ÇANKAYA UNIVERSITY
FACULTY OF ENGINEERING
COMPUTER ENGINEERING DEPARTMENT

Project Report

Version 1

CENG 408

Innovative System Design and Development II

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

Ali Kaan Göksu
201511026
Kazım Ataol Özüseven
201411049
Emre Kasar
201511038
Eyüp Taşkın
201511059

Advisor: *Assist. Prof. Dr. Murat Saran*

Table of Contents

Table of Contents ii

Abstract iv

Özet: iv

1. Introduction 5
   1.1 Motivation 5
   1.2 Problem Statement 5
   1.3 Related Work 5
   1.4 Solution Statement 5

2. Literature Review 6
   2.1 Introduction 6
   2.2 Children Learning Styles 7
   2.3 Children and Games 8
   2.4 Digital Game-Base Learning (DGBL) and Video Games 9
   2.5 Similar Applications 10

3. Software Requirements Specification 10
   3.1 Introduction 10
      3.1.1 Purpose 10
      3.1.2 Scope of Project 11
      3.1.3 Glossary 11
      3.1.4 Overview of the Document 12
   3.2 Overall Description 12
      3.2.1 Product Perspective 12
      3.2.2 Development Methodology 12
      3.2.3 User Characteristics 13
   3.3 Requirements Specification 13
      3.3.1 External Interface Requirements 13
      3.3.2 Functional Requirements 14
      3.3.3 Performance Requirements 19
      3.3.4 Software system attributes 19

4. Software Design Description 20
   4.1 Introduction 20
      4.1.1 Purpose 20
      4.1.2 Scope 20
      4.1.3 Glossary 21
      4.1.4 Overview of document 21

4.2 Architecture design 22
4.2.1 Simulation Design Approach 22
4.2.2 Class Diagram 23
4.3 Architecture Design of Application 24
4.3.1 Main Menu 24
4.3.2 Options Menu 24
4.3.3 Routine Mode 25
4.3.4 Challenge Mode 26
4.4 Activity Diagram 27
4.5 Use case realizations 28
4.5.1 Brief Description of Figure 7 28
4.6 Environment 29
4.6.1 Modelling Environment 29
5. Test Plan, Test Design Specifications and Test Cases 30
5.1 Introduction 30
5.1.1 Version Control 30
5.1.2 Overview 30
5.1.3 Scope 30
5.1.4 Terminology 30
5.2 Feautures To Be Tested 30
5.2.1 Graphical User Interface (GUI) 31
5.2.2 Options (OPT) 31
5.2.3 Routine Mode (RTM) 31
5.2.4 Select Game Mode (SGM) 31
5.3 Item Pass/Fail Criteria 31
5.3.1 Exit Criteria 31
5.4 References 32
5.5 Test Design Specifications 32
5.5.1 Graphical User Interface (GUI) 32
6. Conclusions 46
Acknowledgement 46
References 47

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 evaluation is common. Serious games used for purposes other than mere entertainment. The starting point is the idea of and means the serious game itself. Serious games allow players to encounter certain scenarios which are impossible in real life for various reasons such as safety expense, time, etc. However, they are also believed to have positive effects on the growth of various skills on the players [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.

