a. If the player selects resume the game function on pause game menu, the game resume from where it is left.
  - b. If the player selects an open settings menu on the pause game menu, the player is directed to the settings menu.
  - c. If the player selects to return to the main menu on the pause game menu, the player leaves the current game and directed to the main menu.

### **3.3.3 Performance Requirements**

The application created by using the Unity game engine. The versions of the Unity game engine 2019 are supported. Higher versions must be supported by the application too. The operating system must be based on later versions of the android.

### **3.3.4 Software system attributes**

#### **3.3.4.1 Portability**

The project does not require any additional technological devices rather than smartphones or tablets. That improves the portability of the project. The project developed using Unity 3D. The Unity 3D works on various platforms. Therefore, it provides advantages for portability to various platforms.

#### **3.3.4.2 Performance**

Games cannot be playable unless the player enters initial information.

#### **3.3.4.3 Usability**

The project does not include complex hardware components. Thus, the installation and configuration of the project are fundamental as long as the required system requirements (mentioned in the documentation) are satisfied.

#### **3.3.4.4 Maintainability**

New features, add-ons, and improvements made for the system with developing the technology. For this purpose, object-oriented programming will be applied to make modifications, reduce maintenance costs, and make improvements.

#### **3.3.4.5 Safety Requirement**

Since the project is developed for kindergarten children, it contains some requirements. These requirements for the player are: Should not play the game more than the recommended time. Must be at least four years old.

## **4. Software Design Description**

### **4.1 Introduction**

#### **4.1.1 Purpose**

The purpose of this Software Design Document (SDD) is to detail the architectural and system design of the project titled as “Mind Garden”. The scope of this project is to improve the child intelligence and make entertainment a part of it. The concept of serious games allows using games for a primary purpose other than pure entertainment [17]. Mind Garden is a serious game which is running on mobile devices.

The target audience of this project is kids on primary education. This game will create an opportunity to learn and practice on the different intelligence development techniques. Mind Garden aims to combine this process with entertainment.

In order to provide a better understanding, this SDD includes various diagrams such as UML class diagram, activity diagram, and use case realization diagram.

#### **4.1.2 Scope**

This document contains a complete description of the design of Mind Garden. To develop this game, detailed research is conducted about the kid's intelligence development techniques and appropriate approach to games for kids.

For developing this game Unity Game Engine will be used. Procedures of creating the two-dimensional environment, programming and designing will be performed on Unity Game Engine. For designing of scenes, sprites and *tilemaps* in Unity will be used. As a programming language C# will be used and as an IDE we will be working on Visual Studio.

For designing part various assets from Unity Asset Store and sources will be used. Blender will be used for designing 2D models.

Players will be faced with different game modes. All of these games will be challenging the player in different areas. These games will be more difficult in progress of the game for the observe how players skills, reactions, and approaches change during play this game.

#### 4.1.3 Glossary

Table 4. Glossary of SDD

Term	Definition
<b>Serious Games</b>	A game designed for a primary purpose other than pure entertainment [1].
<b>UML Diagram</b>	A diagram based on Unified Modelling Language.
<b>Mobile Device</b>	A portable computing device such as a smartphone or tablet computer.
<b>SDD</b>	Software Design Document
<b>Unity</b>	Cross-platform game engine developed by Unity Technologies.
<b>Sprite</b>	2D Graphic objects.
<b>Tilemap</b>	A system which stores and handles Tile Assets for creating 2D levels.
<b>Footage</b>	A raw, unedited material which obtained from a video or a game.

#### 4.1.4 Overview of document

The second part of this document describes the Architectural Design of the project. Also, it contains UML class diagram of system and architecture design of game which describes actors, exceptions, basic sequences, priorities and post conditions. Finally, this section contains activity diagram of project.

The third section is Use Case Realization. In this section, a block diagram of the system is displayed and explained.

Final section is related to Environment. In this section, sample footage from pre alpha is given and game is described.

## 4.2 Architecture design

### 4.2.1 Simulation Design Approach

During the development process, we have planned to use Scrum, which is an agile software development methodology. Our game contains sub-games that are fast-moving development projects. Scrum is efficient for creating fast-moving development projects. Also, observing individual effort is easy. This feature enables us to determine problems like distribution of tasks, possible discord in compliance. Scrum divides main work into sprints, which mean tasks that have a period to finish. Every sprint includes its planning, building, testing, and reviewing. Every sprint belongs to a different game. There are three main roles in the scrum, which are product owner, scrum master, and development team. The product owner builds a list of requirements for the product. Scrum Master is responsible for managing the development team and process. The development team includes developer members who work on the product, according to sprints. The development team should have a meeting every day to give information about finished, ongoing, and uninitiated features which planned in sprints. With scrum we can:

- Manage events in case of any problems in the planned events.
- Meetings ensure constant feedback about product to create awareness about the current position
- Building quality products is possible at the scheduled time.
- Planning phase is more flexible to ensure avoiding any clash.

