

HERIOT-WATT UNIVERSITY

MASTERS THESIS

SANSKRIT SHALA – A Game-based platform to learn Sanskrit

Author:

Shubham .P. Shinde

Supervisor:

Dr. Smitha Kumar

*A thesis submitted in fulfilment of the requirements
for the degree of MSc.*

in the

School of Mathematical and Computer Sciences

AUGUST 2023



Student Declaration of Authorship

Course code and name:	F21MP - Masters Project and Dissertation - 2022-2023
Type of assessment:	Individual
Coursework Title:	Masters Project and Dissertation
Student Name:	SHUBHAM PRASHANT SHINDE
Student ID Number:	H00384662

Declaration of authorship. By signing this form:

- **I declare** that the work I have submitted for individual assessment OR the work I have contributed to a group assessment, is entirely my own. I have NOT taken the ideas, writings or inventions of another person and used these as if they were my own. My submission or my contribution to a group submission is expressed in my own words. Any uses made within this work of the ideas, writings or inventions of others, or of any existing sources of information (books, journals, websites, etc.) are properly acknowledged and listed in the references and/or acknowledgements section.
- I confirm that I have read, understood and followed the University's Regulations on plagiarism as published on the [University's website](#), and that I am aware of the penalties that I will face should I not adhere to the University Regulations.
- I confirm that I have read, understood and avoided the different types of plagiarism explained in the University guidance on [Academic Integrity and Plagiarism](#)

SHUBHAM PRASHANT SHINDE

Student Signature : SHUBHAM PRASHANT SHINDE

Date: 21/08/2023

Copy this page and insert it into your coursework file in front of your title page.
For group assessment each group member must sign a separate form and all forms must be included with the group submission.

Your work will not be marked if a signed copy of this form is not included with your submission.

ABSTRACT

Sanskrit (Language of GOD(DEVNAGRI)) being one the most ancient Language, scared and religious language is on a verge of being extinct as very few percent of the population knows it, passing this knowledge to future generations is a challenging task, due to the Sanskrit language being one among the most difficult language to learn which reduces the interest of younger generation . The core objective revolves around gamification to be a fun way to learn this difficult language and create enthusiasm and interest in people.

The game utilizes the visual learning method, including visual resources such as 3D replica objects of basic regular things used daily to give the learner realistic examples. The game displays Sanskrit words and the user would then identify those same objects out of multiple objects in the scene within the given time. This game aims to offer learners an engaging and fun platform to enjoy and learn while encourage more people to learn the Sanskrit language.

While the projects effectively fulfills its intended purpose, future enhancements with inducing more improvements in AI and interaction of player character with the game objects hold the potential to elevate the game engagement and enrich the experience.

ACKNOWLEDGMENT

I would like to thank my supervisor, Smitha Kumar, for her guidance, and motivation and for being very supportive during this project. She helped me to improve in the areas where I was lacking and to understand how I should tackle problems.

I also want to thank my family for being so supportive and keeping me motivated during this project.

CONTENTS

Student Declaration of Authorship	i
ABSTRACT	ii
ACKNOWLEDGMENT	ii
LIST OF FIGURES	1
Chapter 1. INTRODUCTION.....	2
1.1 AIM:.....	4
1.2 OBJECTIVES:	4
Chapter 2. LITERATURE REVIEW.....	5
2.1 THE HISTORY & DEVELOPMENT OF GAMES	5
2.2 HOW GAMES CAN BE USED FOR LANGUAGE LEARNING.	11
2.2.1 RELATION IN GAME & VISUAL LEARNING TECHNIQUES:	11
2.3 UNITY.....	12
2.4 RELATED WORK.	13
2.4.1 DIGITAL RESOURCES AND TOOLS DEVELOPED FOR TEACHING SANSKRIT LANGUAGE.	13
2.4.2 SANSKRIT GAMES AND APPLICATION:.....	15
2.4.3 Analysis	16
2.5 PROGRAMMING ENVIRONMENT	17
2.5.1 TECHNOLOGICAL EVOLUTION IN GAME PROGRAMMING.	17
2.5.2 C# LANGUAGE.	18
2.6 CRITICAL ANALYSIS.....	20
2.6.1 GAMES FACILITATE LEARNING.	20
2.6.2 EXISTING SANSKRIT LEARNING APPS:	20
2.6.3 LIMITATIONS OF EXISTING SANSKRIT LEARNING APPS:	20
2.6.4 WHY BUILD THIS GAME & USE UNITY.....	21
2.6.5 ADVANTAGES OF UNITY FOR GAME DEVELOPMENT:	21
2.6.6 BENEFITS OF CREATING A GAME FOR LEARNING SANSKRIT:.....	22
Chapter 3. FUNCTIONAL REQUIREMENTS	24
3.1 METHODOLOGY SYSTEM DETAILS.	24
3.1.1 GAME DESIGN.....	24
3.2 NON-FUNCTIONAL REQUIREMENTS.	26
3.3 PROGRAMMING LANGUAGE USED.....	27
3.4 TESTING	27
3.5 GAME EVALUATION.	27
Chapter 4. IMPLEMENTATION	29
4.1 IMPLEMENTATION PHASE 2 - PROJECT SETUP:	29
4.1.1 PLANNING AND REQUIREMENTS:	29

4.2	IMPLEMENTATION PHASE 2:	31
4.2.1	PAPER PROTOTYPE:	31
4.2.2	CLASS DIAGRAM:	32
4.2.3	ACTIVITY DIAGRAM:	33
4.2.4	USE CASE DIAGRAM:	35
4.2.5	SEQUENCE DIAGRAM:	36
4.2.6	GITHUB REPOSITORY SETUP:	37
4.2.7	AI APPROACHES :	37
4.2.8	CODE SNIPPETS:	38
Chapter 5.	PROFESSIONAL, LEGAL, ETHICAL & SCIOIAL ISSUES	43
5.1	PROFESSIONAL ISSUES:	43
5.2	LEGAL ISSUES:	43
5.3	ETHICAL ISSUE:	43
Chapter 6.	EVALUATION & RESULT	44
6.1	TESTING	44
6.1.1	SCREENSHOT OF THE GAME.	44
6.2	FEEDBACK	49
Chapter 7.	CONCLUSION	50
7.1	RECOMMENDATION	50
7.2	LIMITATIONS	50
APPENDIX A – PROJECT PLAN	51
1.1	INCREMENTAL METHODOLOGY	51
1.2	RISK ANALYSIS.	53
REFERENCE	54

LIST OF FIGURES

Figure 1 Nimatron	5
Figure 2 tic-tac-toe/Bertie the Brain	6
Figure 3 Noughts and Crosses	6
Figure 4 Tennis for Two	7
Figure 5 Galaxian	7
Figure 6 Pac-Man	8
Figure 7 Donkey-Kong	9
Figure 8 Revenue [30]	10
Figure 9 Initial Scene(first scene)	25
Figure 10 Game-Play	25
Figure 11 Incremental model	26
Figure 12 Unity Settings	30
Figure 13 Paper-Prototype	31
Figure 14 Class Diagram	32
Figure 15 Activity Diagram	34
Figure 16 Use-Casse Diagram	35
Figure 17 Sequence Diagram	36
Figure 18 Start Screen	44
Figure 19 Initial Screen	45
Figure 20 Game Scene and Player	45
Figure 21 Game Scene and Player	46
Figure 22 Game Scene and Player	46
Figure 23 Win Panel	47
Figure 24 Lose Panel	47
Figure 25 Feedback Table	49
Figure 26 Gant chart	51
Figure 27 Gant chart	52
Figure 28 Gant chart	52

Chapter 1. INTRODUCTION

The Computer gaming has come a long way since the first game, called "Tic-Tac-Toe" or "Noughts and Crosses," which was developed in 1952 by British computer scientist Alexander S. Douglas on the EDSAC computer at the University of Cambridge.[1] Then the "Tennis for Two," was developed in 1958. In the 1970s, arcade games like "Space Invaders" and "Pac-Man" dominated the industry, and home gaming consoles like the Atari 2600 were introduced. In the 1980s, due to the development of computers, the industry saw a major shift towards personal computers and the development of more complex games like "King's Quest" and "Leisure Suit Larry." The 1990s brought about the rise of 3D graphics and the introduction of iconic games like "Doom," "Myst," and "Super Mario 64." As during this the CD-ROMs were also developed which made a huge contribution to gaming industry.[2]

In the present time, the gaming industry is a multi-billion-dollar industry with a variety of platforms and genres. Below are some examples regarding the Market size.

Gaming Platform	Market Size (2020)	Top Selling Games (2020)
Console	\$51.2 billion	Call of Duty: Modern Warfare, FIFA 20, Grand Theft Auto V
PC	\$37.6 billion	League of Legends, Minecraft, Counter-Strike: Global Offensive
Mobile	\$77.2 billion	Honor of Kings, PUBG Mobile, Pokemon Go
VR/AR	\$1.8 billion	Beat Saber, Half-Life: Alyx, The Walking Dead: Saints & Sinners
Cloud Gaming	\$1.1 billion	Fortnite, Apex Legends, Assassin's Creed Valhalla
eSports	\$1.08 billion	League of Legends World Championship, The International, Fortnite World Cup

Table 1: History of Gaming. [3, 4]

As described in the above table we can understand that Computers and mobile games have become increasingly popular and famous over the past few decades, and now they are like an Ever-green form of entertainment for people of all ages. As Along with their entertainment value, computer, and mobile games have also become an important tool for learning language. [5]

As the computer and mobile games provide an engaging and interactive way to make the user feel playful and not get bored this concept can also be used for the learners to understand and adapt a new language skill easily which could keep the learners motivated as well as interested in learning. Also this

concept of teaching can benefit the use to learn for any place they wish to, where they won't have to be embarrassed due to failure's. [6]

One of the major advantages of using computers or mobile games for language learning that they provide the learner an opportunity to learn at their own pace. Unlike usual classrooms methods' where the learners must have to push them self to cope-up with the remaining classroom, the games also provide the user with the benefit of repeating the same part again and again until they feel confident about their skills. This individualized approach of learning can help all age group people to develop a minimum basic skill of understanding the specific language that they are studying. [7]

Another benefit of using computers and mobile games for language learning is the immediate feedback that a user can be given or experienced while playing the game. Some Games or applications monitor the user gameplay, responses and progress through which they provide instant feedback, which helps the learner to identify their own strengths and weakness and improve in those aspects accordingly. The games feedback can also help the user to identify their goals and keep a track on their progress towards achieving it.[8]

Through computer and mobile games, the user benefits through collaboration method, basically these games provide a good platform to collaborate with other users. There are a lot of games concepts which are designed to be played in groups or pairs, which could motivate the learner to solve the problem and communicate in the target language. This way of collaborations can help the learner to develop their skills in more natural and authentic way, as the interaction with the partner or other learners who could have different language background and different level of proficiency.[9]

Due to these benefits, we can understand how computers and mobile games could provide us with a different, unique, and effective fun way of learning a new language. As they offer engaging, interactive, and immersive learning experiences which could help the learner to acquire new language skills while enjoying the journey. Because of these points now a days the use of language learning through games is becoming more and more popular. [10]

The topic of SANSKRIT language (Language of GOD(Devanagari))[11] is one of the most interesting and main part of our project, according to the research it is believed that the Sanskrit language have originated in the INDIAN subcontinent around 1500-500 BCE which is also known as the Vedic period. The reason this is called as the Vedic period is because it was the major civilization that occurred in ancient India after the Indus valley civilization which was around 3300BCE to 1300BCE and it matures from 2600BCE to 1900BCE, during the Vedic periods Vedas were composed which name this era as Vedic period. The Vedas are a very chief and one of the most important sources of information as it has detailed knowledge of all the subjects including science, mathematics, astronomy, and medicines among others. All the Vedas were written in Vedic Sanskrit Language, which is the oldest among all, then later it evolved into Classical Sanskrit. This is the language which is used now for the greatest work of Indian Literature, including Holy Books like Ramayana and Mahabharat. Later on, the Sanskrit Grammarian Panini wrote a comprehensive grammar of the Sanskrit language. His work that is known as Ashtadhyayi (Aṣṭādhyāyī)[12-14] is one of the greatest achievements in the field of linguistics. Later on In the middle Age Sanskrit began to decline in term of popularity, as other languages such as Prakrit and Apabhramsha became popular. However, Sanskrit was the only language used for religion, philosophy and literature. In the 19th and 20th centuries, there was a revival of interest in Sanskrit language, both in India and in the West. Scholars and linguists recognized the importance and deep knowledge and its contribution to world culture. [11, 12, 15, 16]

To this day Sanskrit is still being used as the language of philosophy and religious, as well as in classical music and dance. As mentioned above it is also studied in many universities around the world as an important language for understanding the history and the contribution to world culture as well as culture of India.[17-21]

1.1 AIM:

The aim of this project is to develop an interactive and easy-to-use game in Unity Engine[22] that utilizes AI to teach the Sanskrit[11] language to users.

1.2 OBJECTIVES:

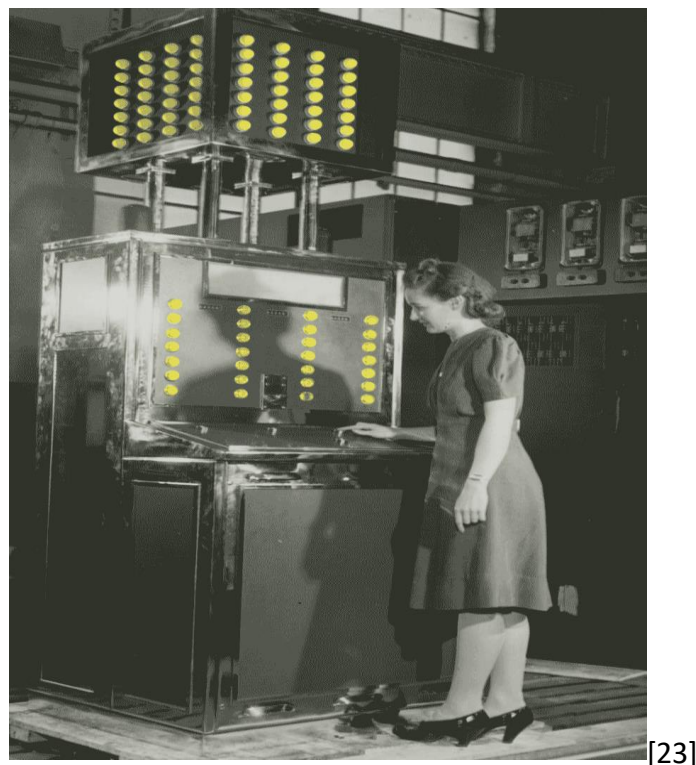
- To investigate how Game can be used for language Learning.
- To identify the various existing games for Sanskrit learning.
- Research about the methodology used in the existing games and their limitations.
- To identify appropriate environment to design and develop a Sanskrit language game.
- To evaluate the usefulness of games in learning.

Chapter 2. LITERATURE REVIEW

The literature review chapter states the detailed review and research on the concept that is mentioned in the objectives (1.2). This chapter includes the history, present, and future of the topics given.

2.1 THE HISTORY & DEVELOPMENT OF GAMES

The Video Game Industry is said to be one of the oldest and most fastest developing Industry, the tremendous growth and changes in this industry can be observed since the past 50 years as the first Game came in the market which was a electronic game named as “Nimatron” [23] it is an electromagnetic relay-based Nim-playing device as shown below in the image (Figure 1 Nimatron), it was designed by Edward Condon and built by Westinghouse Electric in 1940 for the New York World’s Fair. The game was in way which showcased the power of electronic circuits, in which it allowed the player to play the game of Nim VS the computer or against the computer. [24]



[23]

Figure 1 Nimatron

Later on Bertie the Brain, which was the first computer & the first game with AI basically the game also known as tic-tac-toe it was built by Josef Kates in 1950 for the Canadian National Exhibition. It was a very early example of a game which is played on CRT screen. This was an electronic game in which Bertie the Brain used a series of relays and vacuum tubes to control the gameplay, while it was being controlled by the series of buttons which were in the form of the machine. The game was four meters (13 foot tall) which also had artificial intelligence, in which after the player gives the inputs through the controller in the form of three grids and the game used to be play ahead through the grid of lights. In this the difficulty level of the machine was also adjustable. The picture of this game can be seen below in figure number 2 in which the user is comedian Danny Kaye who just won the game against the machine. Surprisingly the main reason of this was not the game but to show case the

vacuum tube called as addition tube which he designed and patented and to attract the potential buyers he enveloped the game with the assistance of and engineers from Rogers Majestics [24]



Figure 2 tic-tac-toe/*Bertie the Brain*

Then later the British Computer Scientist Alexander S. Douglas developed a computer-based version of the tic-tac-toe also called as “Noughts and Crosses” which was on the EDSAC computer at the University of Cambridge. This game was developed in 1952. The Game was one of the earliest implementations of a game on computer and was one of the important moment of the history of video games which also helped in paving the way for the future development and growth in gaming technology. [24, 25]

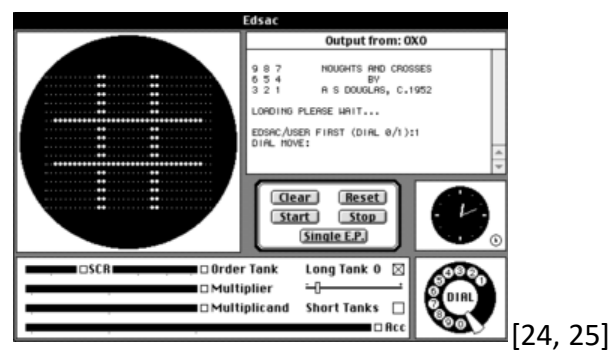


Figure 3 Noughts and Crosses

After some years in 1958 the game named “Tennis for Two” was released. It was physicist William Higinbotham who developed it. He showcased this game first at the Brookhaven National Laboratory’s annual public exhibition. The game was one of the earliest video games which used oscilloscope screen to display the gameplay. But the main purpose of the oscilloscope screen was to display wave forms for the electronic equipment’s.[24, 26, 27]

The game play resembled a game of tennis, in which two knobs were used by two different players to control the moment of the paddles on the screen and the ball was shown in the form of a dot which would bounce back and forth in between these two paddles. If the ball is missed by these paddles then it use to be game over and which every players misses the ball use to be the loser. [24, 26, 27]

"Tennis for Two" was an instant hit when it was shown at the Brookhaven National Laboratory's annual public exhibition in 1958. But amazingly the game was not actually intended for the commercial purpose and just for playing in the laboratory it was considered to be one of the ground-breaking achievements in the video game history. Which laid a foundation for the future games to emerge in the upcoming years. [24, 26, 27]



[24, 26, 27]

Figure 4 Tennis for Two

Furthermore in the year 1970s which was also known as the Golden age of the arcade video game, within these 10 years since 1970 to 1980 the development of arcade games was tremendously amazing. But the main reason of their growth was the start which was the release of "Space Invaders" game which came in 1978 developed by the Taito Corporations which captured the entire market like and made people go super fond of it as it was the first shooting game ever up until then everyone just use to imagine the concept of space as it was one of the trending concept at that duration. This game created a opening and high trend for shoot 'em up games later on which added Galaxian and then the Vector Graphics-based Asteroids in 1979.