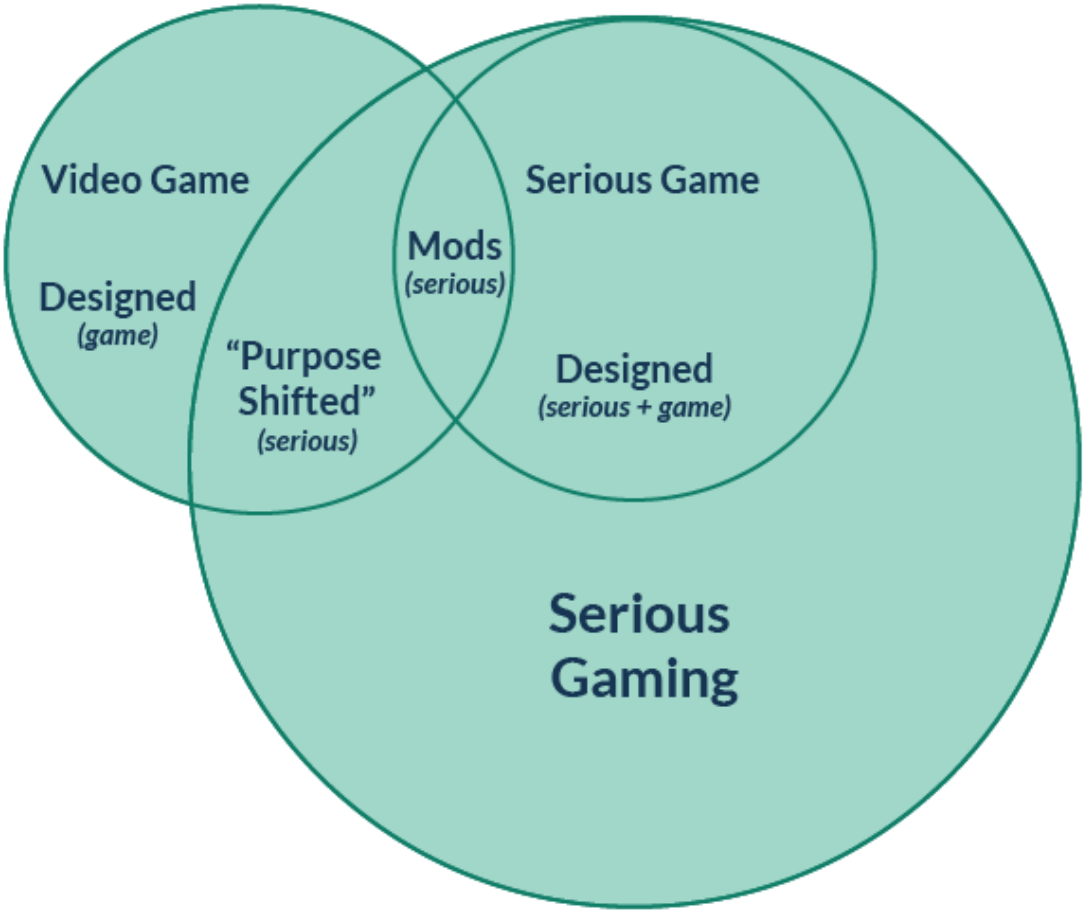

Figure 1. Types of games [4]

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 content discussed, they will not learn that. To accomplish the ultimate goal of child education, a mix of teaching methods and holding a child's interest alive is important. For that purpose, child games and e-learning methods are a magnificently cheap and efficient way to do it [5]. Each child has various characteristics during his or her study. While some students are more active in class, others may be more timid. In general, an involved child likes to attend lectures, such as answering the question, leading other friends into the group. The shy child generally tends to listen to the teacher and is nervous about taking part in a class.

Table 1. Learning Styles

Auditory	Visual	Kinesthetic
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	

The style of learning is sometimes defined as cognitive, affective, social and physiological features that serve as a relatively stable indicator of how students perceive, interact and respond to their learning environment.[5]. There are three types of learning styles, which are usually widely known. That is: auditory, visual, and kinesthetic. Some types of learning styles are categorized according to how the learner knows it best. Visual based learners learn better when they see something, while auditory based learners tend to use listening and auditory-related areas to process information, and kinesthetic based learners would rather to learn by activities which demand physical interaction [6]. The best way for visual students is observation. A instructor's body language and facial gesture 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 is used to educate, students' mindfulness. Digital game-based learning overcome the traditional methodologies [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 gameplaying: Playing a game requires participating in actions aimed at creating a particular state of affairs, using only means allowed by specific rules, where the means permitted by the rules are more limited in scope than they would be in the absence of regulations, and where the sole reason for embracing such restrictions is to make such action possible [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 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

Term	Definition
Player	A person who interact with the game
Unity3D	Cross-platform game engine developed by Unity Technologies.
Serious Game	Games that focuses for primary purpose other than solid entertainment
NPC (Non-player Character):	Game objects that part of the game with artificial intelligence.
Standalone application	Applications that are able to operate independently of other hardware or software.
Software Requirements Specification	Document for pointing to system functions and their potential problems.
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

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.

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:

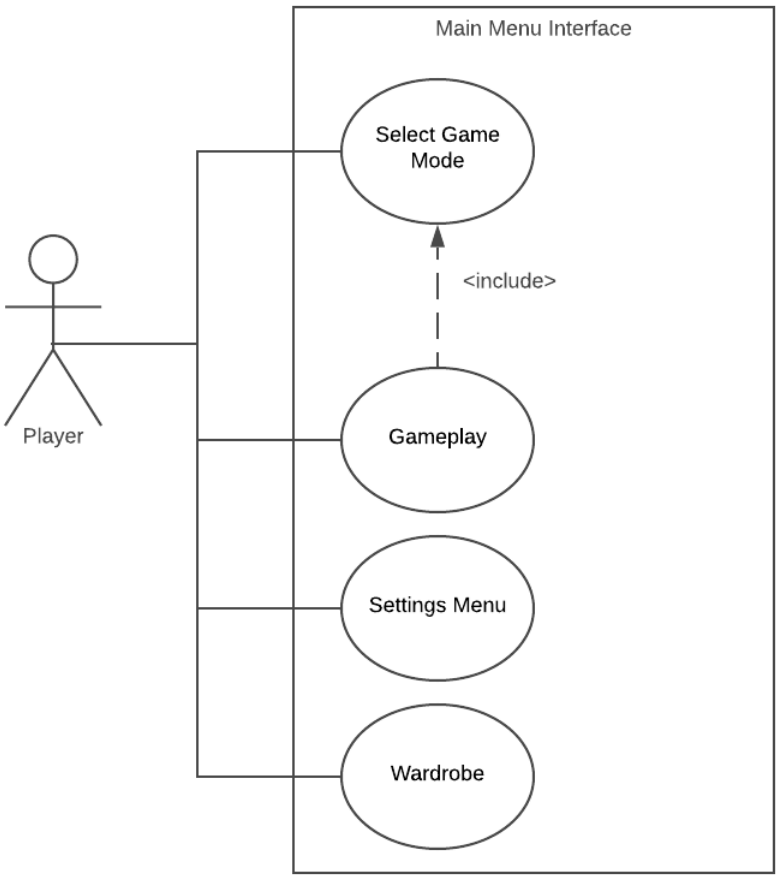

Figure 2. Main Menu Interface Use Case Diagram

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
- Apply Changed Settings

Diagram:

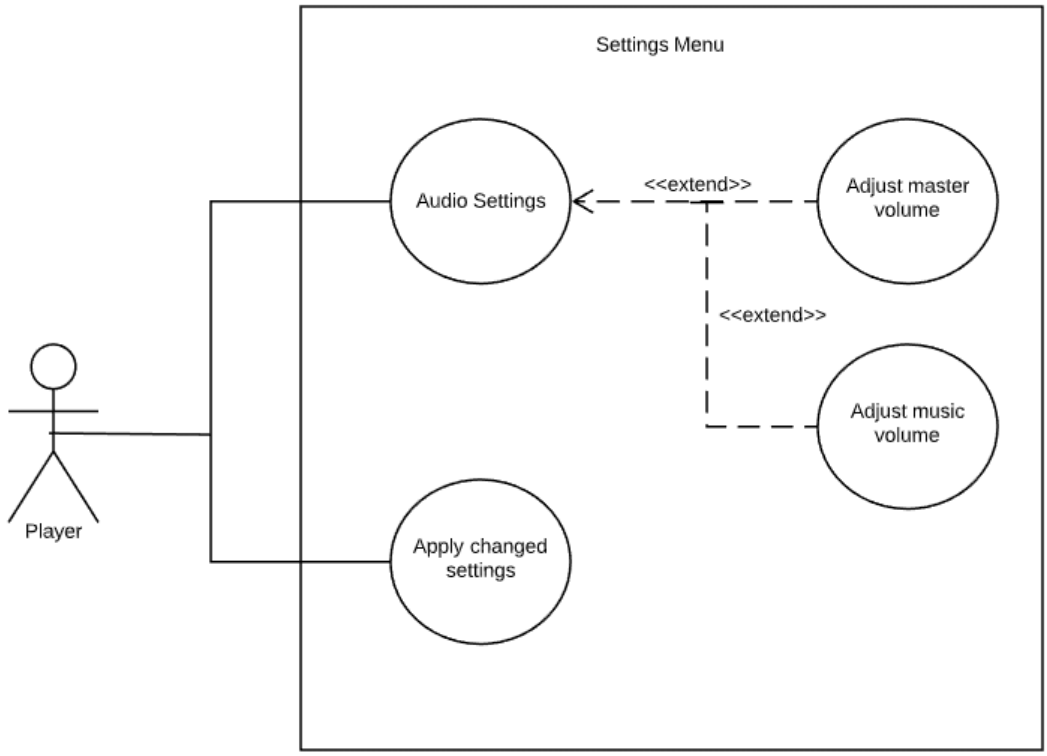

Figure 3. Settings Menu Use Case Diagram

Brief Description:

The use case diagram of the settings screen is shown in Figure 2. The player can change the “Audio Settings”, "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 user can apply the changes by using the "Apply 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 apply changed settings button, all changes are saved.

3.3.2.3 In-Game Features Use Case

Use Case:

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

Diagram:

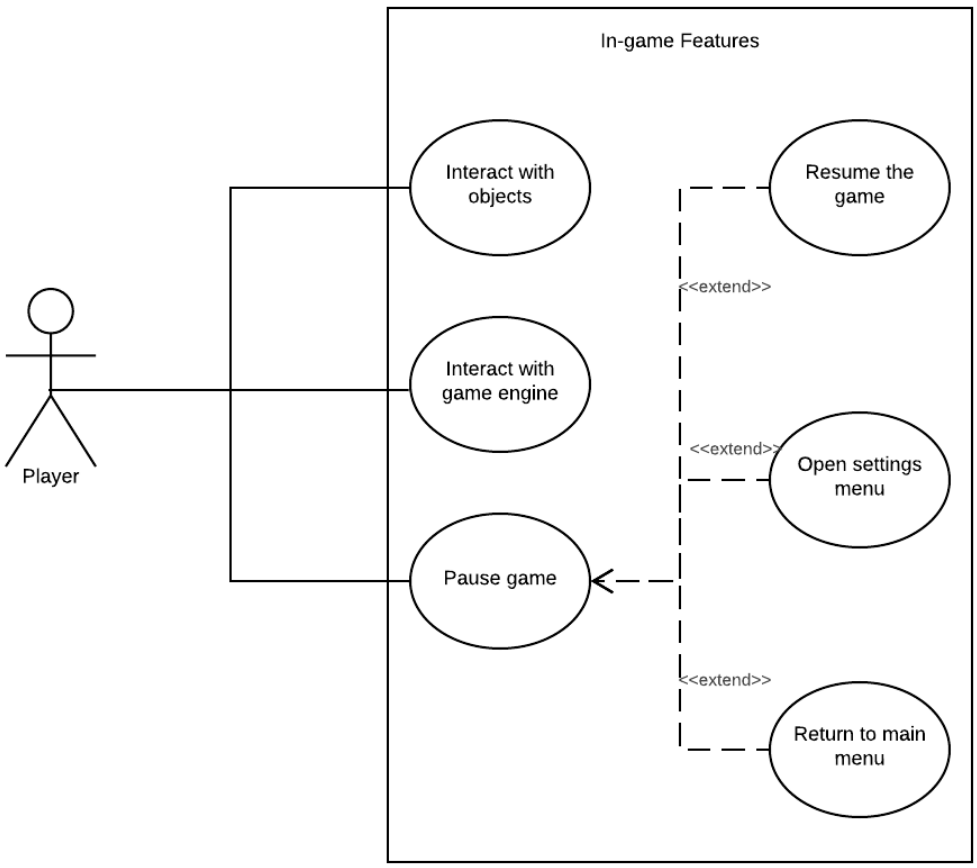

Figure 4. In-game Features Use Case Diagram

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

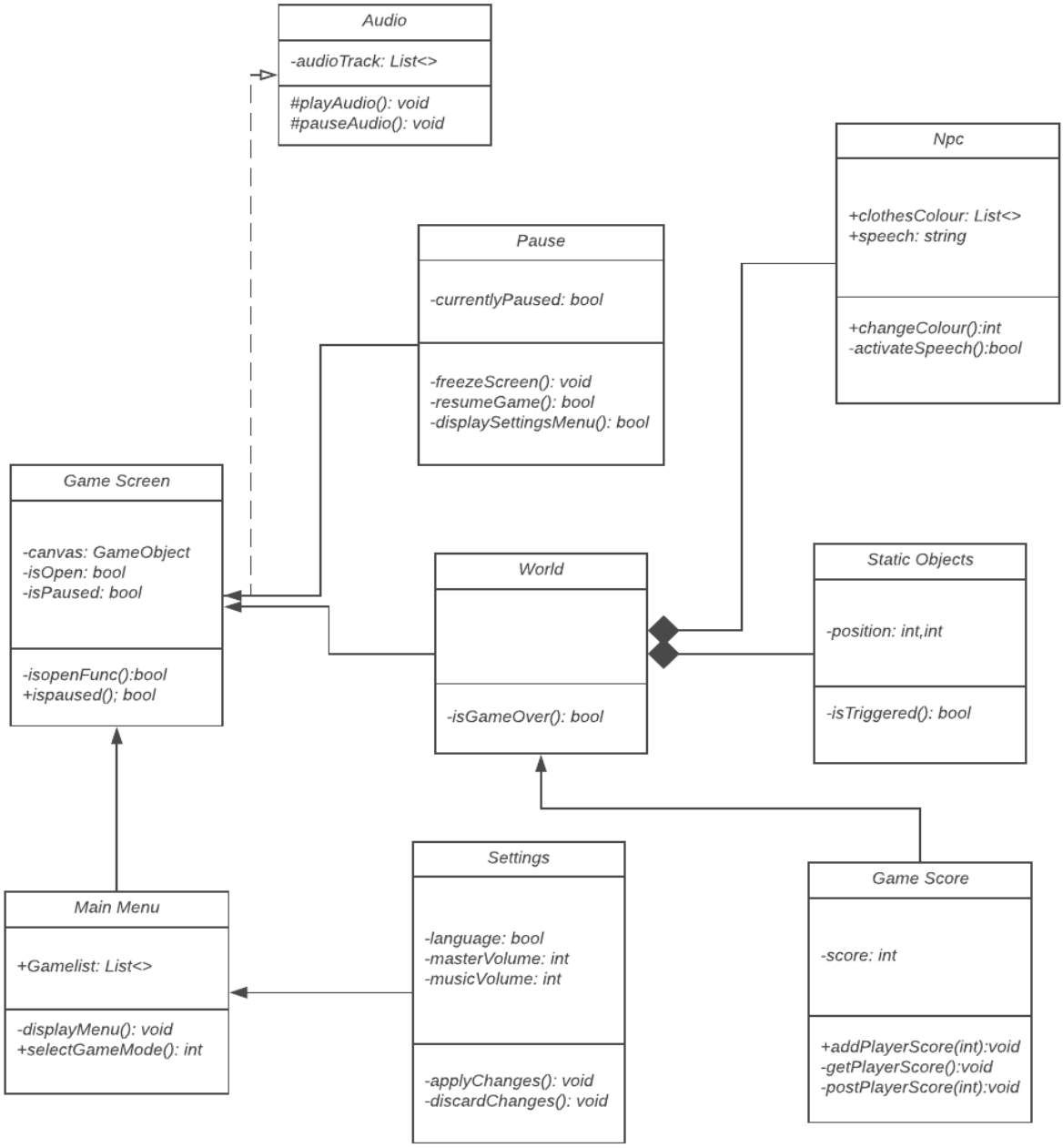

Figure 5. UML Class Diagram

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

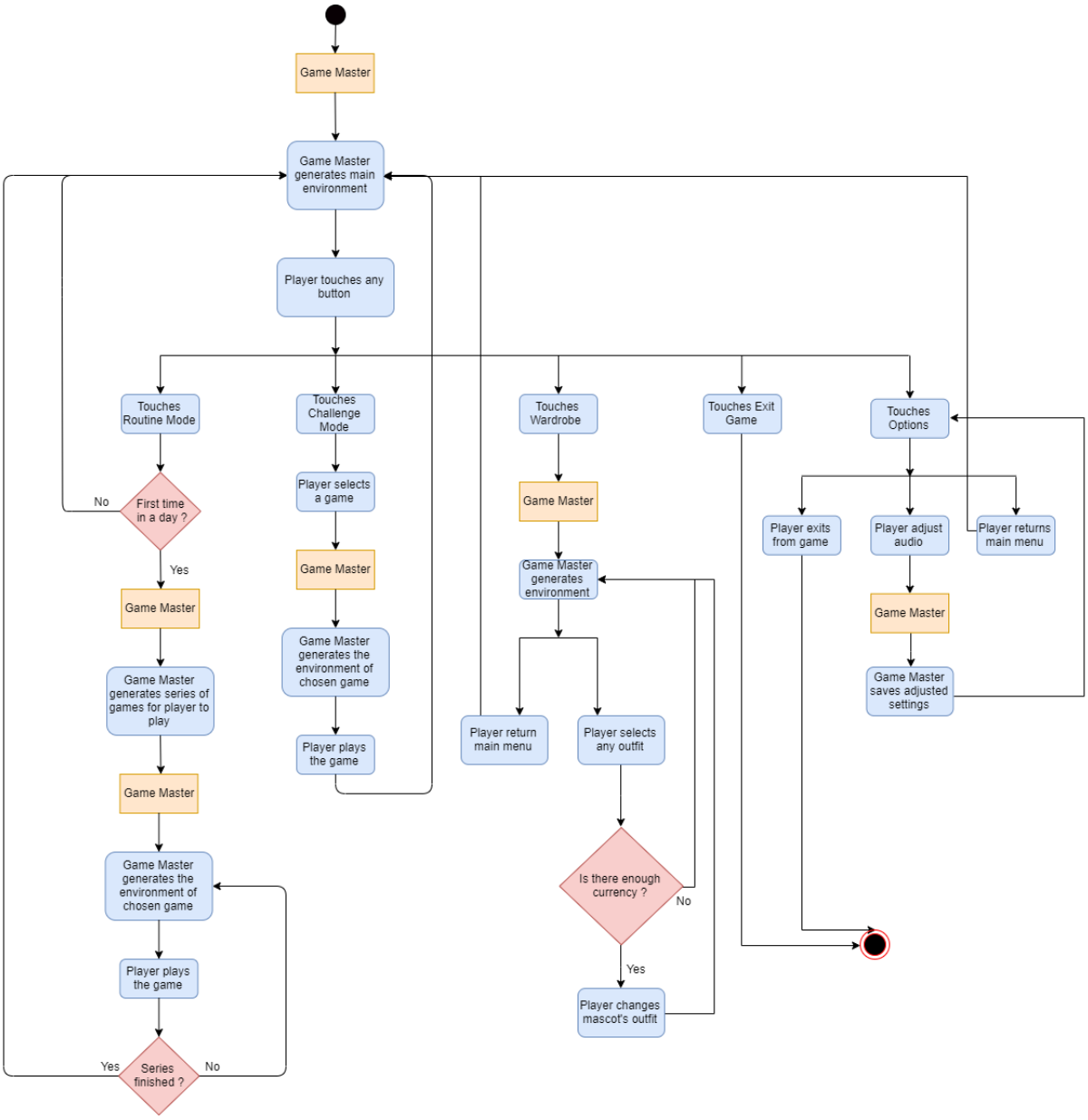

Figure 6. Activity Diagram

4.5 Use case realizations

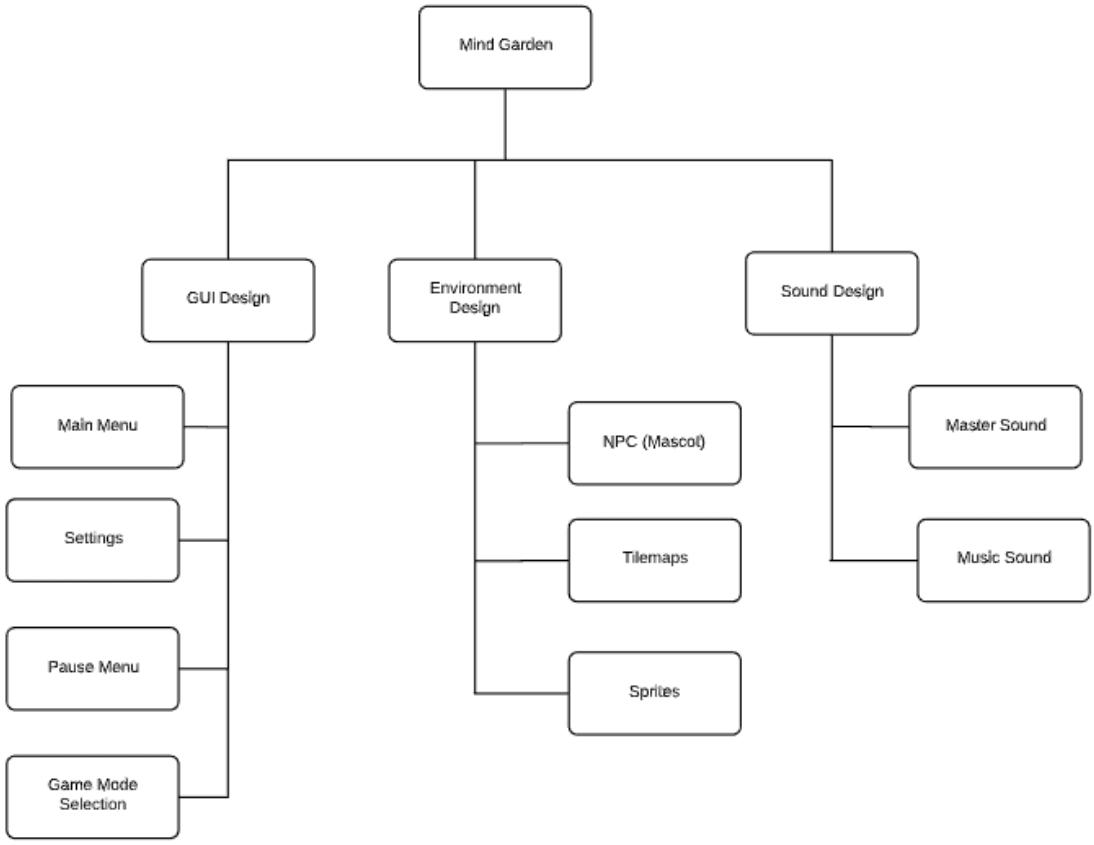

Figure 7. Use Case Realizations

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. Test Plan, Test Design Specifications and Test Cases

5.1 Introduction

5.1.1 Version Control

Version No	Description of Changes	Date
1.0	First Version	March 21, 2020

5.1.2 Overview

Features of Mind Garden specified in the SRS document will test the game. Buttons, and objects of the game will be tested.