**Table 5. Scrum Table**

Sprint 1	Sprint 2	Sprint 3	Sprint 4
2D Modeling	2D Modeling	GUI Design	GUI Design
Coding	Coding	2D Mascot Modeling	Coding
Unit Testing	Unit Testing	Sound Recording	Unit Testing
Integration Testing	Integration Testing	Sound Editing	Animation
Deployment	Deployment	Video Editing	Acceptance Testing
Meeting	Meeting	Creating Survey	Verification Testing
Documentation	Documentation	Documentation	Agile Retrospective
Agile Retrospective	Agile Retrospective	Agile Retrospective	Release

Scrum Table includes four sprints. In every sprint, we have a set of tasks. We have four states for our tasks, and we declare 3 week time period for each sprint. “Uninitiated” means that the state does not have any progress. “Ongoing” means that the state has a process but not finished. “Finished” means that the state is complete and ready for testing. “Pitfall” means that the state has problems, and the current task manager cannot deal with it.

## 4.2.2 Class Diagram

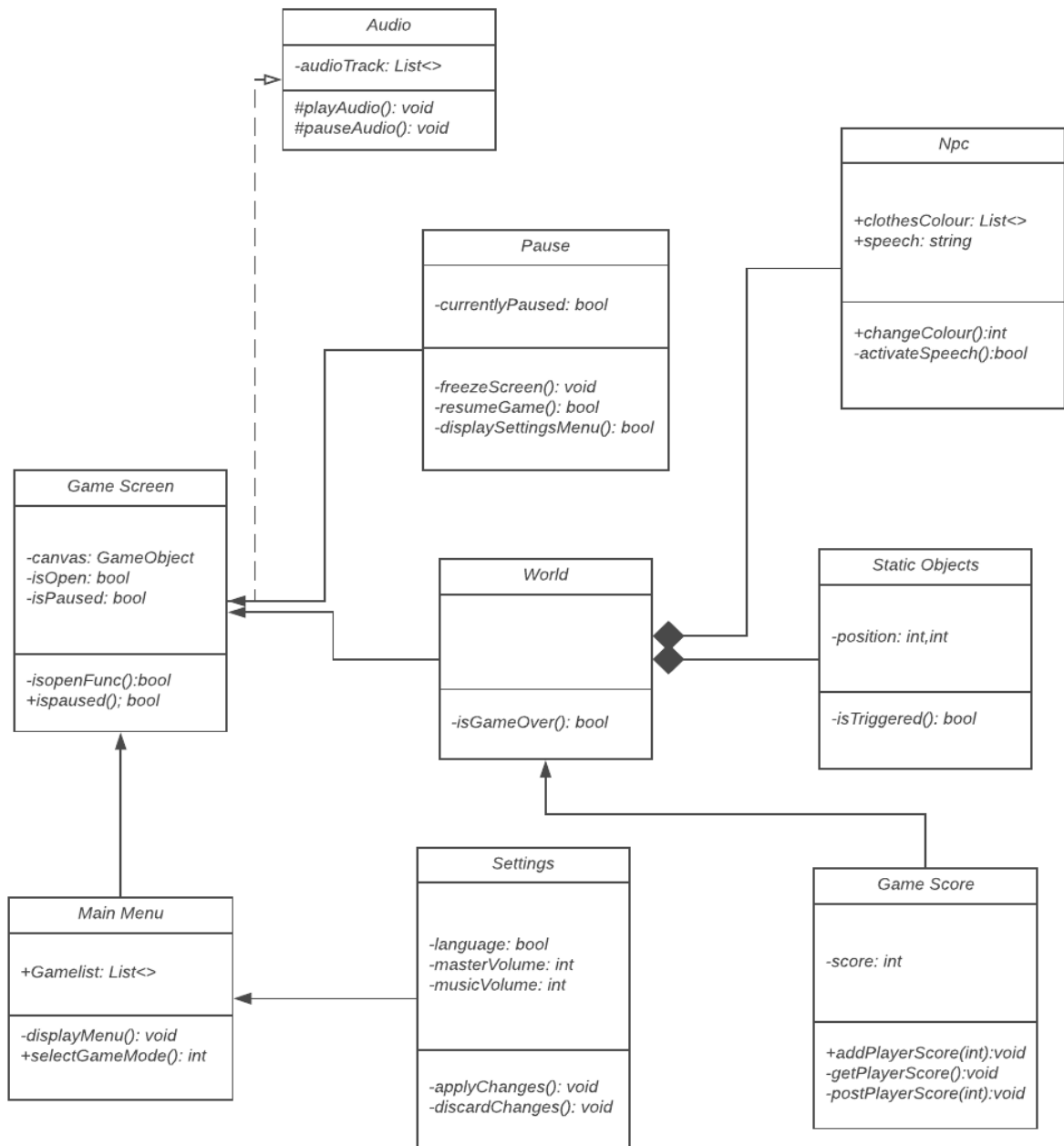


Figure 5. UML Class Diagram

## **4.3 Architecture Design of Application**

### **4.3.1 Main Menu**

**Summary:** This system is used by the player. Players can choose a game mode, can go to the options menu, choose to clothe mascot with arcane dust (the currency of the game) and exit from the game.

**Actor:** Player

**Precondition:** The player must have initial information.

**Basic Sequence:**

1. The player must indicate that he/she is suitable for the application.
2. The player must have initial information.
3. The player can choose the routine game mode to play.
4. The player can choose challenge game mode to play.
5. The player can go to the options menu.
6. The player can clothe the mascot with arcane dust (currency of the game).
7. The player can exit from the application.

**Exception:** None.

**Post Conditions:** None

**Priority:** High

### **4.3.2 Options Menu**

**Summary:** Player can adjust audio settings of the game and change language.

**Actor:** Player

**Precondition:** Player must have initial information.

**Basic Sequence:**

1. The player can adjust the music volume.