In this the "Space Invaders" was an amazing game as in it the players were able to control the laser cannon at the end of the screen and in which they had to shoot down rows of descending aliens or eliminate the aliens before they reach the bottom. The game was quite simple but was extremely addictive, which had multiple levels and as you win one level the next one would be more difficult than the pervious. Which kept the player engaged and play again for a longer duration. Both theses game created a very smooth path for the other future games to easily slide in the market. As the additions of the games began in people. [28, 29]



[28, 29]

Figure 5 Galaxian

In 1980s came one of the most popular games named "Pac-Man". This was also the decade in which the first home video game consoles, like the Magnavox Odyssey and the Atari 2600, were released in the market and introduced to consumers. The "Pac-Man" was developed by the Japanese video game company named Namco. The game was designed by Toru Iwatani which took no time to achieve heights and quickly became one of the biggest hits and one of the most popular video games of all time. The gameplay of "Pac-Man," is as such that the players control a character which must navigate through a maze filled with dots or points which he has to collect but at the same time has to avoid four ghosts that are trying to catch them. The motto or goal of the player is to eat all the dots while running away from the ghosts. But there is a twist while consuming the dots. If you get the power pellets, then the user can also eat the ghosts temporarily. The player is given three chances which are like mandatory life chances for all games. [28-30]

The major reason that "Pac-Man" stands out among other games is due to its simple gameplay including simple mechanics, with adorable and memorable characters, as well as catchy music. The game was a huge commercial success which generated a total revenue around 14 – 39 billion, the game was a booming success in both in arcades and on home consoles. It then encouraged numerous sequels and spin-offs, and also became a cultural icon on its own, appearing in movies, television shows, and even on merchandise today also in many movies and garments it is seen. [6, 28-30]



[31]

Figure 6 Pac-Man

Then came the "Donkey Kong" which was designed by Shigeru Miyamoto and was released in 1981 by Nintendo. The game concept is the most interesting part as the game follows the adventures of a character named Jumpman, who has a task to rescue his girlfriend from giant gorilla named Donkey Kong. [28, 32] The Donkey Kong is holding his girlfriend in clutches. As the player tries to reach his girlfriend the Donkey Kong will throw big barrels which the players need to miss if the barrel hits the player, then it's a game over. This game also includes one twist which is after a certain point the player is able to get a hammer when player holds the hammer then he has the power to break the barrels and also to kill the Donkey Kong and rescue his girlfriend. Donkey Kong was a great success in both commercial as well as on home console which was the highest revenue in 1981 and 1982. In total it sold more than 25 million units including cartridges. [1, 28, 29, 33-36]

The game is recognized to introduce the Mario character which went on to become one of the most historic recognizable and beloved games in the world, which till today is trending. The game helped Nintendo big time to create a ever green position in the game industry as it was the first game to use complex level designs as well as detailed graphics. It was also used as a base for the future development of a game called "Super Mario Bros". [1, 28, 29, 33-36]



[37]

Figure 7 Donkey-Kong

Its sequel "Super Mario Bros" was released during 1985 and was with no surprise one of the most iconic video games ever released. It was designed by Shigeru Miyamoto. As the game play was such that the Mario and his brother Luigi has to rescue the princess Toadstool from the evil Bowser while being attacked by his enemies, the entire gameplay was staged in such a manner that the user would keep on playing the games for hours, as the complexity and engagement with the game was best. During that duration the craze for video game or can be said as the trend of video game was decreasing but due to "Super Mario Bros." it was a revival of the video games industry, the game is also credited for its success and support to the game industry, later on the North American video game crash of 1983 as it introduces varieties of gameplay mechanics and innovations, game designs, including changing levels, power ups and hidden secrets as well. [1, 28, 29, 33-36]

The "Donkey Kong" and "Super Mario Bros." both are considered to be the classics and most important part of the history of video game industry. These two also had a significant impact on popular culture. Due to these two Games Nintendo became one of the most dominant players in the industry and also established a specific platform standard for them games which was followed for many upcoming years. Since then the Game industry reached a revenue of billions with in a very short duration. [1, 28, 29, 33-36]

Later on came the most creative part during the 1990s as it was the era of transition from 2D to 3D games which was a significant turning point in the video game industry which made the users more involved with game due to its graphics and interaction. The games that played a crucial role in this transition are Doom and Super Mario 64, which were also successful. [1, 28, 29, 33-36]

In 1993 "Doom", a first-person shooter game that operates with 3D graphics and it grew to become one of the most influential games in game history, it sold over two million copies in the first 2 years, generating over \$100 million in revenue. Due to its popularity the first-person shooter genre was established. [1, 28, 29, 33-36]

Another game that played a key role in the development of 3D games was Super Mario 64, released in 1996. It's the first game in the Mario series to feature 3D graphics and introduces a revolutionary new style of play combining platforming with exploration. More than 11 million copies of Super Mario 64 have been sold worldwide, generating more than \$300 million in revenue. It was also critically acclaimed and considered the best video game ever made. [1, 28, 29, 33-36]

Many developers began experimenting with new approaches of using 3D graphics to make a more realistic and entertaining game worlds, after the success of Doom and Super Mario 64. A famous example is a series called Grand Theft Auto, which began in 1997. Open-world play is used in the series to let players enjoy free access to 3D environments and interact with various elements. The series has sold over 345 million copies around the world and made more than \$10 billion. [1, 28, 29, 33-36]

The advent of online games was another significant development. When EverQuest and World of Warcraft were released in 1999 and 2004, respectively, gamers could connect with one another across the broad Internet. So we created a whole new gaming experience that allows players to collaborate and compete with each other in real time, no matter where they are. [1, 28, 29, 33-36]

With the release of smartphones and tablets in the late 2000s, the growth of mobile gaming also had a significant effect on the gaming industry. This has led to the creation of a new market for casual and mobile games, which can be played quickly and on small screens. The popularity of the games Candy Crush Saga and Angry Birds, which were launched in 2012 and 2009 respectively, shows how easily gaming can be made available on a portable device. [1, 28, 29, 33-36]

In recent years, a range of new technologies have been developed in this field, such as Augmented and Virtual Reality. In the light of these technical developments, which also make games more interactive and entertaining, there is an increased variety of game design options. [1, 28, 29, 33-36]

The development of video games has been significantly influenced by change from 2D to 3D gaming. It's opened the door for new game genres and gaming scenarios, which have had a strong impact on the industry today. This has resulted in a significant increase of the industry's financial potential, with titles such as Doom and Super Mario 64 generating substantial revenue from their respective developers. The video game market is worth billions of dollars now, and it is expanding yearly. [1, 28, 29, 33-36]

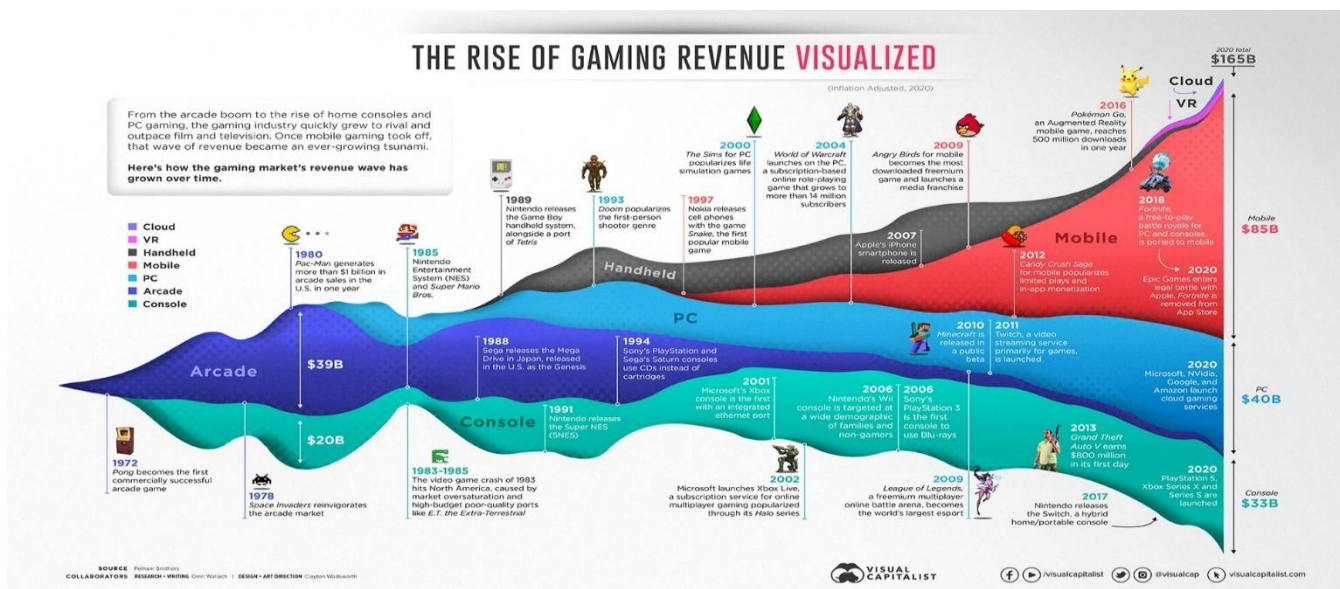


Figure 8 Revenue [30]

2.2 HOW GAMES CAN BE USED FOR LANGUAGE LEARNING.

Games can be used for language learning in a variety of ways, and there are several reasons why games are a valuable tool for language learners. Here are some key points [7-10, 38-42]:

- Learning new vocabulary: Games can employ visual aids like pictures or movies to assist users in their vocabulary development. A picture of a tree with the word "tree" written beside it in the target language, for instance, may be displayed in a language learning game. [7-10, 38-42]
- Grammar practice: In order to assist the learners in their learning of grammar structures and rules, visual guidance may be provided for games. For example, the animation might make it easier to see several types of verb tense and language patterns in a play. [7-10, 38-42]
- Pronunciations practices: In order to improve the pronunciation games can be helpful in such as way that the game could display a short video of a native speaker pronouncing word which would make the learner understand how the word is exactly pronounced and then they can compare their pronunciation with the native speaker. [7-10, 38-42]
- Contextualization : Games uses Visual techniques to offer contexts for learning languages. For example, a real world scenario can be easily created in a game through any video or image in which the learner has to complete the task in the given language. [7-10, 38-42]

2.2.1 RELATION IN GAME & VISUAL LEARNING TECHNIQUES:

- As stated earlier through visual learning techniques a user can experience enhanced engagement with the topic that is being used or presented in the game. [38, 39, 41-44]
- While being presentive and innovative game gain the ability to Improve retention as through Visually seeing these things helps the user to recall the vocabulary or meaning of the specific word easier as a human being the imaginary image of the word comes quickly. [38, 39, 41-44]
- Due to visual learning, it becomes easier for the user to under the complex concepts as well as grammar structures, abstracts and new vocabulary words. Indirectly it Enhances the users Comprehension. [38, 39, 41-44]

Apart for visual learning the basic idea of using Digital games in language learning is a very useful concept, there is also a book named "Digital Games in language learning and teaching" which is edited by Hayo Reinders and Nicola Whitton. This edited volume assembles tighter the information on all essays form various scholars in various fields of language learning and game studies. The book describes and states the different ways in which digital games can be used to increase language learning as well as provide with multiple examples on how various games can be used for different language learning goals. [40, 44]

This idea of teaching can also be added in the classrooms teaching the book named "language learning with Technology: Ideas for Integrating Technology in the classroom" which is written by Graham Stanley, which practically advices language teachers to use who are interested to incorporate technology and also include games in their teaching practices. In this book we can see the various types of examples of how games can be used to support learning which we would be talking later ahead. [38]

The games can also offer a fun and interactive way of making the user engaged with language and offer different aspects of developing the vocabulary, grammar and speaking skills, the article named ""The Use of Computer Games as Foreign Language Learning Strategies" written by Petra Stickler provides a good overview of the topics I stated above.[41]

The book named "Digital Game-based Language Learning Research, Theory and Practices" which is edited by Hsin-Kai Wu co-edited by Bin-Shyan Jong which focuses on the aspects of digital learning, and it also provides insight on research, theory as well as practical applications with in the field. The sharing the comparative knowledge on this topic, the book sheds light on opportunities and challenges faced while implementing the game with language learning. [39, 40, 44, 45]

Overall digital technology holds the potential to increase the accessibility of language learning through raising its engagement and effectiveness. However, to develop it further in future it would still require some more amount of research and development to make sure that the digital tools and resources are optimized. [38, 39, 41-44]

2.3 UNITY

In 2005 the Unity Technologies released their first Game Engine named "Unity". The Unity Technologies we founded in 2004 in Denmark, they started with the development for the Mac OS X platform, but as to grow in industry and to cope up with new technologies they also expanded the system to support Windows and other operating systems. [22, 46-48]

Due to its simplicity of use and reasonable cost, Unity Game Engine soon became popular among independent developers and small game companies. In its early years, it was mostly utilized to create 3D games for mobile devices.[20, 47-49]

Unity Technologies announced the release of Unity 4 in 2012, which made substantial enhancements to the engine's capabilities and tools, including the addition of Mechanism, a powerful animation engine, support for DirectX 11, and a new animation system. [20, 47-49]

With the 2015 release of Unity 5 and the 2018 launch of Unity Technologies' High-Definition Render Pipeline (HDRP), which significantly enhanced the engine's visual capabilities and made it easier to produce visually gorgeous games, Unity saw substantial growth in the years that followed. [20, 47-49]

In the gaming industry, Unity Game Engine is a well-liked cross-platform game engine. It was initially made available in 2005 by Danish-American software company Unity Technologies, which specializes in making tools for game production. The engine was first created for the Mac OS X platform, but it eventually gained support for Windows and other operating systems. [20, 47-49]

With the addition of new tools and capabilities to make game production more user-friendly and accessible, Unity has seen substantial development and improved over time. The Unity engine's visual capabilities were enhanced in 2018 with the release of the High-Definition Render Pipeline, enabling game developers to produce visually gorgeous games. With the advent of C# and Visual Scripting tools, the engine's scripting languages have also been improved, making it simpler to create games without the use of complex code. Some of the best games created using Unity include: [20, 47-49]

- A game called Cuphead which is a run and gun game. This game art style is inspired by 1930s cartoons, this game was released in 2017 and published by StudioMDHR Entertainment. which is

a classic 2D platform-based game which includes animation and challenging Game play experience.[49]

- Ori and the Blind Forest the critically acclaimed adventure game published by Microsoft Studios and developed by Moon Studios. It was released in 2015 on all platforms such as Microsoft Windows, Xbox One, and Nintendo Switch. The Game has a beautiful graphics as well as immersive storyline. [50]
- The game named Hollow Knight being released in 2017 and published as well as developed by Team Cherry. The Game is an Action-Adventure game and is also available on all platforms.[51]
- A game developed by Inner Sloth named "Among us" was released in 2018 and gained huge popularity in 2020. Particularly during covid-19 pandemic. The game has a simple game mechanics, fun graphics. [52]

Apps for language learning may be created using the robust gaming engine Unity, which can provide a broad range of interactive experiences. A large number of Unity-powered language learning applications have been developed over the past several years, employing the engine's cutting-edge graphics, animations, and interactive features to create entertaining and engaging language learning experiences. [20, 47-49]

The robust gaming engine Unity may be used to develop a wide range of interactive experiences, including apps for language learning. Unity has been used to make a lot of language learning apps recently, utilizing the engine's cutting-edge visuals, animations, and interactive capabilities to produce fun and immersive language learning experiences.[20, 47-49]