5.1.3 Scope

This document contains the test plan of the use cases, test cases, and test design features.

5.1.4 Terminology

Acronym	Definition
GUI	Graphical User Interface
ST	Settings
RTM	Routine Mode
SGM	Select Game Mode

5.2 Features To Be Tested

Each section lists the main features to be checked and provides a brief overview of them all. At the end of this document there will be a Test Design Specification added for each major feature.

5.2.1 Graphical User Interface (GUI)

Graphical User Interface parts used in this project. We separated the GUI in 4 parts which are Main Menu, Settings, Routine Mode, and Select Game Mode. These parts also have some common parts. GUI parts contain testing of GUI components such as objects, buttons, etc.

5.2.2 Settings (ST)

This part contains test cases and test plans for Settings. Settings contain buttons, sliders and checkboxes. The testing of these features will be expected from the participants. The testing of this requirement will come off later in this document.

5.2.3 Routine Mode (RTM)

This section includes test scenarios and test plans for Routine Mode. Routine Mode includes objects, pause and resume options. Participants must check whether the objects' buttons and mechanics work correctly. Testing these requirements will occur later in this document.

5.2.4 Select Game Mode (SGM)

This part contains test cases and test plans for Select Game Mode. Select Game Mode contains objects, pause and continue options. . Participants must check whether the objects' buttons and mechanics work correctly. The testing of these requirements will come off later in this document.

5.3 Item Pass/Fail Criteria

5.3.1 Exit Criteria

- %100 of the test cases are executed
- %85 of the test cases passed
- All High and Medium Priority test cases passed

5.4 References

[1] [Online]. Available: https://github.com/CankayaUniversity/ceng-407-408-2019-2020-A-serious-game-to-improve-the-specific-fields-of-child-intelligence/wiki/Software-Design-Document. [Accessed 21 March 2020].

[2] [Online]. Available: https://github.com/CankayaUniversity/ceng-407-408-2019-2020-A-serious-game-to-improve-the-specific-fields-of-child-intelligence/wiki/Software-Requirements-Specification. [Accessed 21 March 2020].

5.5 Test Design Specifications

5.5.1 Graphical User Interface (GUI)

5.5.1.1 Subfeatures To Be Tested

5.5.1.1.1 Play Routine Mode (GUI.SRTM_BTN)

Player enters the routine game mode by clicking the *Routine Mode* button.

5.5.1.1.2 Play Select Game Mode (GUI.SSGM_BTN)

Player enters the select game mode by clicking the *Select Game* button.

5.5.1.1.3 Quit Button (GUI.QT_BTN)

Player can close the game with selecting *Quit* button.

5.5.1.1.4 Pause Button (GUI.P_BTN)

If the player is in routine mode, he can stop the game with the *Pause* button.

5.5.1.1.5 Resume Button (GUI.RSM_BTN)

Player can resume game with selecting the *Continue* button.

5.5.1.1.6 Change Volume Setting Button (GUI.CVS_BTN)

Player can changes volume by selecting the *Volume Setting* button.

5.5.1.1.7 Music On/Off Button (GUI.MOF_BTN)

Player clicks the *Music On/Off* button and turns the music off and on.

5.5.1.1.8 Wardrobe Button (GUI.MWB_BTN)

Player clicks to access Mascot's wardrobe for clothing of Mascot.

5.5.1.1.9 Settings Button (GUI.ST_BTN)

Player clicks the *Settings* button and displays settings panel.

5.5.1.2 Test Cases

Table 6. Test Cases

TC ID	Requirements	Priority	Scenario Description
GUI.SRTM_ BTN.01	3.1.1	H	Select " Routine Mode " button. After selecting, games wil be displayed.

TC ID	Requirements	Priority	Scenario Description
GUI.SSGM_B TN.01	3.1.2	H	Select " Select Game " button. After selecting, game categories wil be displayed.

TC ID	Requirements	Priority	Scenario Description
GUI.QT_BTN .01	3.1.3	H	Select " Quit " button. After selecting, the game will be closed.

TC ID	Requirements	Priority	Scenario Description
GUI.P_BTN .01	3.1.3	M	Select " Pause " button. After selecting, the game will be paused.

TC ID	Requirements	Priority	Scenario Description
GUI.RSM_ BTN.01	3.1.3	M	Select " Resume " button. After selecting game will continue.

TC ID	Requirements	Priority	Scenario Description
GUI.CVS_BT N.01	3.1.3	L	Select " Change Volume Setting " button. After selecting, the volume of the game can be changed.