2. The player can adjust the master volume.
3. The player can change language from a list.
4. The player can apply changes.
5. The player can discard changes.



**Exception:** None

**Post Conditions:** Any applied changes are saved. To change the language player must restart the application.

**Priority:** Medium

#### 4.3.3 Routine Mode

**Summary:** Player will play series of games. Players must play in routine mode one time in a day. The player can get to next game after current game finishes. The player can pause the game by opening options menu. The player can exit from application but it will give a warning.

**Actor:** Player

**Precondition:** Player must interact with this button for the first time in a day.

**Basic Sequence:**

1. The player can interact with game objects.
2. The player can get to next game after current game finishes.
3. The player can pause the game.
4. The player can adjust master volume through the options menu.
5. The player can adjust music volume through the options menu.
6. The player can exit from the application.

**Exception:** Potential bugs in games and scene transition.

**Post Conditions:** After finishing routine mode players cannot access routine game mode again.

**Priority:** High

#### 4.3.4 Challenge Mode

**Summary:** The actor is player. The player can choose any game to play to improve routine game mode. The player can pause the game by opening the options menu. The player can exit from the application.

**Actor:** Player

**Precondition:** Player must have initial information.

**Basic Sequence:**

1. The player can interact with game objects.
2. The player can pause the game.
3. The player can adjust master volume through the options menu.
4. The player can adjust music volume through the options menu.
5. The player can exit from the application.