The well-known language learning platform "Mondly," which employs gamification and interactive experiences to teach users a new language, is an illustration of a language teaching software made with Unity. In an aesthetically appealing and immersive 3D environment, the app presents a range of interactive tasks, such as quizzes, conversation simulations, and pronunciation drills.[20, 47-49]

"LinguaTrip," an app that enables users to practice real-life language abilities by touring various virtual settings and performing language-specific activities, is another illustration of a language teaching app created in Unity. Users may practice their language abilities in a fun and engaging way while interacting with virtual characters, exploring virtual landscapes, and more.[20, 47-49]

Overall, Unity's adaptability and strength make it an excellent choice for language teaching and learning applications, enabling developers to build interesting and interactive experiences that can improve language learning results.[20, 47-49]

Due to its simplicity of use, cross-platform compatibility, extensive documentation, and community support, Unity Game Engine is the favored option for many game makers. With its simple tools and UI, developers can produce high-quality games with little effort, and its large asset store makes it simple to include third-party components and plugins.[20, 47-49]

2.4 RELATED WORK.

2.4.1 DIGITAL RESOURCES AND TOOLS DEVELOPED FOR TEACHING SANSKRIT LANGUAGE.

- Mobile Application: There are a lot of Mobile applications that have been developed and are available for the masses to learn Sanskrit. For e.g., Sanskrit Dictionary App, Sanskrit grammar app, Learn Sanskrit app etc. With these applications, learners can access Sanskrit Vocabulary, Grammar

rules, and solve exercises given to have a better understanding on Sanskrit and can use it anywhere and everywhere.[18, 53-55]

- E-Learning Platforms: Along with Mobile applications, there are also several platforms which provide Online learning called e-learning Platforms. For e.g., Samskrita Bharati and Samskrita Sanhralaya. These platforms provides learners with online courses on vocabulary, Grammar and literature by using multimedia resources such as audio recordings, videos and interactive exercises.[56]
- Digital Dictionaries and collections: Digital Sanskrit dictionaries and collections also termed as Corpora/Corpus For e.g., Digital Corpus of Sanskrit, Cologne Digital Sanskrit Lexicon etc. Are being used by learners and researchers to enhance and upgrade their knowledge. These collections provide learners with access to extensive collection of Sanskrit texts and Vocabulary.[57]
- Digital Libraries and archives: In addition to above, there are also Libraries and Archives present online to provide Learners and researchers access to an extensive collection of Sanskrit literature, which includes Texts, Manuscripts and dissertations. To name a few digital libraries as such are Digital Library of India and Sanskrit Documents Website.[58]

Computer Games: As mentioned in the earlier section, there are several computer games also that have been developed for teaching Sanskrit, these games offer an immersive and engaging platform for learners. [58]

One of the interesting applications is the Sanskrit Wordnet. It is a lexical database for the Sanskrit language, the Sanskrit wordnet is created by the Indian Institute of Technology (IIT) Bombay with the support of the Department of Information Technology, Government of India. Basically it was a part of a larger Wordnet project, whose aim was to create the lexical database for different languages . [59]

Now about how the Sanskrit Wordnet works, the Sanskrit Wordnet has a large number of words and their semantic relations which are organized into a group of words with the same meaning(synsets). Also, there are two used to build the Sanskrit word net one which is the expand method and the other is the merge method. In the first method the wordnet is created by using the data in the existing wordnet while in the second method the sub-wordnets for a specified domain are built and later combined together. The database used for the Sanskrit wordnet is the Hindi wordnet, even though using the Hindi wordnet as the source the Sanskrit wordnet recognized the real lexical structure of Sanskrit language. [59]

The creation of Sanskrit wordnet also includes the use of computational linguistics techniques such as corpus analysis and manual annotation. [55, 59]

- The Sanskrit wordnet can be used for the task such as retrieving information like text classifications, document clustering and also text summarization. [55, 59]
- In terms of machine translation the database can be useful for the translation of Sanskrit to other languages which can be also automated in the future and added to robots. This could be helpful for the people who don't want to learn but just need help in the translation for a work like a dictionary. [55, 59]
- As mentioned in the above point , the Sanskrit language can also be used for supporting natural language processing tasks give as sentiment analysis , text parsing as well as named entity recognition. [55, 59]

- The semantic analysis can also be done by using the Sanskrit wordnet database which could help in performing analysis of Sanskrit texts, identifying synonyms, antonyms and semantic relations between words. [55, 59]

This is used as a valuable resource for many students, researchers and others who are interested in understanding and learn the Sanskrit language. The various applications it can be used for is information retrieval, machine translation as well as natural language processing. [59]

2.4.2 SANSKRIT GAMES AND APPLICATION:

- Sanskrita Bharati Kerala.[54]
- Sanskrit for Yoga by Drops. [60]
- Sanskrit English Dictionary. [60]
- Learn Sanskrit. Speak Sanskrit. Study Sanskrit by [Bluebird Languages](#). [60]
- Sanskrit Shabdmitra.[55]
- ShabdRoop is a mobile game available on the Google Play Store and the App Store. [60]
- Sanskrit Quiz which is available on various websites includes quizzizz.com. [60]

Now a similar concept game that we are going to implement somewhat in our game. IN 1985 a game named "Where in the World is Carmen Sandiego?" was released and was one of the popular game in 1990s it was used as an educational game in which the user would be playing as a detective who has to track down the a notorious criminal named Carmen Sandiego.[61]

In this game various locations around the world are shown in which you have to choose and then you have to find the clue that will lead you to the Carmen's whereabouts. The user is entirely engaged with this game and has to be focused they have to use their deduction and problem-solving skills to solve the puzzles and decode the code or clue to progress through the game. In addition, there are other game assets like agents that the player can include or recruit to help the user search. These agents have different ability and skills which are displayed to the user then the user chooses which one he wants and selects the specified agent appropriate for the task of finding Carmen and solving the case. [61]

Later on there were many new updates and new upgraded game versions as shown below:

- The game named "Carmen Sandiego returns" which was a reboot of the original game with an updated graphics as well as updated game play. [61]
- Then the game "Carmen Sandiego: The Secret of the Stolen Drums" which is a 3D adventure game in which the player or user has to track Carmen across the globe for recovering the stolen musical instruments. [61]
- The game "The ClueFinders" series – was a educational games series in which the player had to solve puzzles and explore exotic locations for uncovering clues and solve the mysteries related to it. [61]
- The game "National Geographic Challenge!" as the name feels it is a quiz game that would test the knowledge of the players. The knowledge would be tested regarding these aspects which are knowledge of geography, knowledge in history as well as in science. [61]

- The game "GeoGuessr" is an online game which amazingly is using Google Maps street view for challenging the player to identify the location that they are currently in. [61]
- The game "Odyssey: The Search for Ulysses" is an adventure game in which the player or user has to travel through the Mediterranean to find our hero Ulysses. [61]
- The game "Expedition Titanic" is an adventure game in which the player or users has to uncover the secrets and solve puzzles while exploring the sunken Titanic. [61]
- Then again, the game "Where in Time is Carmen Sandiego?" but with a very amazing advancement and with a futuristic approach in with a spin-off of the original game where the player or user have to travel through time to find and capture the Carmen and also her Henchmen. [61]
- The game "The Oregon Trail" is a classic educational game in which the player has to travel to the westward on the Oregon trail while tackling challenges and making various decisions all along the way. [61]
- The game "Super Solvers: Outnumbered!" is also an educational game in which the player has to escape the castle and to do that they has to solve math and logic puzzles. [61]

2.4.3 Analysis

- All these games have a very basic interaction method and have used quizzes by showing images.[60]
- The existing games are in 2D. [60]
- We are using unity to develop the game in 3D. [22]
- Sanskrit Quiz: Sanskrit Quiz is available on several websites, including quizzizz.com and proprofs.com. It is developed using PHP, JavaScript, and HTML programming languages.[60]
- ShabdRoop: It is developed using Java and Kotlin programming languages for Android and Swift for iOS. [60]

In the Sanskrit Wordnet it was tested and that is how it is helping this project. The Sanskrit wordnet use standard techniques to test and evaluate the quality of their lexical databases, which is inter-annotator agreements and precision-recall analysis. Presenting it in a simple example they told a group of annotators to manually annotate a subset of the given database, in which the inter-annotator agreement is calculated in order to verify the consistency in annotations. Going further to test the accuracy of the word database, they used precision – recall analysis for its evaluation. These results from the above mentioned test were used to evaluate and justify if the Sanskrit Wordnet is reliable and accurate resource for Sanskrit language or not, in which the Sanskrit Wordnet was found eligible. [59, 62]As in this project we would be planning to use the same concept but with some changes and including AI with it.

For the testing of our game, we are going to use the user testing method in which the user will be given a small questionnaire in the beginning of the game and a small feedback after the game ends to get an idea of the user experience. these questionnaire won't be related to personal details apart from the users his level of proficiency in Sanskrit language. The above given method is similar to this reference paper.[63, 64]

Game developers use a variety of methods to test their games before release, including functional testing, compatibility testing, performance testing, and usability testing. Functional testing involves ensuring that all game features and mechanics are working as intended. Compatibility testing is done to ensure the game works on different platforms and hardware configurations. Performance testing is done to ensure the game runs smoothly and without glitches. Finally, usability testing is done to ensure the game is user-friendly and intuitive. All of these methods are crucial to ensuring the success of a game upon release. [65]

2.4.3.1 CHALLENGES.

There are few concerns about how computer games are effective for language learning skills and making language more enjoyable, some critical analysis are mentioned below: [48, 65]

- Limited feedback -Through this research it is stated that computer games may not provide enough feedback as comparative to the human feedback, even though some games provide feedback they are not that effective as some users might not be able to express them self fully or can have a wrong idea about their current knowledge. [48, 65]
- Limited Interaction - Through a game there is a very limited interaction as of to improve learners language skills , as computer games or any platform based games will be designed for a specified task. Also the verbal; skills are best developed by the user if he is able to communicate with other people in similar language. [48, 65]
- Limited culture context - Also games are not able to provide enough culture related context to the learner to get a complete idea about the language they are learning. As language is a close tied to the culture due to which learner many need to do a separate research on their own. [48, 65]
- Limited transferability – Computer games may not be as effective as traditional language in terms of transferability of language skills. As they may not relate to real-life situations as effectively as traditional language instructions. [48, 65]

2.5 PROGRAMMING ENVIRONMENT

As Game development has been significantly evolved from simple 2D programming using assembly language to complex 3D gaming with artificial engine as well as advance physics engine in it over the past years. Some of the traditional as well as modern technologies that has been used to develop games while focusing on their programming aspects are mentioned below. [66-68]

2.5.1 TECHNOLOGICAL EVOLUTION IN GAME PROGRAMMING.

- Assembly language - assembly language has been used by programmers in 1950s to 1990s, It was basically a low level programming language which was directly executed by the CPU due to which it used to be it fast and efficient. [66-68]
- Later on in 1972 C language was released which was developed by Dennis Ritchie at Bell Labs. After which in 1983 C++ language was released, in 1991 Python language was released but was not much popular back then in 1995 the Java language was released & In the year 2000 C# (Pronounced as C sharp) Was released. [66-68]

- In the gaming industry the most preferred language in those times were C and C++ as game development needs complex coding. These both languages soon became the primary language for developing the game, currently C++ is still used in the gaming industry because of being efficient and flexible as well as an object oriented programming language. [66-68]
- The game engine such as Unity, Unreal engine and cry engine used use C++ before later on the C# language was introduced, later on developers started using it more due to its availability of resource and flexibility as well as compatibility. [66-68]
- The physics engine was added in unity later, as it is used to Simulate the physical Interaction between the objects in the game, some of the Physics engines are box2D, Bullet physics and physX.
- Later on AI was introduced to the games industry as it made the game more realistic and challenging for the learners and players. The Machine learning technique to train the AI agents was used, as the name of the techniques were techniques Network & Reinforcement learning. [66-68]

2.5.2 C# LANGUAGE.

In 2000, Microsoft introduced a modern object-oriented language called C# (pronounced "C sharp") as a part of the .NET initiative. It is a simple, modern as well as type-safe and general-purpose language. C# is similar in syntax to C++ and JAVA, although it also comprises attributes of languages such as Delphi and Visual Basic.[66-68]

Microsoft developed C# in response to extended acceptance of JAVA, which at the time was a considerably popular programming language for developing web-based applications. Hence, Microsoft wanted to create a similar language to JAVA, but with features that would make it relatively easier to develop Windows-based applications. As a result, C# 's first version was released in 2002 as part of the .NET Framework 1.0 .[66-68]

Leading to its Popularity, today millions of developers use C# to build windows and web-based applications, as C# is easy to use and is a reliable language to improve the performance of applications. Many active community of developers support C# by contributing to its development and sharing their knowledge and expertise with others. [66-68]

Below are several tools and components that are used to develop, test and deploy C# applications:

Visual Studio[69]: An Integrated development environment (IDE) for Windows, which offers an intact set of tools for building Window, webs and mobile applications with C#. [66-68]

The software framework called .Net developed by Microsoft provides a set of libraries and tools to construct windows and web-based applications with the use of C# language. [66-68]

The .Net core which slight is different from the .Net it is a free open-source, cross-platform development framework which is used to build Web-based application, Windows and also mobile apps by using C# language.it supports the development in multiple platforms as Windows, Linux & macOS as it is fast and lightweight. [66-68]

Xamir is the set of tools is used to build cross-platform mobile applications with the help of C# language it basically allows the developer to write the C# code and compile it on many other platforms such as windows, iOS, Android. [66-68]

Arjun is a cloud computing platform developed by Microsoft that provides various range. Services for managing, deploying, as well as maintaining and building C# applications in Cloud. [66-68]

The C# programming environment is basically a very powerful tool which can be used to design These applications mobile applications as well as develop windows. Because of this reliability, good performance and easy to use. C# has become one of the most popular languages in the recent times. [66-68]

- Popularity: Based on the popularity that C# has, it is being used in many industries, including software development and also it is used in game development, especially with Unity. As Unity is one of the most Popular game engine available in the industry with the large community of developers also requires a programming language which has a large resource easily available to two which most of the users beautiful C# language. [66-68]
- Those who are familiar other languages such as Java understanding and editing in C# language easier for them. Even for beginners it is easier to use unity as it is synced with Visual Studio code Visual Studio both of them mix the game development what is it I recently the unity by itself provides very previous types of tutorials and resources to help to developers to learn see sharp and to understand how to implement it and unity. [66-68]
- As mentioned earlier the cross-platform between C# and unity is its biggest advantage also as unity allows the developers to create games for multiple platforms suggest mobile, windows or Mac, console, as well as VR. Due to C# being a cross-platform language making easier to shift games in various platforms without rewriting the large proportion of code. This what's the developer in a beneficial position as it minimizes the time and helps the developer to reach for a wider audience which basically means this increase this the productivity. [66-68]
- Being a high-performance language C# is used to create games as it increases the gameplay as well as the response, as unity also has tools to optimise the games performance such as built in profiler which allows the developer to develop the game in different platforms and devices which can operate smoothly and efficiently in both of them. [66-68]
- Regarding flexibility the Combination of these both C# as well as Unity provides the developer with high degrees of flexibility for developing a game. As C# allows object-oriented programming, which make it quite easier to create reusable codes with an extended Functionality. Unity is component-based architecture that provides for the modular development easy for adding new features and edit the game design. On the other hand, the Asset store in Unity offers a amazing and wealthy resources, including the plugins and ready to use assets with animation infused in it. This makes game more interactive and engaging and less time consuming to the development part. [66-68]

Overall, game development have evolved from a simple assembly language to a complicated game engine, physic engine, graphics libraries and AI. It requires all in one language as well so even if the other programming languages may have some benefits which C# has but C# has all of them in one package. for example, some language could have strong Object-oriented Programming or automatic memory management but doesn't have cross-platform support. Also the reason for using this combination C# and Unity offers the developer to create a high quality game in multiple platforms as both of them have a very powerful set of tools. [66-68]

2.6 CRITICAL ANALYSIS

2.6.1 GAMES FACILITATE LEARNING.

In this session arguments that support how games can be helpful in terms of learning languages are presented and explained. Learning through games is proven to be helpful as they are user friendly and provide better experience and opportunities, making it easier for the user to learn the language. [9, 38, 40, 44]

Learning through games has been proven to be helpful as the interaction and engagement is more. Below are a few points on why games are a good option for learning language. [9, 38, 40, 44]

Based on the literature review and these research papers [9, 38, 40, 44] it can be identified that games do help in learning in terms of Active learning, providing feedback and reinforcements, ability to repeat multiple times, Flexibility and personalization. [9, 38, 40, 44]

Overall, games are high end tools due to flexibility, involvement, hands on learning, recurrence and consolidation ability. By integrating games into education, participants can reinforce and develop knowledge skills and entertaining and captivating manner. [9, 38, 40, 44]

2.6.2 EXISTING SANSKRIT LEARNING APPS:

- Sanskrit by HinKhoj: This is a beginner friendly app with basics in Sanskrit like grammar and pronunciation explained using examples in Hindi and has a lot of limitations which may not suit advance learners.
- Learn Sanskrit by Code Rays Technologies: This app offers grammar, vocabulary along with exercises and audio recordings but has a complex interface and the contents are difficult to access as well as navigate.
- Learn Sanskrit by MBD Group: This app too is a basic version for beginner's and not suitable for advanced learners as it also provides basic grammar and vocabulary with audio recordings with no advance content.