TC ID	Requirements	Priority	Scenario Description
GUI.MOF_ BTN.01	3.1.3	L	Select “ Music On/Off “ button. After selecting, the music can be turned on or off.

TC ID	Requirements	Priority	Scenario Description
GUI.MWB_ BTN.01	3.1.4	M	Select “ Wardrobe “ button. Player can change the appereance of mascot.

TC ID	Requirements	Priority	Scenario Description
GUI.ST_BTN .01	3.1.5	M	Select “ Settings “ button. After selecting, settings panel will appear.

5.5.2 Routine Mode (RTM)

5.5.1.3 Subfeatures To Be Tested

5.5.1.1.1 Interact with Objects (RTM.IO)

Player can interact with game objects.

5.5.1.4 Test Cases

TC ID	Requirements	Priority	Scenario Description
RTM.IO.01	3.1.7	H	Touch any interactable game object to interact.

5.5.3 Select Game Mode (SGM)

5.5.3.1 Subfeatures To Be Tested

5.5.3.1.1 Choose Category (SGM.CC)

Player can choose any category. Player can choose any game from chosen category.

5.5.3.2 Test Cases

TC ID	Requirements	Priority	Scenario Description
SGM.CC.01	3.1.7	H	Press any category button to choose game category.
SGM.CC.02	3.1.7	H	Press any game button to choose game.

5.6 Detailed Test Cases

5.6.1 GUI.SRTM_BTN.01

TC_ID	GUI.SRTM_BTN.01
Purpose	Select " Routine Mode " button.
Requirements	3.1.1
Priority	High
Estimated Time Needed	1 Minutes
Dependency	The game is executed.
Setup	The game need install in the device.
Procedure	[A01] Select "Routine Mode" button from main menu.
	[V01] "Routine Mode" will be started.
Cleanup	Exit

5.6.2 GUI.SSGM_BTN.01

TC_ID	GUI.SSGM_BTN.01
Purpose	Select " Select Game Mode" button Player can choose from different game modes.
Requirements	3.1.2
Priority	High
Estimated Time Needed	1 Minutes
Dependency	Any mode need to be must be chosen.
Setup	Display the game modes.
Procedure	[A01] Select "Select Game Mode" button from main menu.
	[A02] Choose a game mode from the list.
	[V01] It was seen that the chosen game mode is started.
Cleanup	Exit

5.6.3 GUI.QT_BTN.01

TC_ID	GUI.QT_BTN.01
Purpose	Select “ Quit Game “ button.
Requirements	3.1.3
Priority	High
Estimated Time Needed	Less than 1 minute
Dependency	Any mode should be running / Main Menu.
Setup	Exit button started to work.
Procedure	[A01] Select “ Pause “ button.
	[A01] Select “ Quit Game“ button.
	[V01] It was seen that the program was closed.
	[A03] Game started again.
	[A04] Clicked to the “Quit Game” from the menu.
	[V02] It was seen that the program was closed.
Cleanup	-

5.6.4 GUI.P_BTN.01

TC_ID	GUI.P_BTN.01
Purpose	“Pause” the game.
Requirements	3.1.3
Priority	Medium
Estimated Time Needed	Less than 1 minute
Dependency	Any mode should be running.
Setup	Pause button started to work.
Procedure	[A01] Select “Settings” button.
	[A02] Select “Pause” button
	[V01] It was seen that the game was paused.
Cleanup	Options menu

5.6.5 GUI.RSM_BTN.01

TC_ID	GUI.RSM_BTN.01
Purpose	“Resume” the game.
Requirements	3.1.3
Priority	Medium
Estimated Time Needed	Less than 1 minute
Dependency	Any mode should be running and need to be paused.
Setup	Resume button started to work.
Procedure	[A01] Select “Settings” button.
	[A02] Select “Resume” button.
	[V01] It was seen that the game was continued.
Cleanup	Options menu

5.6.6 GUI.CVS_BTN.01

TC_ID	GUI.CVS_BTN.01
Purpose	Select " Change Sound Volume Setting " button.
Requirements	3.1.3
Priority	Low
Estimated Time Needed	1 Minute
Dependency	Any mode should be running / Main menu options.
Setup	The game's volume need to be changed.
Procedure	[A01] Select "Settings" button.
	[A02] Select "Change Sound Volume Setting" button.
	[V01] It was seen that the game's sound volume is changed.
Cleanup	Options menu

5.6.7 GUI.MOF_BTN.01

TC_ID	GUI.MOF_BTN.01
Purpose	Select " Change Music Volume " button
Requirements	3.1.3
Priority	Low
Estimated Time Needed	Less than 1 minute
Dependency	Any mode should be running / Main menu options.
Setup	Continue button started to work.
Procedure	[A01] Select "Settings" button.
	[A02] Select "Change Music Volume " button.
	[V01] It was seen that the game's music volume is changed.
Cleanup	Options menu

5.6.8 GUI.MWB_BTN.01

TC_ID	GUI.MWB_BTN.01
Purpose	Select " Wardrobe " button.
Requirements	3.1.4
Priority	Medium
Estimated Time Needed	1 Minute
Dependency	Any mode need to be must be chosen
Setup	Display the outfit options of mascot.
Procedure	[A01] Select " Wardrobe " button.
	[A02] Choose a outfit from the wardrobe.
	[V01] It was seen that the Mascot is changed.
Cleanup	"Routine Mode" or "Select Game Mode" buttons.