**Exception:** Potential bugs.

**Post Conditions:** None

**Priority:** Medium

## 4.4 Activity Diagram

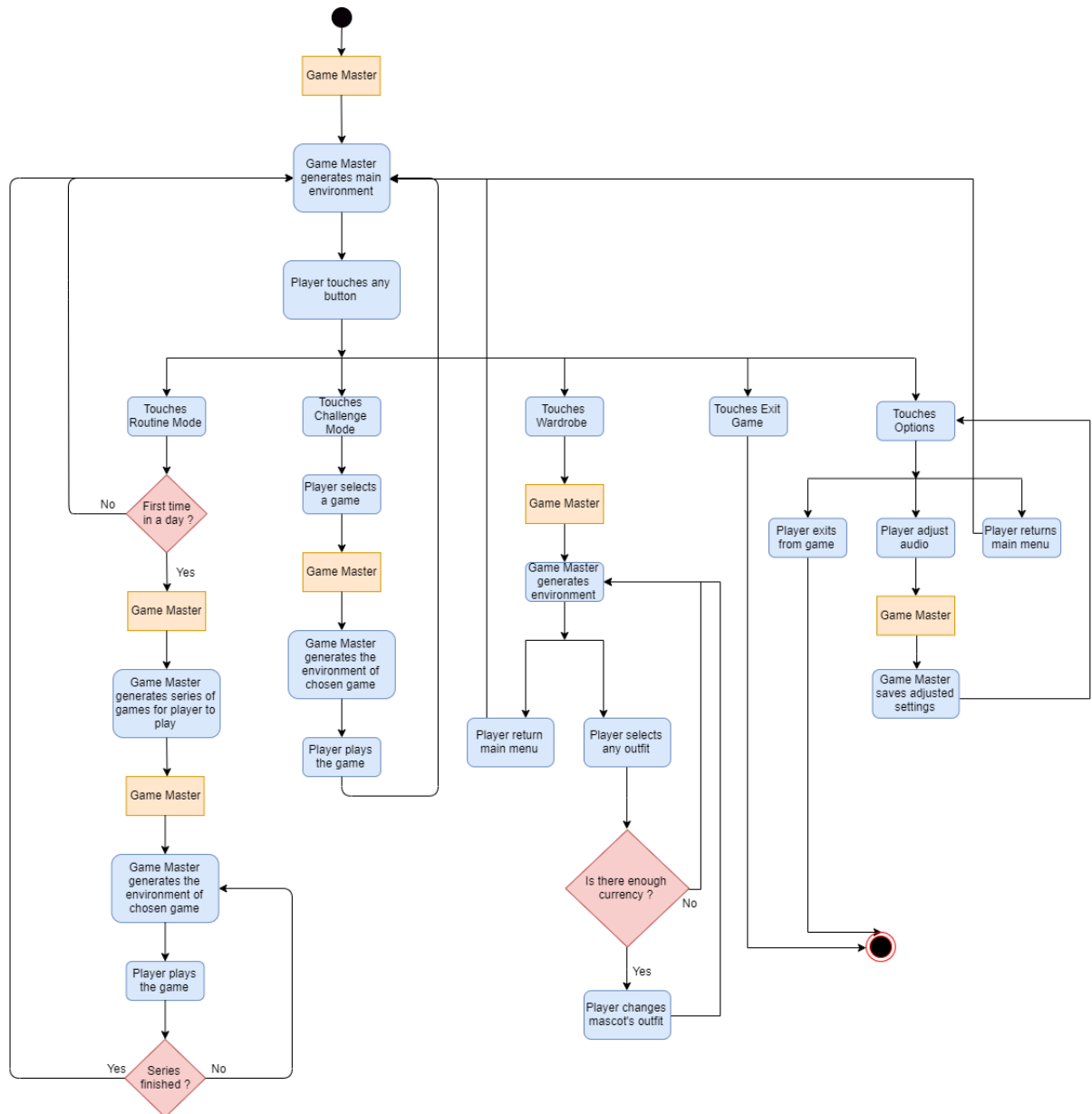
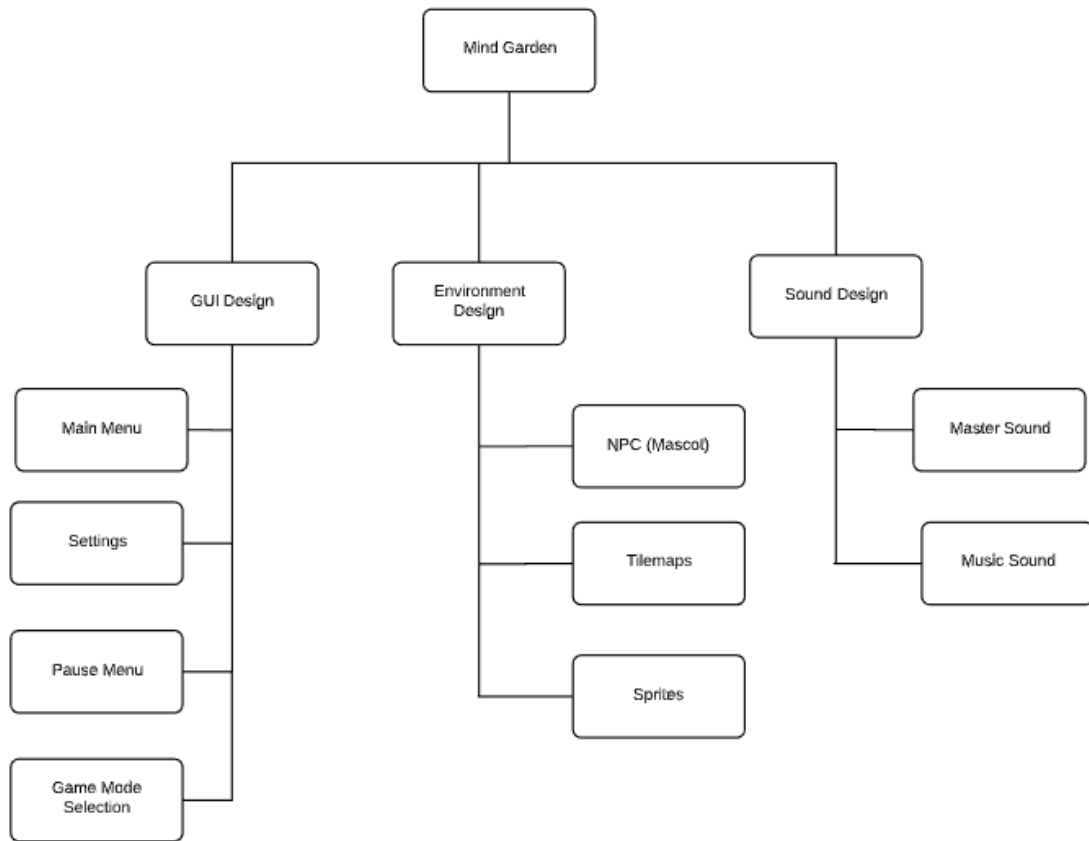