2.6.3 LIMITATIONS OF EXISTING SANSKRIT LEARNING APPS:

- Almost all existing Sanskrit apps provide only basics which the advanced learners do not find handy which decreases their further enthusiasm.
- Existing Sanskrit apps fail to provide interactive features such as audio, video recordings and are unable to provide opportunities for written and verbal Sanskrit.
- Users find it difficult to navigate the content and access various features as the interface is not user-friendly as well as some games don't contain much information to provide with.
- Most of the apps do not provide encyclopedic overview of the language which makes it difficult for the user difficult to master it and understand the meaning of it.

In conclusion, after having so many Sanskrit learning apps, they still may lack various features such as content and user experience and do not fulfil the entire demand of the user as such they have to rely on other sources i.e. textbooks and online courses as well to completely understand the language.

2.6.4 WHY BUILD THIS GAME & USE UNITY.

Sanskrit, is one of the ancient languages in the world, is known for its rich vocabulary, grammar & literature. It is considered as a sacred language by many. As it is also called as Mother of all Languages stated by Sir William Jones (1746-1794) [41, 70, 71]. Which makes it a ancient language too. However, it's usage has declined over the past years due to language difficulty and less enthusiasm and lack of resources. To tackle this issue, we've come up with this fun game using Unity software to help learn Sanskrit. The other games have very basic concepts and are a quizze or more towards a educational application focused specifically on teaching the user the language. But this game would be focusing on how to make the user engage with the game and making it more fun as well as motivating. [13, 14, 22, 47, 48, 67, 69, 70, 72-77]

Although there are numerous resources available to learn Sanskrit, development of games specifically for learning this language are rare. This gap indicates an opportunity to develop an creative and fun engaging game which could motivate learners. [14, 22, 47, 48, 67, 69, 70, 72-77]

A Software such as unity has several advantages one of it is as unity have its own resources, assets and publishing method it makes easier for a new user to get more attention on their game regarding resource unity has its own platform of developers as well where they interchange ideas as well as help each other in unity and error related problems. Apart from this regarding the technical part Unity has a benefit of building this game in a wide range of platform which include mobile and VR as well. As well as Unity is easily compatible with window, mac and Linux too. [14, 22, 47, 48, 67, 69, 70, 72-77]

As Unity has a set of powerful tools with high rendering pipeline and also links with other editors and compilers easily as well such as visual studio code, etc. in which unity also adds the basic syntax which is already linked to Unity. Through unity heigh definition games can also be made. [14, 22, 47, 48, 67, 69, 70, 72-77]

Lastly, this game could employ gamification techniques like rewards, tracking progress and leaderboards for better learner engagement with quality learning while providing them with a sense of achievement. [14, 22, 47, 48, 67, 69, 70, 72-77]

To conclude, a game build on Unity to learn Sanskrit would be a valuable addition to the already existing resources with a noteworthy engaging and interactive nature of the game combined with customizability ,accessibility and gamification potential of Unity, making it a compelling and effective Sanskrit learning tool. [14, 22, 47, 48, 67, 69, 70, 72-77]

2.6.5 ADVANTAGES OF UNITY FOR GAME DEVELOPMENT:

As stated earlier in 1.2.3 it is understandable that Unity is a powerful game engine which allows the developers to create design and play games for various platforms, including mobile, desktop, as well as consoles. The Unity Engine provides a variety of range of features including tools that make the game

development much easier and faster. Some benefits of using Unity for game developments are as follows:[22, 47, 48, 67, 72-74]

- As Unity is compatible it supports multiple cross-Platform which gives the developer the benefits of creating allowing developers to create games in different platforms for various devices and operating systems. [22, 47, 48, 67, 72-74]
- As unity has a very user-friendly interface which makes it quite simple and easy for the user to learn and adapt for beginner as well as experienced developer. [22, 47, 48, 67, 72-74]
- In terms of game design and editing unity allows the developer to create different and unique and engaging games which make it a flexible Game Engine. [22, 47, 48, 67, 72-74]
- Unity has a vast community of developers due to which it becomes easier to interchange ideas resource and helpful for learners to grow. [22, 47, 48, 67, 72-74]

2.6.6 BENEFITS OF CREATING A GAME FOR LEARNING SANSKRIT:

- Interactive and fun learning – Games are well known for their engagement and interactive nature as they keep the user motivated for a longer duration compared to the books games, movies, most etc. are more enjoyable and effective to recall. A game for learning the Sanskrit can make the language more fun and easy to remember. [7-9, 38, 41, 42, 75, 78-80]
- Retention of Information – Learners are able to retain the information that they have learnt much better as compared to regular type of learning, as games offer a better context for learning and allowing the user to more practical knowledge and chance to represent their own. [7-9, 38, 41, 42, 75, 78-80]
- Accessibility – As Sanskrit is one of the most ancient and difficult language in the world a game would make it more accessible and interesting for new and other users who may not have access or means for traditional learning resource and who might also have less time as well as find the traditional learning methods difficult. [7-9, 38, 41, 42, 78-80]
- Cultural Preservation – As I mentioned earlier due to Sanskrit language being one of the difficult and ancient language there is a chance of it being extinct within India as well as many youngster's think of it as an optional language and a language that is not necessary to learn due which creating an enthusiasm in them is a necessity. And a game would be a good start for it. [7-9, 38, 41, 42, 71, 76, 78-81]
- Personalized Learning - A game can help the learner to learn from any place and can help to learner to learn at his own pace. Also, later on the game can be added changes as per the user's requirements. [7-9, 38, 41, 42, 78-80]
- Multimodal Learning – As a game have the ability to incorporate multiple modalities of learning which are visual, auditory and kinesthetic, that makes the learning far more easier to grasp and recall. With the use of animation and sound effects, puzzles it makes the learning experience more immersive and effective. [7-9, 38, 41, 42, 78-80]

- Addressing the Gap in Literature - As mentioned earlier, when it comes to good games they have a certain gap in the literature which restricts their development in Sanskrit. Therefore developing a game for learning Sanskrit can contribute to making the language more accessible and fill the gap. [7-9, 38, 41, 42, 78-80]

Overall, it can be stated that developing a game to learn Sanskrit while using Unity software will be beneficial for learners as well for the preservation of Sanskrit Language. As Unity provides many advantages for the development of Game, deciding to make it as an ideal choice would be beneficial. Also this Game would help to provide the future generation the enthusiasm that it need. [7-9, 38, 41, 42, 78-80]

Chapter 3. FUNCTIONAL REQUIREMENTS

3.1 METHODOLOGY SYSTEM DETAILS.

3.1.1 GAME DESIGN.

The game is designed in such a way that through this game, users will be able to learn and practice Sanskrit language skills, including grammar & vocabulary, in an engaging and immersive way. and we hope that this report will provide a useful introduction to this exciting and innovative approach to language learning. Games are used for language learning as Visual learning and Visual teaching are one of the most efficient learning methods.[18, 29, 44, 46, 54, 78, 80, 82]

The game is about providing an immersive and enjoyable experience for learners who wish to learn Sanskrit, as in the beginning of the game the user will be provide or shown few 4 to 5 words in Sanskrit and there meaning in English for a specified duration like a popup notification, after few sec the main game scene will open in which there would be a bunch of different things in which the user has to pick or click on the specified objects that were the given 4 words. For example, if the word is chair then from the scene the user has to click on the chair in the entire scene. The method of teaching by showing images of particular objects is commonly referred to as "visual learning" or "visual teaching". This approach uses visual aids such as pictures, diagrams, videos, and other visual materials to help children or new learners understand and remember information. Visual learning is often used to teach young children who are not yet able to read or write, as well as children who are more visually oriented learners. The following specific goals could be achieved by this game: [18, 29, 44, 46, 54, 80, 82]

- To introduce learners to the basics of Sanskrit grammar and vocabulary.
 - To help learners develop their reading skills in Sanskrit.
 - To make learning Sanskrit a fun and engaging experience.
 - To make the user recall and learn the meaning of the specific words in a easier way.
-
- Game Interface - The game will be designed in such a way that it could attract and engage the learners easily. There would be three buttons as a regular games interface are which includes a Start button, Option Button and Quit Button these all would be in the initial scene which would be the first Scene as you open the game. Once clicked on start The scene will be designed with four objects related Sanskrit words and then the user has to select those objects form the scene wile the object being randomly placed in the scene. [29, 46, 82]

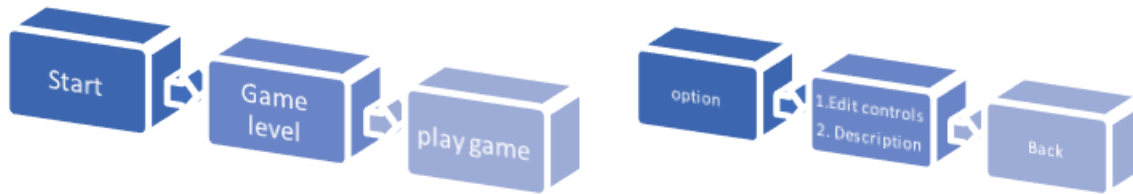


Figure 9 Initial Scene(first scene)

- **Game Mechanics** – The game mechanics involves showing the learner 4-5 Sanskrit words with their English translation for a specific duration before the main game scene appears in which random objects will be displayed in the scene including the objects who's name were displayed before. The user or learner has to then recall and choose the object out of the scene. [29, 46, 82]

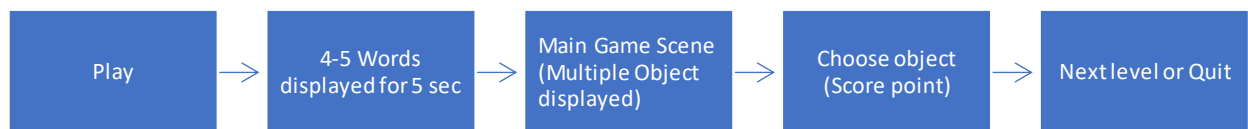


Figure 10 Game-Play

- **Scoring System** – The game have a scoring system which would make the game more engaging and would make the game feel like a competing situation. The scoring system of the game will be based on how many objects the player is able to collect without selecting the wrong objects. [29, 46, 82]
- **Leveling System** – The game will have multiple level with each level being difficult than before. Each level will have different objects and name as well as the time duration of selecting those objects will also Decrease with the increase in level. As learner will be passing on to the further level he will be shown more complex words. [29, 46, 82]
- **Feedback System** – The game will provide instant feedback to the played in the form of ratings the player will be given within 5 star ratings. Also if the game gets over and the player is not able to cross the level he will shown the words and their meanings again at the end. So for the greed of getting good score the player will be more focused in further levels. [22, 65, 69]
- **Competitive System** – The game will have an AI integrated enemy player before that finds all the game objects and before the countdown timer is over the player will have to find those objects. [22, 65, 69]

Overall, after including the game mechanics , leveling system, scoring system, feedback system will create a game that will achieve the goals of introducing the learn to basic of Sanskrit language. [29, 46, 65, 82]

3.1.1.1 INCREMENTAL MODEL.



Figure 11 Incremental model

The approach for software development model in this thesis is the Incremental model, An incremental model focuses on the development of a specific process throughout until the software is developed. Each of these represent a complete cycle.[83]

- This process includes the search for requirements, in the game it would be assets, platform & language preference. [83]
- In the Design part the game is compiled, assembled, and code script is added. [83]
- After the designing part the Testing and implementation is done to be accurate and sure before publishing it. [83]

3.2 NON-FUNCTIONAL REQUIREMENTS.

The Non-functional requirement which describes the overall behavior, characteristics, as well as quality of the system. Below are some non-functional requirements for this game[18, 46, 54, 55, 65, 82]:

- Performance –The game should be responsive and fast with minimum also the game should be able to handle a good number of people all users.[18, 46, 54, 55, 65, 82]
- Scalability - scalability the game should be easily able to handle multiple levels without any performance issues or downtime. [18, 46, 54, 55, 65, 82]
- Security - the game should be secure if it is connected to online with appropriate measures the data should be protected from hackers. [18, 46, 54, 55, 65, 82]
- Reliability - the system should be available and functional all time with minimal errors. [18, 46, 54, 55, 65, 82]
- Compatibility - The game should be compatible with different and multiple operating systems as well as different devices and platforms. [18, 46, 54, 55, 65, 82]
- Access ability and maintainability - The game should be available to multiple users and for people with hearing or speaking impairments. Also, it should be easy to maintain the code as well as easily able to modify or enhance its graphics & assets. [18, 46, 54, 55, 65, 82]

As stated above it is clear that the non-functional requirements are as crucial as the functional requirements as it contains reliability, security as well as access and maintaining the system. [18, 46, 54, 55, 65, 82]

3.3 PROGRAMMING LANGUAGE USED.

The programming language or programming environment that is going to be used in this project is C#. There are many reason which has be explained in brief in section no 2.6 Programming Environment. The main reason of using C# is that not all the languages such as C, C++ or java , etc. requires all the tools and packages, which C# has. [66-68]

To develop a full fledge game and to work on multiple platforms C# is capable as it also have cross-platform package in it. Which is very beneficial in terms to design a game which could work on windows as well as mobile and VR. [66-68]

The Unity Engine has separate feature where you can set the preferences to sync it with Microsoft Visual Studio[69] that allows it to generate an initial script . Every asset that will be Used in the game needs to be sync with the C# script to control the working of those assets. [66-68]

Due to syncing it with different C# scripts it allows the user to make changes in that particular assets without disturbing the Physics and controls of the other assets. [66-68]

3.4 TESTING

- For testing the game after reach implementation of the assets in the specific scene Unity has an inbuilt feature which helps to run and Debug the amount of game prepared. [22, 65, 69]
- The Feature stated above helps to understand if there is any error while the implementation as well as managing the script, this is in our case is C# script. [22, 65, 69]
- Apart from Unity the other application that we are using is Visual Studio code which Also has its own set of tools and debug Features to identify if there is any new error while we are coding. [22, 65, 69]
- Once we are thorough with all these three test, then Unity has a feature of building the game in different platform through which we will rectify if there are any errors after creation of the game. Once it is built it will be tested again by the developer to reach check if there is any Glitch or any error throughout playing the game. This process will be done until the game works as expected. [22, 65, 69]

3.5 GAME EVALUATION.

Evaluating an educational game can be done in different ways such as:

- User feedback - this is the most important point as well as a video reliable way do evaluate the effectiveness off again and this method would be used in this project. The user who have play the game will be provided is it 5 questions regarding the game interface, interaction, engagement, Gameplay, Overall game. This feedback will be collected as soon as the user just finished playing the game the user would have to rate within five stars for these questions. [65]
- pre and post game assessment - in this method the user has to answer some questions before playing the game and after playing the game, these are the pre assessment and post assessment to get the knowledge of the user for this particular language. In this method the user will then compare both these assessments to get the idea of his improvement. [65]

- Learning analytics - in this method the user data is collected such as the time taken by the user to complete a level, the number of correct selection as well as incorrect selections and the score he achieved on each level. Players improvement is decide by comparing his play in each level. [65]
- Expert evaluation - the expert evaluation can be basically then by the experts of the specified language in our case it is Sanskrit it can be asked For these experts to play the game and to evaluate the games content design and its effectiveness. [65]
- Long term retention - in this method we can conduct an assessment after certain duration as well as follow-ups after a given time period such as a week or month to understand if the learner is able to recall the specific words and the game play. [65]

Overall, It is not denied that to understand the effectiveness of a game which helps people to learn language would require a comprehensive approach to be evaluated, so to understand the effectiveness of the game we would use the user feedback method because in the user feedback it provides with the benefit of interaction with player or learner in person due to which even if the player doesn't want to provide any written feedback a verbal feedback can be easily taken form them Which would help to identify the areas that need to improve. [65]

Chapter 4. IMPLEMENTATION

4.1 IMPLEMENTATION PHASE 2 - PROJECT SETUP:

4.1.1 PLANNING AND REQUIREMENTS:

In the begin of the project is started by identifying the game's requirement and creating a development plan. It includes defining assets, platform on which the game has to work(e.g., PC, console, mobile), as well as the language requirements(e.g., C#, JavaScript). To achieve all of these a well detailed plan is created to get a outline of the development process and set project milestones. [46]

After the requirements are established, an explicit development plan is constructed. This plan summarizes a step-by-step procedure for developing the game and declares a clear project milestones or targets. It acts as a roadmap for the development team, assuring that all the team is on the same page and steering the projects toward successful completion. [46]

4.1.1.1 PROJECT SETUP:

The project setup includes necessary software and tools for the development of games. This involves installation of software's such as Unity and Microsoft Visual Studio as well as the configuration for the environment. Unity serves as the game engine and Microsoft Visual Studio is used for coding in C# language, we can use other platform to code as well but as Unity has its own library and is supported well with Microsoft Visual Studio for generating intelligence while coding. [22, 66] [69]

In our project this two software are key components of the project development.