5.6.9 GUI.ST_BTN.01

TC_ID	GUI.ST_BTN.01
Purpose	Select " Settings " button. It shows credits.
Requirements	3.1.5
Priority	Mid
Estimated Time Needed	Less than 1 minute.
Dependency	The game is executed.
Setup	The gameneed install in the device.
Procedure	[A01] Select " Settings " button.
	[V01] Display the "Settings".
Cleanup	Exit

5.7 Test Results

5.7.1 Individual Test Results

Table 7. Test Results

TC ID	Priority	Date Run	Run By	Result	Explanation
GUI.SRTM_BTN.01	H	07.05.2020	Ali Kaan Göksu	Pass	"Routine Mode" button selected. After selecting, games displayed.
GUI.SSGM_BTN.01	H	07.05.2020	Kazım Ataol Özüseven	Pass	"Select Game" button selected. After selecting game categories displayed.
GUI.QT_BTN.01	H	07.05.2020	Eyüp Taşkın	Pass	"Quit" button selected. After selecting the game closed.
GUI.P_BTN.01	M	07.05.2020	Ali Kaan Göksu	Pass	"Pause" button selected. After selecting the game paused.
GUI.RSM_BTN.01	M	07.05.2020	Ali Kaan Göksu	Pass	"Resume" button selected. After selecting the game continue.

TC ID	Priority	Date Run	Run By	Result	Explanation
GUI.CVS_BTN.01	L	07.05.2020	Emre Kasar	Pass	Change Volume Slider worked properly.
GUI.MOF_BTN.01	L	07.05.2020	Emre Kasar	Pass	Change Music Volume Slider worked properly.
GUI.MWB_BTN.01	M	07.05.2020	Eyüp Taşkın	Pass	Mascot Store is opended.
GUI.ST_BTN.01	M	07.05.2020	Ali Kaan Göksu	Pass	After select “Setting” button Settings Panel appear.

5.8 Summary of Test Results

Table 8. Sumary

Priority	Number of TC's	Executed	Passed
H	3	3	3
M	4	4	4
L	2	2	2
Total	**9**	**9**	**9**

We have executed 9 test cases and all of them are passed.

5.9 Exit Criteria

We have executed all test cases and 100% of test cases are passed. All of the high and medium priority test cases are passed. Exit criteria is met.

Table 9.Exit Criteria

Criteria	Met or Not
%100 of the test cases are executed.	M
%85 of the test cases passed.	M
All High and Medium Priority test cases are passed.	M

6. 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.

References

[1] "MENTALUP," MentalUP Beyin Egzersizleri, 2015. [Online]. Available: https://www.mentalup.net/. [Accessed 1 November 2019].

[2] "Kodable: Programming for Kids," SurfScore, Inc, 2012. [Online]. Available: https://www.kodable.com/. [Accessed 1 November 2019].

[3] T. Susi, M. Johannesson and P. Backlund, "Serious Games - An Overview," 2007.

[4] R. Jurasckha, «Prodigy: Math Learning Platform,» 29 September 2019. [Online]. Available: https://www.prodigygame.com/blog/digital-game-based-learning/. [Accessed: 1 November 2019].

[5] A. P. Gilakjani, "Visual, Auditory, Kinaesthetic Learning Styles and Their Impacts on English Language Teaching," Journal of Studies in Education, vol. 2, no. 1, 2011.

[6] L. Leopold, "Prewriting Tasks for Auditory, Visual, and Kinesthetic Learners," TESL Canada, vol. 29, no. 2, 2012.

[7] "LDPride," August 2014. [Online]. Available: http://www.ldpride.net/learningstyles.MI.htm#Learning%20Styles%20Explained. [Accessed 20 October 2019].

[8] F. Blumberg, Learning by Playing: Video Gaming in Education, New York: Oxford University Press, 2014.

[9] S. E. Nielsen, B. Meyer ve B. H. Sørensen, Serious Games in Education: a Global Perspective, Aarhus: Aarhus University Press, 2011.

[10] Ş. Yaşar ve G. Alkan, «MUHASEBE EĞİTİMİNDE OYUNLAŞTIRMA: DİJİTAL OYUN TABANLI ÖĞRENME,» Muhasebe ve Vergi Uygulamaları Dergisi, pp. 331-352, 2019.

[11] «Philosophy of Science,» 1967.

[12] N. A. Mat Zin, A. Jaafar and S. Y. Wong, "Digital Game-based learning (DGBL) model and development methodology for teaching history," WSEAS Transactions on Computers, vol. 8, no. 2, pp. 322-333, 2009.

[13] K. Corti, "Games¬based Learning; a serious business application," 2006.

[14] "Toca Boca: The Power of Play," Spin Master, 2010. [Online]. Available: https://tocaboca.com. [Accessed 1 November 2019].

[15] "Unity Real-Time Development Platform," Unity Technologies, [Online]. Available: https://unity3d.com/unity/system-requirements. [Accessed 22 November 2019].

[16] "IEEE Recommended Practice for Software Requirements Specifications," IEEE Computer Society, 1998.

[17]D. Djaouti, J. Alvarez and J.-P. Jessel, "Classifying Serious Games: the G/P/S model," Handbook of Research on Improving Learning and Motivation through Educational Games: Multidisciplinary Approaches, 2011.

[18] Eridani, D. (2014). The Development of 3D Educational Game. Semarang: International Conference on Information Technology, Computer and Electrical Engineering (ICITACEE).