Figure 6. Activity Diagram

## 4.5 Use case realizations



**Figure 7. Use Case Realizations**

### 4.5.1 Brief Description of Figure 7

Components of the Mind Garden Project are shown in Figure 4. All designed systems of the simulation are displayed in the block diagram in the figure. There are three main components of the system which have their sub-systems.

#### 4.5.1.1 GUI Design

GUI design is responsible for interaction between the actors and the system. There are four sub-systems in this design which are Main Menu, Settings, Pause Menu and, Game Mode Selection. The Main menu is a start page. Settings include options for the game, you can change and show the settings. Pause Menu showed up when you pause the game. Game Mode Selection provide to choose game mode Challenge or Routine.

#### **4.5.1.2 *Environment Design***

Environment Design is responsible for managing the environment in which the user interacts with objects. The NPC (mascot) motivates the player. The tilemaps and, sprites work on environment design.

#### **4.5.1.3 *Sound Design***

The sound design module provides to avoid boring game time for the player. This sub-system includes Master Sound and Music Sound.

### **4.6 Environment**

#### **4.6.1 Modelling Environment**

The Environment of the project will be developed using Unity3D and its tools. Additionally, the project will include some free assets from Unity's Asset Store to develop the game quicker. To avoid boringness, the environment of the game will construct as much interactive as for children. For that purpose, the environmental design of the game should not contain violence and adult content. It must contain objects such that introduce kindergarten students to their surroundings like introducing to animals, fruits, and objects [18]. Furthermore, a mascot figure will be used as a guide liner for the player. That allows the game easy to understand.

## 5. Conclusions

“Mind Garden” is a digital platform which contains different type of serious games. To improve children’s mindset, “Mind Garden” enables us to address a different type of mental skills of children. There are two ways to play “Mind Garden”. Routine mode is a series of serious games for users to play once in a day to save the progress of player’s improvement. Challenge mode is for practice by giving the player a choice to play any of the platform’s games. This mode is useful to practice games to improve the results of routine mode. There is a mascot for explaining the graphical user interface containing buttons and games. Rewarding system is especially important in games to keep the player attached. Every finished task gives the player a reward that can be used in the “Wardrobe” section. Using the “Wardrobe” player can adjust the appearance of mascot. To prevent game addiction, the player can play routine mode once in a day and the game itself is playable for a specific amount of time.

Some of the advantages of serious games are:

- So that it is a digital platform, application is effortless to access.
- Prepare children to use another application.
- Changing children’s perspective on the concept of education positively.
- Teaching the concept of time management.
- Produced for a primary purpose rather than pure entertainment.
- Prepare children for further education.
- Avoid harmful effects of non-serious games.

Education life could be difficult. Everyone has a different approach to different lectures. To make these approaches more confident, making people adapt and improve their mental attributes is very promising for finding their learning style and adapting education life. Serious games create a healthy environment for education, positive impacts on the life perspective of individuals and easy access from digital problems. It is an efficient and enjoyable way to prepare children for the future. If their future gets clearer, guidance for next generations would be more promising. Mind Garden can be a small game platform at the start, but it has an endless development process. New games and new learning styles will appear as humankind gets bigger and better. Mind Garden is an adaptable, never-ending software application which will extend its capabilities as it extends children’s capabilities.

## Acknowledgement

We are grateful for guidance we have received from Assist. Prof Dr. Murat SARAN. The help we received from him was a great asset to improve this project and ourselves.

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