When it comes to Unity it is a very popular game engine which provides a comprehensive set of tools, libraries and features for game development also it can use multiple development platforms specific to Androids, Ios, Desktop etc. It severs as the foundation for generating the game's scenes, assets integration and implementation, implementing the gameplay mechanics. Unity also provides access to the developer to create and manipulate game objects, apply physics, handle animations, rigid body, audio sources, and much more. [22]

On the other hand, Microsoft Visual Studio is an integrated development environment(IDE) mainly used for coding in C#. C# is a programming language Widely used in game developments with Unity. The Visual Studio offers a variety of features that streamline the coding process one of which is the intelligence which predefines a base for code, it also help in editing debugging and project management tools. [22, 66] [69]

By Setting Up both of these the development team establishes the infrastructure to start building the game.

To install Unity and Microsoft Visual Studio[69] for game development, it is required to follow these steps.

4.1.1.2 UNITY:

- Visit the official Unity website at <https://unity.com/>[22]
- Choose the appropriate version of Unity based on your operating system (Windows or macOS).Click on the "Download Installer" button to download the Unity Installer. Later follow the on-screen instructions to install. [22, 66]

- Once installed we have to set the platform on which we have to develop the game our game is develop for the Windows, Mac , Linux platform. [22]
- We have to define the editor as well by default it selects the Visual Studio but if in case it has not then we have to put it as preference as shown below. [22]

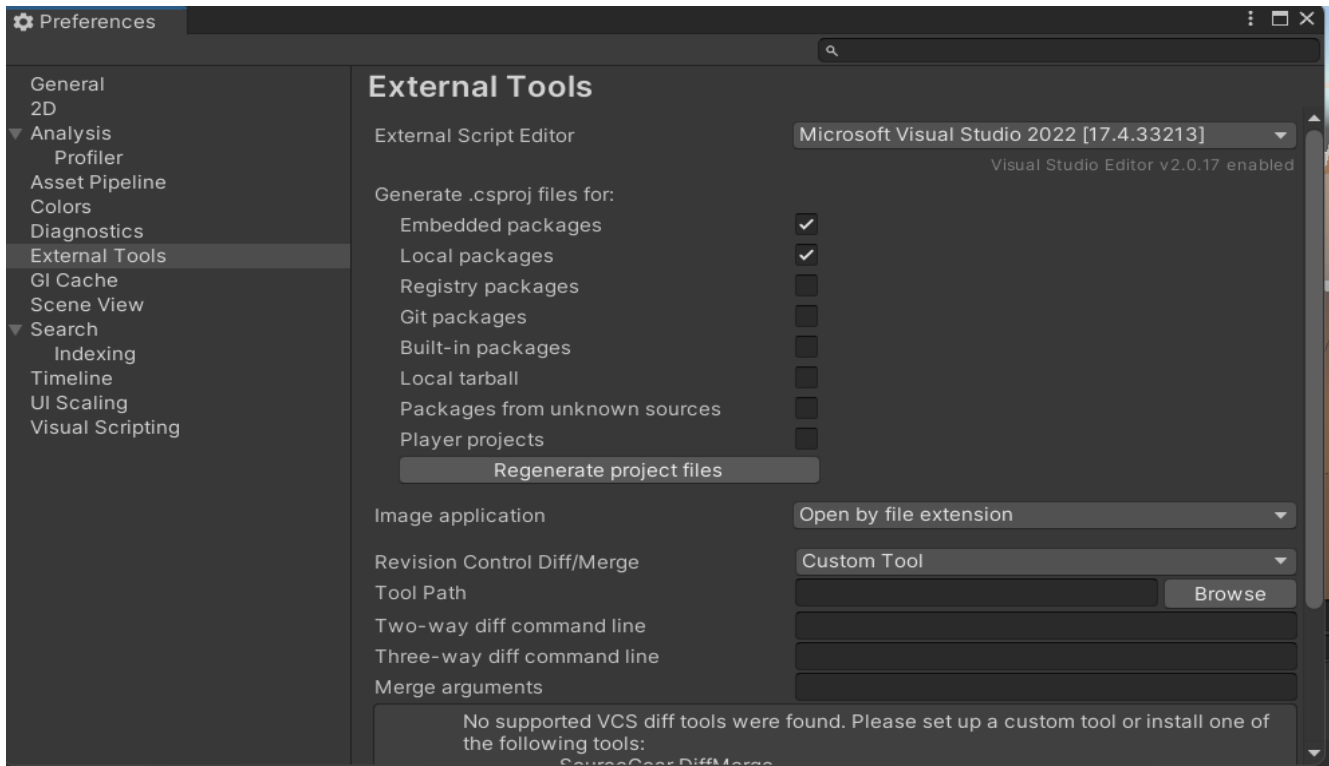


Figure 12 Unity Settings

4.1.1.3 Microsoft Visual Studio:

- Go to the official Microsoft Visual Studio website at <https://visualstudio.microsoft.com/>. [69]
- Choose the version of Visual Studio that suits your needs (e.g., Visual Studio Community, Visual Studio Professional, etc. Click on the "Download" button to download the Visual Studio Installer. [69]
- Once the installer is downloaded, run it and follow the prompts to install Visual Studio on your machine. [69]
- After installation we have install libraries of unity in the Visual Studio, these libraries help in debugging as well as offers features to streamline coding and ensure code quality. [69]

4.1.1.4 C# SETUP:

The C# programming language is already setup within the visual studio code as in the installation of the Visual Studio it also ask for the language installation. [66]

4.2 IMPLEMENTATION PHASE 2:

4.2.1 PAPER PROTOTYPE:

The main reason for the paper prototype is to understand the game-play, how the game is going to be played, what all things are necessary and unnecessary in that game. The paper prototype can be anything just to get a rough idea about the game, by anything i mean a cardboard, slate, pencil, eraser etc. After getting a clear idea the development team can easily understand from where they must start the game as well as makes easy to proceed with the digital implementation of the game.[46] [22]

Below is the image of paper-prototype where I have used regular things, the pen cap is the player and the two boxes are wall other things such as hair clip, ring, spoon, butterknife, dry-cell-battery are the objects that the player has to find. [46] [22]



Figure 13 Paper-Prototype

4.2.2 CLASS DIAGRAM:

Below is the class Diagram to represent the game object-oriented structure and relationships between the classes. The class diagram is useful as it helps in organizing and managing the code.[84]

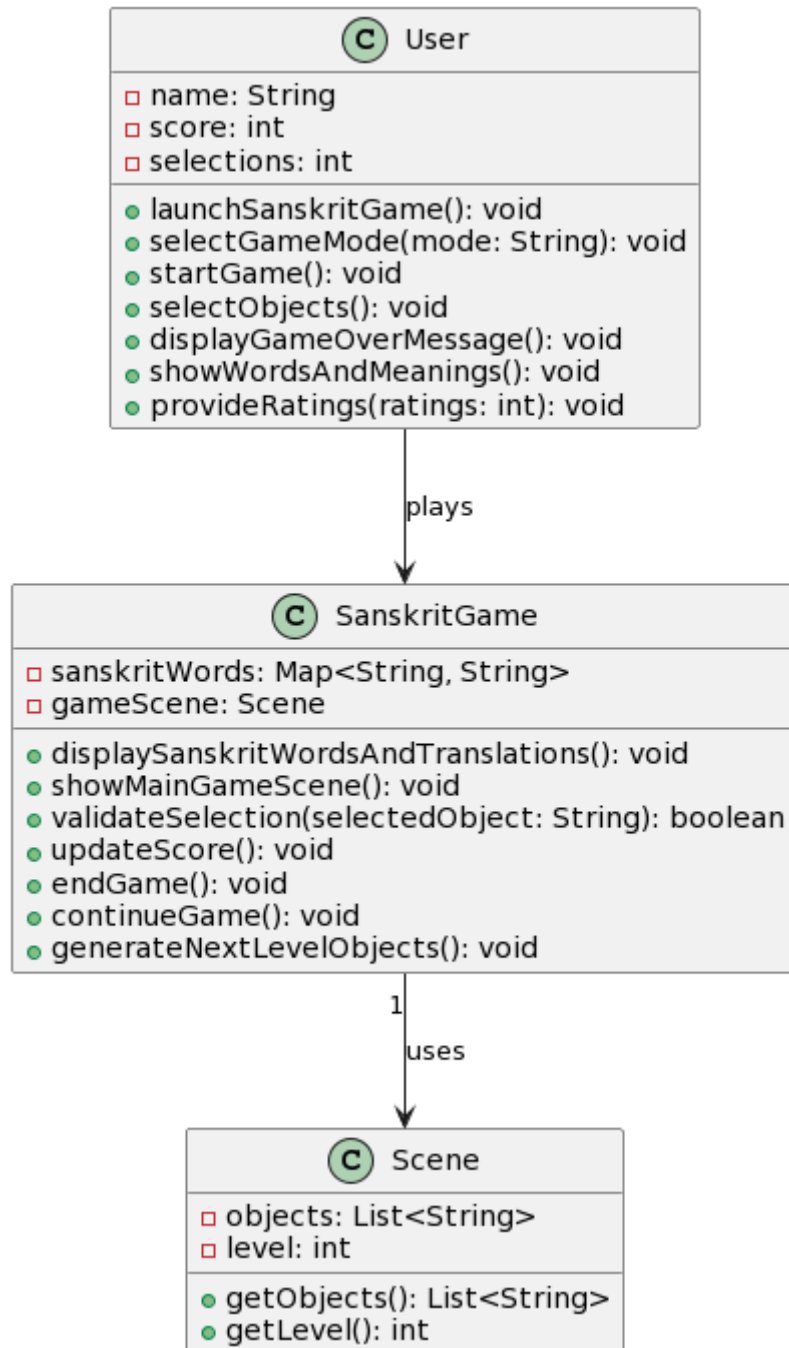


Figure 14 Class Diagram

The attributes and methods are added to provide more details about the classes. [84]

The **User** class consist a private attribute **name, score, and selections**, which represents the users current score, and number of objects selected. These classes also have method for launching the Sanskrit game,

selecting game mode, initiating game, selecting objects, displaying objects, showing words and their meaning. [84]

The **SanskritGame** class has private attributes **SanskritWords** which is represented as a map of Sanskrit words as well as its translation also the **gameScene**, is represent as an a part of the Scene class. The class now validates the selection, updating the score, ending the game, continuing the game, as well as generating next level. [84]

The Scene class defines the game scene and consist of private attribute as objects, list of the objects in the scene as well as level, the present level of the game. Also it includes the methods to retrieve the level and objects. [84]

The diagram also represents the relationship between the class. The user class plays the SanskritGame, and the SanskritGame uses the Scene Class. [84]

4.2.3 ACTIVITY DIAGRAM:

An activity diagram illustrates the flow of activities within the game as well as the processes, outline of the action sequence and decisions made by the player and the system. [84]

- The activity diagram states the flow of the activities and decisions in the game. [84]
- The way the user starts the game by launching the Sanskrit game, then selecting the game mode, and starting the game. [84]
- After start the Sanskrit game displays the Sanskrit word and its translation as well as pronunciation in English, followed by showing the main game scene. [84]
- The player then has to select the objects from the scene. [84]
- After selection of the correct objects out of multiple objects the object will disappear so will the name that is being displayed. [84]
- After the object is picked up by the player the score board also increments. [84]
- If incase the AI enemy player finds the 26 objects before the user finds the 5 object's then also it is a lose. [84]
- The loop will continue until its either win or lose. [84]
- If it is a lose then player can restart or quit the game. [84]
- If it is a Win the player can choose to go the next level or restart or quit the game. [84]
- In the next level the there would be different name and the player would have to find them with less time than the previous level. [84]

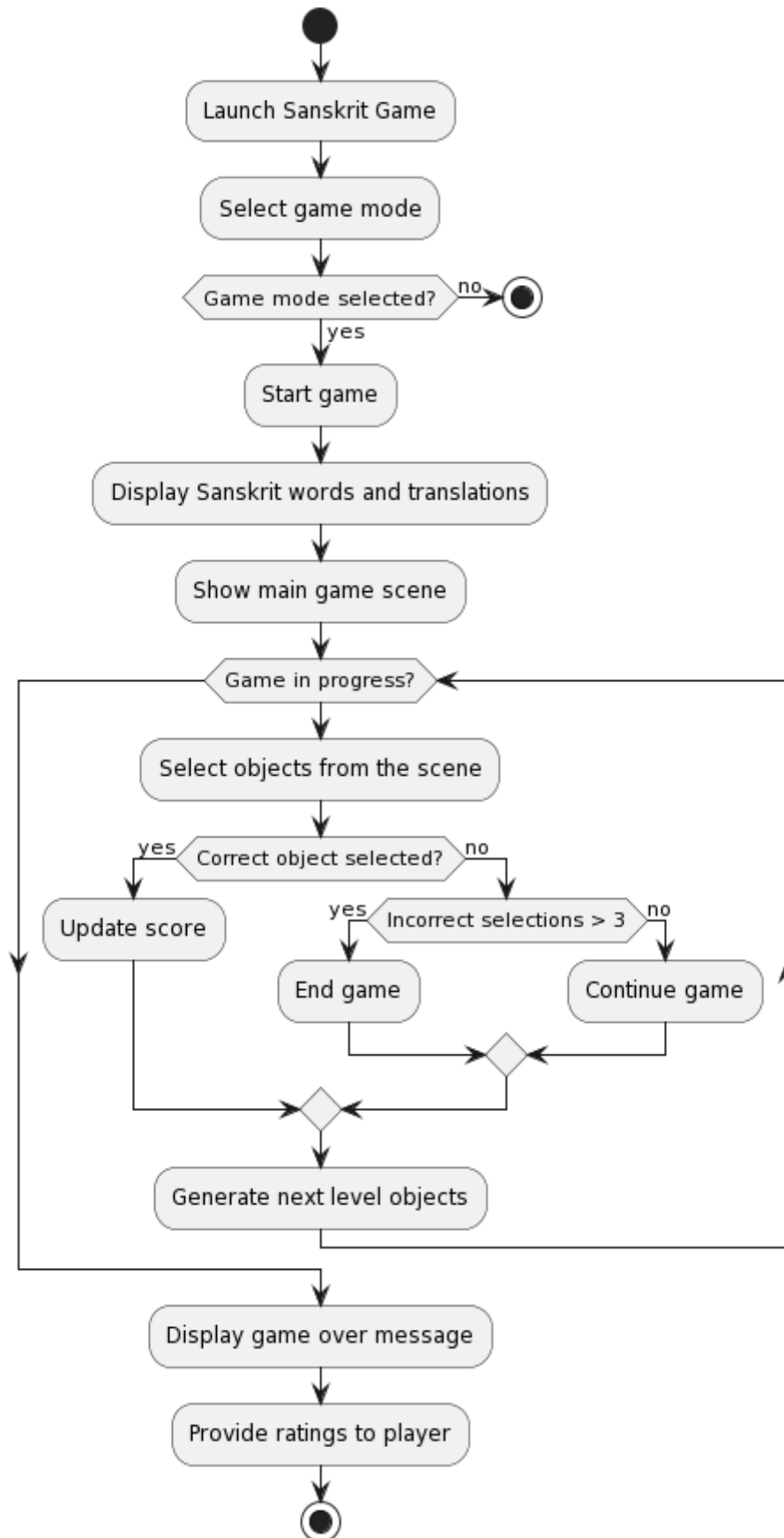


Figure 15 Activity Diagram

4.2.4 USE CASE DIAGRAM:

A use case diagram describes interactions and scenarios within the system and the player. It helps to understand the games users interaction and also the functionalities of the game. [84]

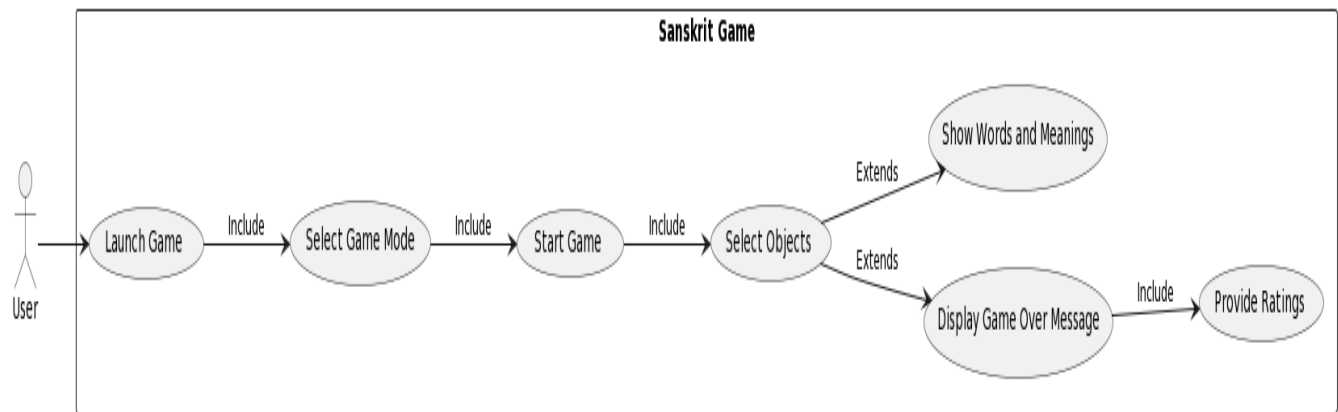


Figure 16 Use-Casse Diagram

Slight more details have been added to the use case by incorporating the “includes” & “extends” relationships. [84]

The use cases included in the diagram are described below :

- "Launch Game": States the user is launching the Sanskrit game. [84]
- "Select Game Mode": states the user is selecting the game. [84]
- "Start Game": User is starting the game. [84]
- "Show Words and Meanings": words and its meaning canvas is displayed. [84]
- "Select Objects": User is selecting the specific objects with in the game scene. [84]
- "Display Game Over Message": if win or lose is displayed. [84]

The “include” relationship states that the use case is being used is an important part of the base use case. For example, in the Select Game Mode is included after the launch game use case which shows that selecting the game would be a necessary step within the game launch process. [84]

The “extends” relationship states that the these use cases add functionality or variations to the base use case. In this diagram, the both select objects as well as the display game over message extend from the start game use case which mean after starting the game the user would need to select the game objects, after all the required objects are selected the game shows the game over message either by win panel or lose panel. [84]

The arrows are use to represent the low of direction from the user to the respective use cause which is going to be use next. [84]

4.2.5 SEQUENCE DIAGRAM:

The sequence diagram displays the interaction between objects and components in the game with in specific scenarios, with insights into its behavior. The below methods use are only to make the reader understand the sequence diagram while in the game coding different names of method have been use. [84]

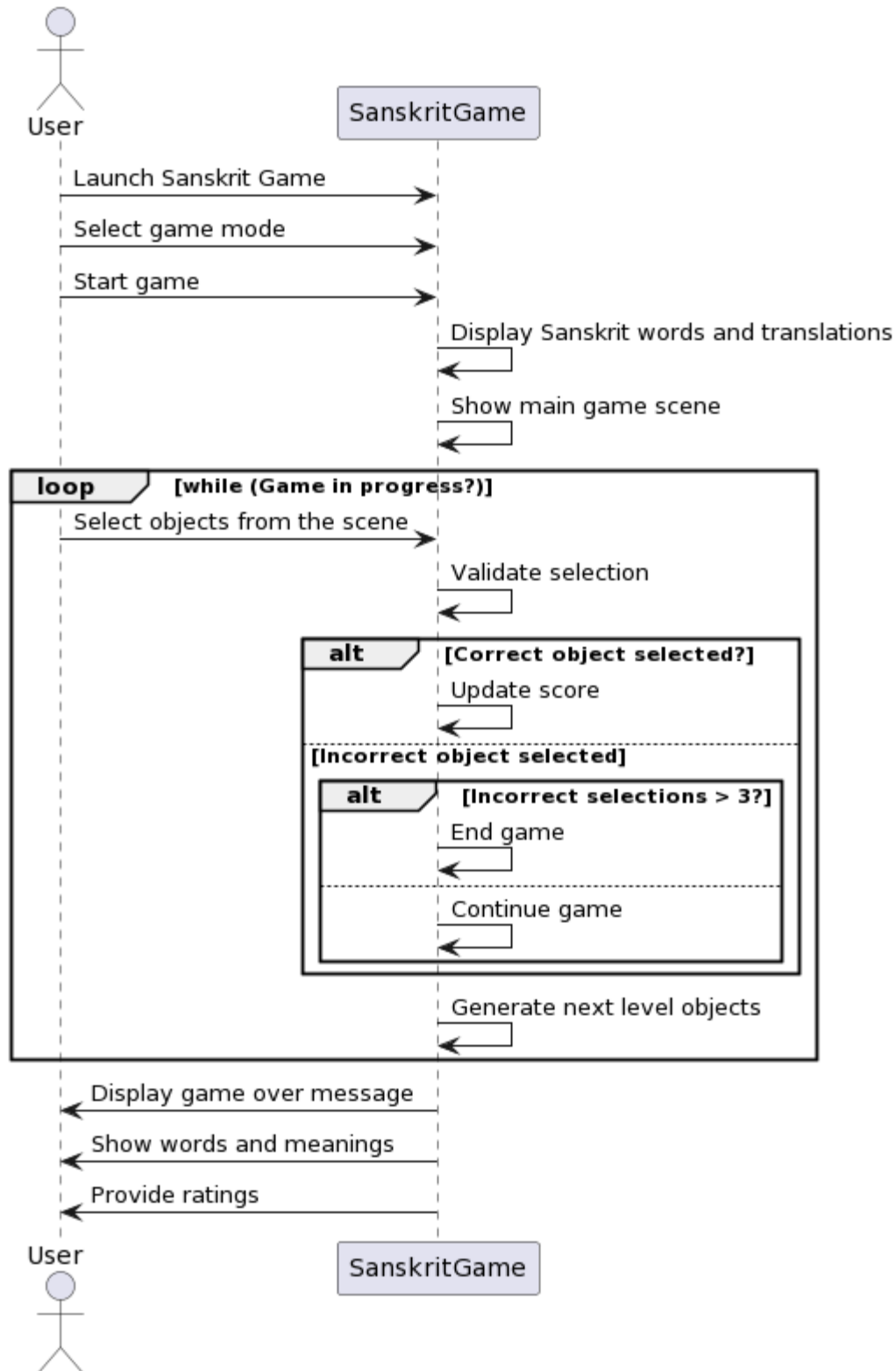


Figure 17 Sequence Diagram

The sequence is initiated by the user after calling the `launchSanskritGame()` method. [84]

- Then the game mode is selected by calling the `selectGameMode(mode: String)` method.
- The user starts the game by calling the `startGame()` method.
- The game receives the start game request and then proceeds.
- It then displays the Sanskrit words with its meaning in English as well as its pronunciation by calling `displaySanskritWordsAndTranslation()` method.
- After this the main scene is displayed by calling `showMainGameScene()` method.
- Then user then selects the game objects by calling the `selectobjects()` method.
- The selected objects is then verified using the `validateSelection()` method.
- If the object selected are correct then the score is updated with an increment of one with each selection by calling the `updateScore()` method.
- If the player exceeds the time it is a game over by calling `endgame()` method, and if he win he can choose whether to go to next level or not by calling `continueGame()` method.
- The next level is generated by calling the next level object `generateNextLevelObjects()` method.
- The loop of selecting the objects, verifying it as well as generating is carried on until the game is over.

4.2.6 GITHUB REPOSITORY SETUP:

- By login in the GitHub website we can easily create a repository to add our project. The details to create a repository is given in the account itself after login. [85]
- A GitLab repository is used to keep a backup of the project by creating repository online. [85]
- It allows the code to be safe and also it can be directly pushed (uploaded) from the Visual Studio directly. [85]
- It also helps in maintaining logs of the project being updated each time we update and add it. [85]

4.2.7 AI APPROACHES :

When it comes to implementing AI approach there are multiple methods of AI used in games such as follows.

- Potential Field approach: provides a degree of autonomy to the object in the game scene, as it makes the movement of the objects more dynamic and responsive. These AI cause the object's to move in a particular way more like these objects a certain attractive and repulsive force. [86, 87]
- Voronoi Diagrams : Voronoi diagrams are used to create different scenes in the game by dividing the game world into different regions and assigning objects or elements to that particular region it is

design based on points called “seeds” or “sites” in which each points represents a region. This implementation requires a lot of coding as well as time to integrate. [86, 87]

- Finite State Machines : FSMs model is a set of States and transitions in which each state defines a specific behaviour and based on the condition the transition occurs. Mostly used for designing a characters behaviour. [86, 87]
- Decision Trees: these trees are Ai Behaviours which makes decisions based on the input condition given to characters , mostly used in enemy characters to determine attacking and retreating. [86, 87]
- **Pathfinding Algorithms:** Pathfinding algorithms such as A*(A-star) are used to generate the shortest path from one point to another in a game environment. They are mainly used for character navigation. [86, 87]
- In this Thesis the pathfinding Algorithm is used to create competitiveness as it is integrated in the enemy player. If this enemy player finds the 26 game objects before the user then it is a lose. The user has a benefit as the enemy player also works as a guid to give the user a hint that where these object’s are placed. [86, 87]

4.2.8 CODE SNIPPETS:

The code snippets will be precise and only specific important code such as object word disappear, Word Mangers, Pickup Object, Ai Implementation. And only focuses on the core part of that code.

In the code snippets part the line shown below which states using System. are library’s use to support the functions used in Unity.

4.2.8.1 OBJECT WORD DISSAPPEAR:

```
using System.Collections;
using System.Collections.Generic;
using System.Text.RegularExpressions;
using TMPro;
using Unity.VisualScripting;
using UnityEngine;

public class Object_Dissappera_Word : MonoBehaviour
{
    public string word;
    public GameObject[] textObjects; // Array of TextMeshPro GameObjects
    public GameObject textObjects_alert; // Array of TextMeshPro GameObjects
    /*public bool wordMatched = false;*/

    private void Update()
    {
        if (Input.GetMouseButtonDown(0))
        {
            CheckMatch();
        }
    }

    private void CheckMatch()
    {
        for (int i = 0; i < textObjects.Length; i++)
        {
            TMP_Text textMeshPro = textObjects[i].GetComponent<TMP_Text>();
            Debug.Log("TextMeshPro Text: " + textMeshPro.text);
        }
    }
}
```

```

        Debug.Log("Word to Match: " + word);
        // Check if the textMeshPro contains the word to be matched
        if (textMeshPro.text == word)
        {
            return; // Exit the loop after destroying the matching text object
        }
        else
        //if (textMeshPro.text != word)
        {
            if (isChecking == true)
            {
                DisplayAlert("Point Cursor Correctly");
            }
            else
            {
                DisplayAlert(" Search for other Object");
            }
        }
    }
}

```

- The main part of this script is the CheckMatch() where it iterates through the textobjects, if the word is matched it exits the loop, if it is not matched then it displays alert based on isChecking. [22, 66]
- Before it there are two methods OnTriggerEnter(Collider other) and OnTriggerExit(Collider other) both these methods detects if the collider is collided with the game object. And if the player character has entered the trigger zone. [22, 66]
- If the player enter the trigger zone and user presser mouse down button then the check match function is called. [22, 66]

4.2.8.2 WORD MANAGER:

```

public class Word_Manager_Script : MonoBehaviour
{

    private void Start()
    {
        // Randomize and assign words to TextMeshPro components
        RandomizeWords();
    }

    public void RandomizeWords()
    {
        CustomShuffle(words);
    }

    private void CustomShuffle(List<string> list)
    {
        int n = list.Count;
        List<int> availableIndices = new List<int>(n);
        for (int i = 0; i < n; i++)
        {

```

```

        availableIndices.Add(i);
    }
    for (int i = 0; i < 5; i++)
    {
        if (availableIndices.Count == 0)
        {
            Debug.LogWarning("Not enough unique elements to choose from.");
            break;
        }

        int randomIndex = Random.Range(0, availableIndices.Count);
        int k = availableIndices[randomIndex];
        availableIndices.RemoveAt(randomIndex);

        textMeshProArray[i].text = words[k];
        Initial_Words_Screen_Scrip.wordText[i].text =
Initial_Words_Screen_Scrip.words_m[k];

        randomIndexesK[i] = k;
    }
}
}

```

- The word manager script is use to manage the words displayed each time the game is initiated different set of words is displayed. [22, 66]
- This different set of words is generated by CustomShuffle(List<string> list) mehtode. [22, 66]
- In this method the words are shuffled and assigned to the textmeshproarray component in a random order. The k value is the value generated by the for loop to define the value of the random index. [22, 66]
- All these method are linked together and initiated when the game starts due to Start() method. [22, 66]

4.2.8.3 PICKUP OBJECT:

```

public class Pick_Up_Gameobject : MonoBehaviour
{

    private void OnTriggerEnter(Collider other)
    {
        if (other.gameObject.CompareTag("Shuffle_Objects"))
        {
            if (!hasItem)
            {
                /*if (Input.GetMouseButtonDown(0))
                {*/
                canPickup = true;
                //currentNearObject = other.gameObject;

                Debug.Log("Player entered the trigger area of a pickup object.");
                for (int i = 0; i < objectsIwantToPickUp.Length; i++)
                {
                    if (objectsIwantToPickUp[i] == other.gameObject)

```

```

        {
            objectsInRange[i] = true;
            check = true;
            Debug.Log("Objectindex " + i);
        }
    }
}

private void OnTriggerExit(Collider other)
{
    canPickup = false;
    //currentNearObject = null;
    for (int i = 0; i < objectsIwantToPickUp.Length; i++)
    {
        if (objectsIwantToPickUp[i] == other.gameObject)
        {
            objectsInRange[i] = false;
        }
    }
}

void Update()
{
    if (canPickup && Input.GetMouseButtonDown(0))
    {
        /* for (int i = 0; i < playerTextMeshPros.Length; i++)
        {
            string playerText = playerTextMeshPros[i].text;
            Debug.Log("Player Text: " + playerText);*/

        for (int j = 0; j < objectsIwantToPickUp.Length; j++)
        {
            Debug.Log("Object Word: " + objectsIwantToPickUp[j]);
            if (objectsInRange[j] == true) // Check if the object is in range
            {
                string objectWord =
objectsIwantToPickUp[j].GetComponent<Object_Dissappera_Word>().word;
                Debug.Log("Object Word: " + objectWord);

                for (int k = 0; k < playerTextMeshPros.Length; k++)
                {
                    string playerTexts = playerTextMeshPros[k].text;
                    Debug.Log("Player Text: " + playerTexts);
                    if (objectWord == playerTexts)
                    {
                        Debug.Log("Picking up object...");
                        PickupObject(objectsIwantToPickUp[j]);

                        StartCoroutine(DeactivateObjectsWithDelay(playerTextMeshPros[k], objectsIwantToPickUp[j]));

                        break;
                    }
                }
            }
        }
    }
}

private IEnumerator DeactivateObjectsWithDelay(TMP_Text textMesh, GameObject
objectToDeactivate)
{

```

```

        yield return new WaitForSeconds(2.0f); // Delay of 2 seconds

        textMesh.gameObject.SetActive(false);
        objectToDeactivate.SetActive(false);
        Audio_Controller_Script.PlayObjectDisappearSFX();
        yield return new WaitForSeconds(2.0f);
        DropObject();
    }

    private void PickupObject(GameObject objectToPickUp)
    {
        Rigidbody objectRigidbody = objectToPickUp.GetComponent<Rigidbody>();
        if (objectRigidbody)
        {
            objectRigidbody.isKinematic = true;
        }

        objectToPickUp.transform.position = myHands.transform.position;
        objectToPickUp.transform.parent = myHands.transform;

        hasItem = true;
    }

```

- This is one of the main script as it attached to the player character and also controls the player picking up the object with checking if the object to be picked is correct or not. [22, 66]
- The pickup is initiated if the place is in the correct trigger point and the collider is collided it is checked by the OnTriggerEnter(Collider other) & OnTriggerExit(Collider other) methods. [22, 66]
- If he is then enters the update function where is checks in canpick is true as well as if the left mouse key is pressed. If it is then it enters the function. [22, 66]
- After entering the function it checks if the word matches to the displayed word if it does then the PickupObject(GameObject objectToPickUp) method is called. [22, 66]

Apart from these scripts there are many other scripts being used such as Again_Retry, Animation, Audio_Controller, Exit_Main_Scene_0, Exit_Surrender, Initial_Words_Screen and more in total this project consist of 22 Scripts.

Chapter 5. PROFESSIONAL, LEGAL, ETHICAL & SOCIAL ISSUES

5.1 PROFESSIONAL ISSUES:

- The Project will include comprehensive plan, with a well researched literature in which each used resource is referenced if these aspects are not covered then there are chances of plagiarism as well as an unresearched project will not be able to be updated there are multiple new technologies and inventions happening each day. [83, 88]
- The software development methodology for this projects is incremental methodology it is crucial to follow each step if not there are chances for not being able to complete the project before deadline.[83, 88]

5.2 LEGAL ISSUES:

All the software that are being used is Licensed and approved as Microsoft Visual Studio is the community version which is downloaded from the official Microsoft website as well as for students it is free. [22, 47]

Assets used in the game are downloaded from Unity official website - <https://assetstore.unity.com/>

Similar the Unity Student's have free access to the asset store and Login.[22, 47]

5.3 ETHICAL ISSUE:

The feedback System used in this project for testing the effectiveness of learning of a learner or player will be collected in a very basic format but for that the player or Learner will be asked to fill the consent form as to use the feedback to improve the game in future, though the players Name and any personal data won't be used or asked apart from 4-5 questions related to the Game. [65]

- Social Issue: NONE.

Chapter 6. EVALUATION & RESULT

6.1 TESTING

In the evaluation and result gives more idea about how the game will work and what are the results based on the user feedback. The screenshots of the game-play have been added below with description.

6.1.1 SCREENSHOT OF THE GAME.

6.1.1.1 START SCREEN

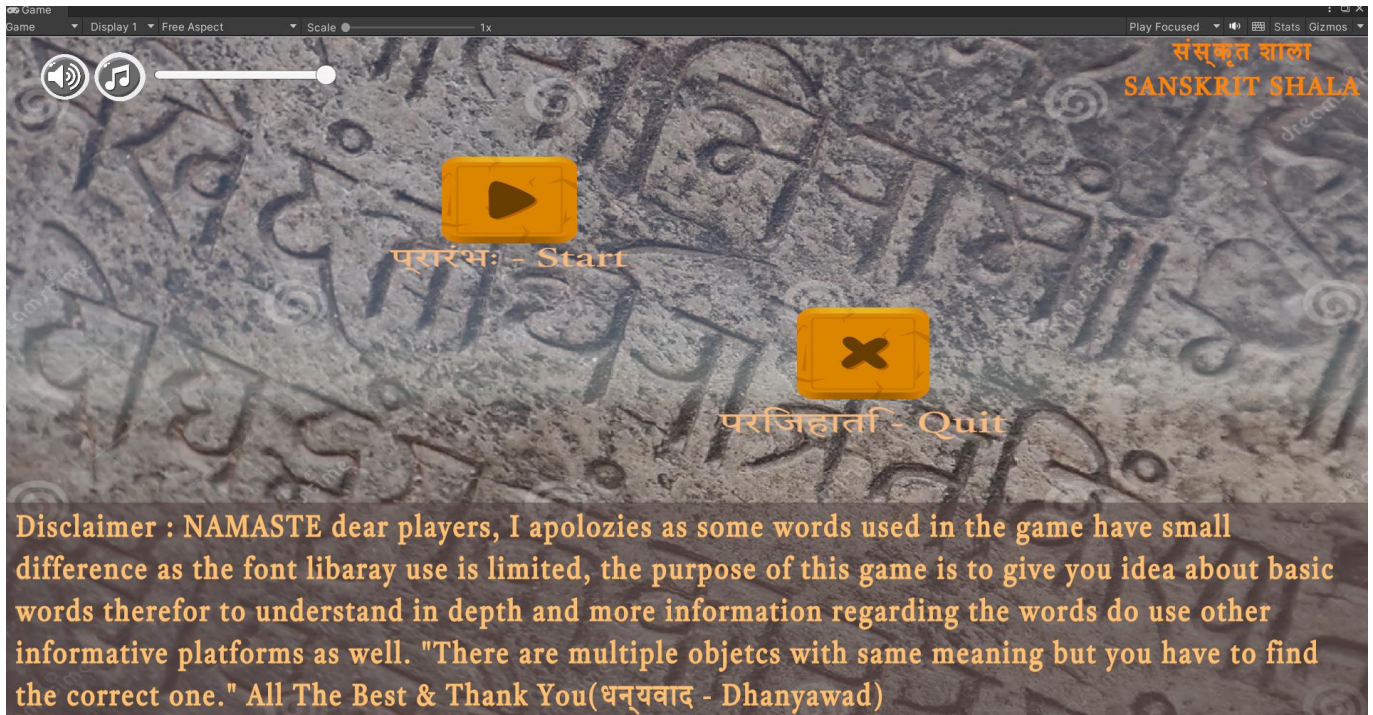


Figure 18 Start Screen

Initially when the game is launched the above shown image (Figure 18) screen will be displayed in which we have two buttons one is start and one is exit, as well as there would be a volume button in the upper-left corner of the screen. In the right corner of the screen will be the name of the game and in the below there will a note(Disclaimer). [22, 66]

The volume controller is used to control the music and SFX volume it has on and off features as well as volume low has can be performed with the slider. [22, 66]

The start button initiates the game where as the quit button will make the player exit the game.

The Disclaimer is to inform the player about the game and provide them with the acknowledgement of words used in the game.

When the user clicks on start button the next screen Initial Screen is shown which is (Figure 19).

6.1.1.2 INITIAL BEFORE GAME STARTS

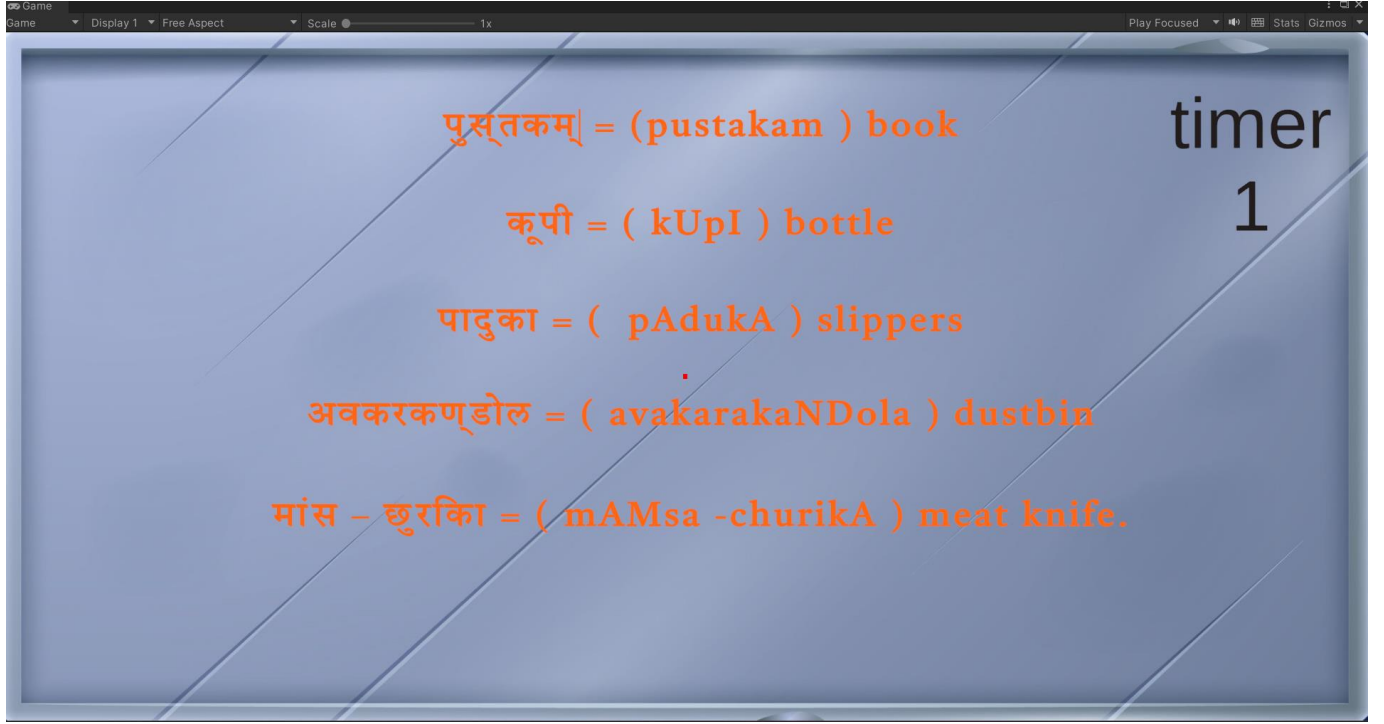


Figure 19 Initial Screen

In the Initial Screen the Sanskrit words are displayed with its pronunciation and what it is called in English. It will be shown only for 10 secs .

6.1.1.3 GAME SCENE



Figure 20 Game Scene and Player

Once the Initial screen timer is off the main game scene is shown as displayed in the (Figure 20,21 & 22). In the main game scene the player is shown 5 words in the above panel if the user wishes to hide the panel he can click on the down-arrow button shown in the right corner of the screen. [22, 66]

In the left upper corner there is audio controller button to control audio music and its volume .

The score is in the right part of the screen which gets updated as the player picks the correct object with the correct name as shown in the (Figure 21).

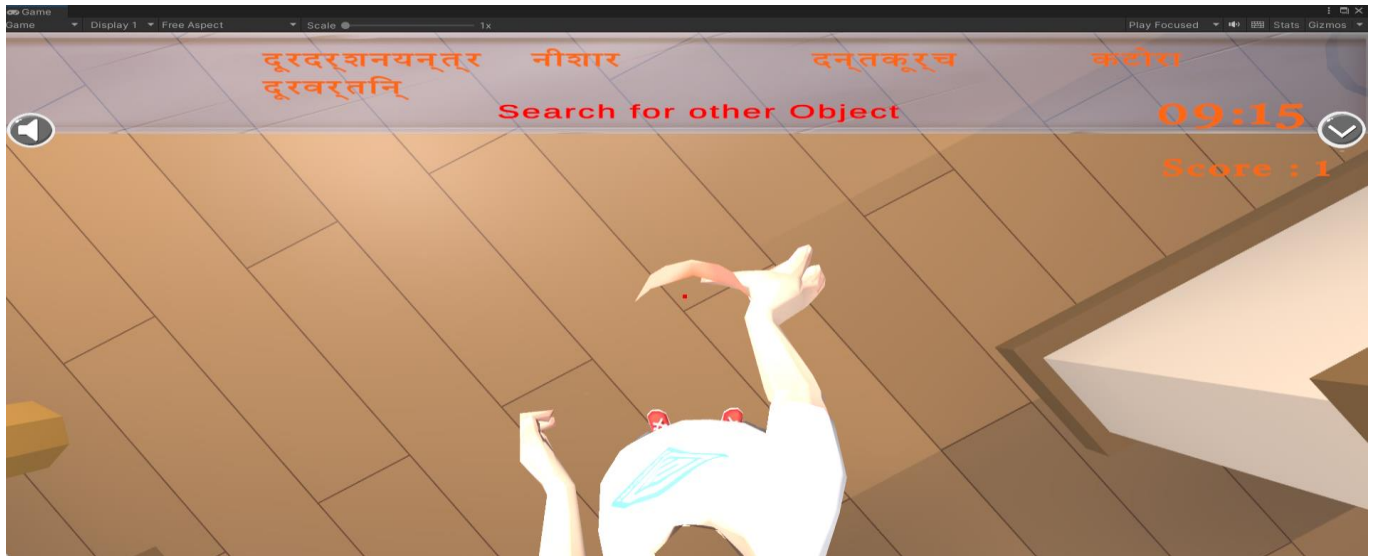


Figure 21 Game Scene and Player

The character shown in (Figure 22) is the enemy having AI A* pathfinding algorithm if this character goes near all the 26 objects it's a game over, the purpose of implementing this is to make the user feel more competitive. The user has a benefit as the enemy player also works as a guid to give the user a hint that where these object's are placed. [86, 87]



Figure 22 Game Scene and Player

6.1.1.4 WIN SCREEN



Figure 23 Win Panel

After all the objects are collected the win panel will be displayed in which the player can choose if he wants to quit the game or restart the game or wants to go to the next level. If he chooses to go to the next level the player will get less time than the pervious level to choose the objects and the objects will be different in each level. [22, 66]

6.1.1.5 LOSE SCREEN



Figure 24 Lose Panel

If in case the player is not able to find the objects in the given time then he will lose and the lose panel will be displayed in which the player can decide if he wants to start the game again or wants to exit the game. [22, 66]

Below are the words and its meaning and pronunciation in which they will be displayed in the initial screen out of these 26 words any 5 words will be displayed in the game.

1. कपिल -पुस्तका = (pATala - TippaNIpustikA)red-note-book
2. कागजस्य चषकम् = (kAgadasya caSaka)paper-cup
3. द्राविकशलाका = (drAvikazalAkA) wax-candel
4. भित्तिघटी = (bhittighaTI) Wall Clock
5. मांस = (mAMsa)Meat
6. कटाहकम् =(kaTAhaka) pan
7. पिच्छिल = (picchila) orange
8. पुस्तकम् = (pustakam) book
9. सङ्गणक = (saGgaNaka) computer
10. दर्पण = (darpaNa) mirror
11. दूरदर्शनयन्त्र दूरवर्तिन् = (dUradarzanayantra dUravartin) tv remote
12. नौका = (naukA) boat
13. दन्तकूर्च = (dantakUrca) toothbrush
14. पादुका = (pAduka) slippers
15. नीशार = (nishar) curtains
16. अवकरकण्डोल = (avakarakaNDola) dustbin
17. मधुरपिष्टकम् = (madhurapiSTakam) cake
18. उपधान = (upadhAna) pillow
19. नीलवर्ण-टिप्पणीपुस्तिका = (nllavarNa - TippaNIpustikA) blue notebook
20. कटोरा = (kaTorA) white bowl
21. पेटिका = (petika) brown box
22. आसन्द = (Asanda) chair
23. चषकः = (caSaka) cup
24. उत्पीठिका- चित्रकट = (utpIthika- citrakaTa) dinning carpet
25. मांस – छुरिका = (mAMsa - churikA) meat knife.
26. कूपी = (kUpI) bottle

6.2 FEEDBACK

The game is tested by fellow students and few more known people including me , as for the feedback the feedback is taken in person and not on records as I don't want to risk any confidentiality. The generalized feedback received we the over all interaction is good and the game is also help-full to learn the language as well as fun to play but only while picking up the object the user has to do multiple click and find the exact point from where the object can be picked. [65]

Below is the table of the feedback taken form the users orally. The ratings are Out of 10.

No-User	Intiraction	Learing	Play-Full	Feedback
user 1	8	9	9	issue with pick-up
user 2	8	9	9	issue with pick-up
user 3	7	10	9	issue with pick-up
user 4	9	10	9	issue with pick-up
user 5	8	10	9	issue with pick-up
user 6	9	10	9	issue with pick-up
user 7	9	10	9	issue with pick-up
user 8	9	10	9	issue with pick-up
user 9	8	10	9	issue with pick-up
user 10	8	10	9	issue with pick-up
user 11	8	9	9	issue with pick-up
user 12	7	9	9	issue with pick-up
user 13	7	9	9	issue with pick-up
user 14	8	9	9	issue with pick-up
user 15	9	9	9	issue with pick-up
user 16	8	9	9	issue with pick-up
user 17	7	9	9	issue with pick-up

Figure 25 Feedback Table

Chapter 7.CONCLUSION

This Chapter Provides the ultimate culmination this thesis, encompassing the attained output as well as prospects for futuristics endeavors. Spanning from the educational aspiration to develop, design and evaluate and engaging Sanskrit vocabulary game. The research embarked upon the initial phase of gathering comprehensive insights into game – based learning continued with meticulous game development process, defining assets, platforms, and programming language. The implementation of the game was next step with Ethical, legal, and social considerations were scrupulously addressed. After designing the game and doing multiple test through different user feedbacks rigorously evaluated the games efficiency and user experience, achieving the goal of creating a user friendly fun educational game.

7.1 RECOMMENDATION

This project functions as a base for developing educational games the integrate language learning in a fun and enjoyable interactive gameplay. To enhance the projects, future interactions the following points could be added:

- **Advanced Ai Behaviors:** Advance AI techniques such as neural networks for character behavior, natural language processing for more interesting dialogue, and procedural content generation for dynamic game development can be integrated. [86, 87]
- **User – Centered Design:** Include user feedback to enhances the games usability and learning effectiveness. Regular playtesting with learners can give a good insights into how well we can achieve the educational goal. [86, 87]
- **Multiplayer Features:** Introduce multiplayer features that would make the game more competitive and interesting as competing with other players generate more interactive environment and increases the game play as well as increase social interaction. [86, 87]
- **Localization:** The game can also be expanded into multiple languages and multiple scenes or places in the game. Which could help more countries to regain their language in youngsters.
- **Additional Game Element:** More diverse game play elements can be introduces including new challenges as well as rewards to keep the user engaged with the game. [86, 87]

7.2 LIMITATIONS

Despite the educational purpose, this project has some limitations. The complexity of language learning could require more refined AI and natural language processing techniques to provide personalized learning experience. [86, 87]

Its necessary to evaluate the game’s teaching vocabulary as to validate the education impact. Additionally the project’s focus on expanding it to cover a wider range of education topic could require significant adjustments. All Conclusive this project show cases how game development techniques, AI approach, and educational strategies can be combined all together to create an engaging and education gaming experience. Although there is a room for improvement and expansion, the project serves as a point for the growth and development of future educational games and how effective they can be in learning outcomes. [86, 87]

APPENDIX A – PROJECT PLAN

1.1 INCREMENTAL METHODOLOGY

In section 3.1.1.1 Incremental model the basic of how the model works is explained which initiates from the requirements and ends after implementation. The difference in incremental model and methodology is that incremental Methodology is a broader approach which encompasses several different software models including the instrumental model. The instrumental methodology emphasizes delivering the game or software in small parts and incremental release to continuously provide an updated version of a game or software, this adapt to change is done through the customer's review/feedback and through the continuous development research. [83, 88]

Given below in the Gantt chart it is shown how the instrumental methodology would be executed in this project. [83, 88]

It starts from the first part that is planning or requirements includes project setups and all the software setups. [83, 88]

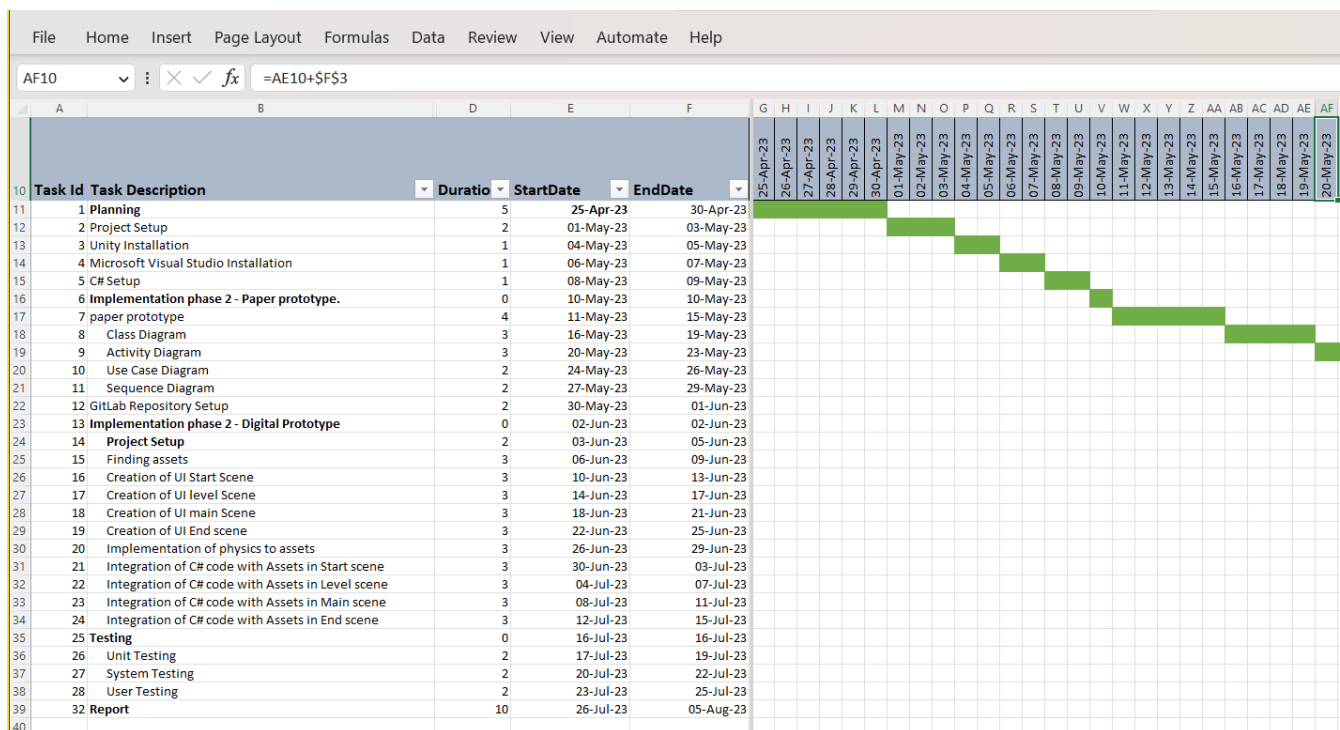


Figure 26 Gant chart

In the next phase 1 Game design and gameplay is created & in the phase 2 which is initiated by arranging the assets and ended after integrating of C# in this assets which completes the entire game. [83, 88]

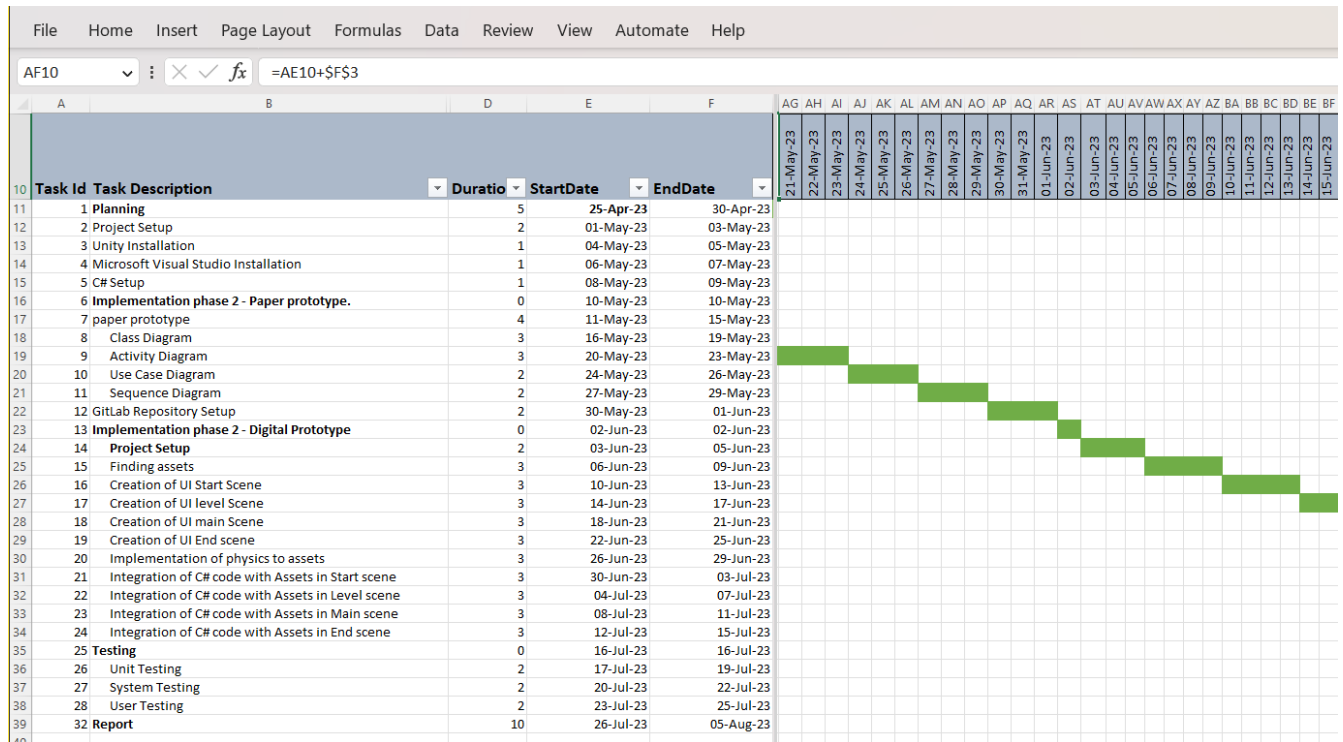


Figure 27 Gant chart

In the end the different testing is done and then the Final report is create. [83, 88]

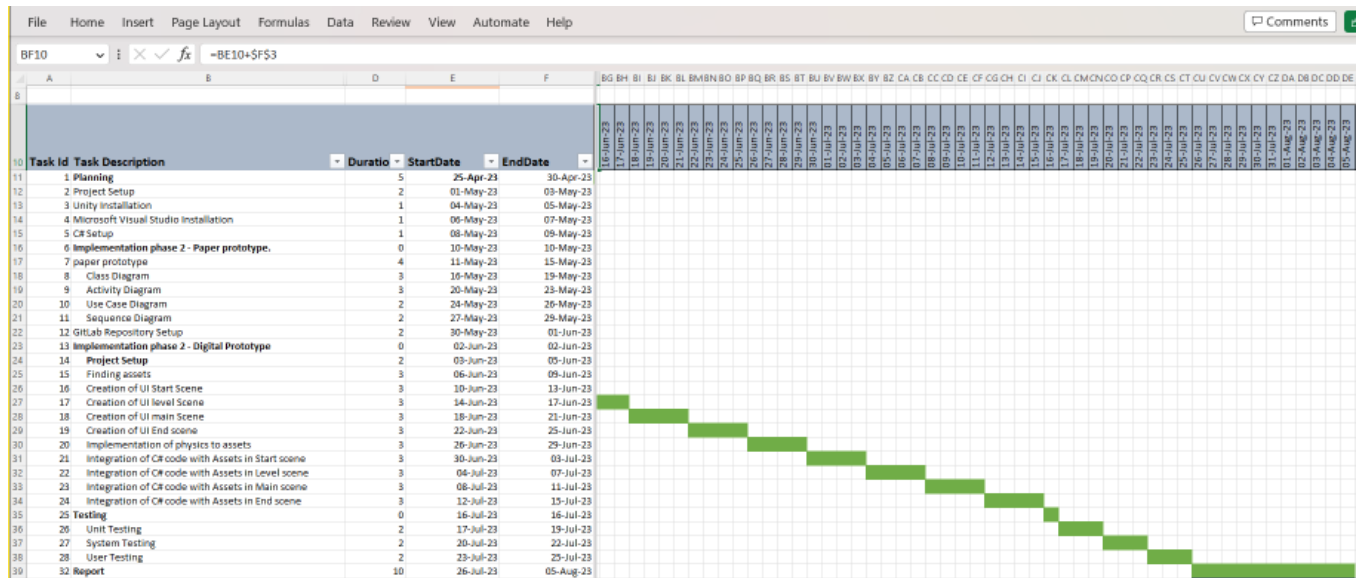


Figure 28 Gant chart

1.2 RISK ANALYSIS.

The risk for such project would be.

- Data loss/ corrupt file.

This issues includes Data loss, file merged, files getting corrupted or the software getting malfunctions. Such issues can be addressed or tackled by always keeping multiple backup files and folders saved in external hard-drive as well as online on privet repository on GitHub & on one drive as well. Also Unity provides a back to be saved directly by syncing it with GitHub. [74]

- Damage of hardware

Damage of hardware is as similar to Data loss but in this case if the data is only saved on external hard-drive or on different folders in the same Computer or laptop could cause to loss of the data so in order to be prepared for this , it is better to save the data on online websites as well or on multiple hard-disk. [74]

- Creation of AI.

While the creation of AI it is important to make sure it will not affect the remaining assets code as well as while implementation of the AI in order to make the game a smooth gameplay the AI code should be coded in a precise way to be efficient in time complexity as well as in space complexity if not then the game play wont be productive. [46, 82]

REFERENCE

- [1] J. E. L. a. S. Jamin, "History of Computer Games," *EECS Department*, pp. 2,3,4)9/06/2006.
- [2] D. K. Jill Cirasella, "The History of Computer Games," CUNY Graduate Center, City University of New York (CUNY) 2006.
- [3] P. Zackariasson and T. L. Wilson, *The Video Game Industry: Formation, Present State, and Future*. New York: Routledge, 2012.
- [4] A. Predescu and M. Mocanu, "A data driven survey of video games," in *IEEE*, Bucharest, Romania, 25-27 June 2020.
- [5] S. Kalitina, "Devsisters: How to Stay in the Game?," in *Overcoming Crisis: WORLD SCIENTIFIC*, 2022, pp. 221-233.
- [6] K. Wong, "The Data-Driven Myth and the Deceptive Futurity of "the World's Fastest Growing Games Region": Selling the Southeast Asian Games Market via Game Analytics," *Games and Culture*, vol. 18, no. 1, pp. 42-61, 2023.
- [7] R. Wibawa, A. Lokacarya, F. Kurniawan, and Y. Udjaja, "Japanese language learning game "Miryoku" using android-based speech recognizer API," *Procedia Computer Science*, vol. 216, pp. 547-556, 2023.
- [8] Z. Ç. Koroğlu and F. Kimsesiz, "Use of Game-Based Teaching and Learning to Foster Intercultural Communication in English Language Education," in *Handbook of Research on Fostering Social Justice Through Intercultural and Multilingual Communication: IGI Global*, 2023, pp. 139-161.
- [9] K. H. S. Ibrahim, "Video game-based L2 learning: Virtual worlds as texts, affinity spaces, and semiotic ecologies," in *Research Anthology on Virtual Environments and Building the Metaverse: IGI Global*, 2023, pp. 280-296.
- [10] K. S. Valievna, "THE VARIETY OF LANGUAGE SOCIAL NETWORKS AND THEIR APPLICATION IN LEARNING FOREIGN LANGUAGES," *INTERNATIONAL JOURNAL OF SOCIAL SCIENCE & INTERDISCIPLINARY RESEARCH ISSN: 2277-3630 Impact factor: 7.429*, vol. 12, no. 01, pp. 138-141, 2023.
- [11] T. Burrow, *The Sanskrit Language*. UK: FABER & FABER LTD, 1955.
- [12] I. d.-t. c. s. b.-s. border-box, m.-b. var(--list-item-margin-bottom), G. Lotha, I. d.-t. c. s. b.-s. border-box, m.-b. var(--list-item-margin-bottom), and K. Kuiper, ""Aṣṭādhyāyī," ed: The Editors of Encyclopaedia., march 2015.
- [13] I. d.-t. c. s. b.-s. border-box, m.-b. var(--list-item-margin-bottom), G. Lotha, I. d.-t. c. s. b.-s. border-box, m.-b. var(--list-item-margin-bottom), and K. Kuiper, "Aṣṭādhyāyī," ed: The Editors of Encyclopaedia., march 2015.
- [14] B. S. Gillon, "Pāṇini's "Aṣṭādhyāyī" and Linguistic Theory," *Journal of Indian Philosophy*, vol. 35, no. 5/6, pp. 445-468, 2007.
- [15] S. Acharya, A. K. Pant, and P. K. Gyawali, *Deep learning based large scale handwritten Devanagari character recognition*. Kathmandu, Nepal: IEEE, 15-17 December 2015.
- [16] S. K. Manocha, *Deep Learning Approaches for Devanagari Handwriting Recognition*. Noida, India: IEEE, 03-04 September 2021.
- [17] A. N. Holambe, S. N. Holambe, and R. C. Thool, *Comparative study of Devanagari handwritten and printed character & numerals recognition using Nearest-Neighbor classifiers*. Chengdu, China: IEEE, 09-11 July 2010.
- [18] N. J. Malhar Kulkarni, Sayali Khare, Hanumant Redkar, Pushpak Bhattacharyya, "Introduction to Sanskrit Shabdmitra: An Educational Application of," *aclanthology.org*, MUMBAI / BOMBAY, 2019.
- [19] M. A. H. a. M. Hilton, "Learning Science through Computer Games and Simulations," in *The National Academic Press*, Washington DC, 2015, vol. 10.17226/13078: Committee on Science Learning:.
- [20] K. Facer, "Computer Games and Learning," *futurelab*, -, 2006.

- [21] B. Klimova and J. Kacet, "Efficacy of Computer Games on Language Learning," *Turkish Online Journal of Educational Technology*, vol. 16, no. 4, p. 8, oct-2017.
- [22] J. K. Haas, "A history of the unity game engine," *Diss. Worcester Polytechnic Institute*, vol. 483, no. 2014, p. 484, 2014.
- [23] L. ROUGETET, "MACHINES DESIGNED TO PLAY NIM GAMES."
- [24] A. Smith, *They Create Worlds: The Story of the People and Companies That Shaped the Video Game Industry, Vol. I: 1971-1982*. CRC Press, 2019.
- [25] Y. Zhao and R. Slayton. (2023) Tool, Doctor, and Hooligan: History of Antivirus Software in China, 1989–2010. 43-54. Available: <https://doi.ieeecomputersociety.org/10.1109/MAHC.2022.3220114>
- [26] W. Higinbotham, "Tennis for two," *Brookhaven National Laboratory (Oscilloscope)*, 1958.
- [27] A. De La Cruz and J. Ryan, "Tennis for Two."
- [28] S. L. Kent, *The Ultimate History of Video Games, Volume 1: From Pong to Pokemon and Beyond... the Story Behind the Craze That Touched Our Lives and Changed the World*. Crown, 2010.
- [29] J. D. Ivory, "A brief history of video games," in *The video game debate*: Routledge, 2015, pp. 1-21.
- [30] O. Wallach and C. Wadsworth, "years of gaming history, by revenue stream (1970–2020)," *Visual Capitalist*, pp. 2000-2007.
- [31] N. Beume *et al.*, "Measuring flow as concept for detecting game fun in the Pac-Man game," in *2008 IEEE Congress on Evolutionary Computation (IEEE World Congress on Computational Intelligence)*, 2008: IEEE, pp. 3448-3455.
- [32] M. J. P. Wolf, *Encyclopedia of Video Games: The Culture, Technology, and Art of Gaming* (no. v. 1). Greenwood, 2012.
- [33] D. Spring, "Gaming history: computer and video games as historical scholarship," *Rethinking History*, vol. 19, no. 2, pp. 207-221, 2015.
- [34] A. Elliott, "Simulations and simulacra: History in video games," *Práticas da História Journal on Theory, Historiography and Uses of the Past*, vol. 2017, no. 5, pp. 11-41, 2017.
- [35] D. Scheff and A. Eddy, "Game Over Press Start to Continue: The Maturing of Mario," ed: New York: Vintage, 1994.
- [36] J. Ryan, *Super Mario: How Nintendo Conquered America*. Penguin, 2011.
- [37] P. Ozkohen, J. Visser, M. van Otterlo, and M. Wiering, "Learning to play donkey kong using neural networks and reinforcement learning," in *Artificial Intelligence: 29th Benelux Conference, BNAIC 2017, Groningen, The Netherlands, November 8–9, 2017, Revised Selected Papers 29*, 2018: Springer, pp. 145-160.
- [38] G. Stanley, *Language learning with technology: Ideas for integrating technology in the classroom*. Cambridge University Press, 2013.
- [39] K. Bayas, "Jonathon Reinhardt: Gameful second and foreign language teaching and learning: Theory, research, and practice," *Applied Linguistics*, vol. 43, no. 5, pp. 1037-1040, 2022.
- [40] H. Reinders, *Digital games in language learning and teaching*. Springer, 2012.
- [41] Y. G. Butler, "The use of computer games as foreign language learning tasks for digital natives," *System*, vol. 54, pp. 91-102, 2015.
- [42] A. Nousia, "THE INTEGRATION OF NEW TECHNOLOGIES AND VIDEO GAMES IN PRESCHOOL EDUCATION," *European Journal of Open Education and E-learning Studies*, vol. 8, no. 1, 2023.
- [43] R. Godwin-Jones, "Games in language learning: Opportunities and challenges," 2014.
- [44] J. M. Sykes, "Digital games and language teaching and learning," *Foreign Language Annals*, vol. 51, no. 1, pp. 219-224, 2018.
- [45] J. Reinhardt, *Gameful second and foreign language teaching and learning: Theory, research, and practice*. Springer, 2018.
- [46] L. Č and D. Hodak, "Advanced Mechanisms of Perception in the Digital Hide and Seek Game Based on Deep Learning," in *2022 International Conference on Smart Systems and*

- Technologies (SST)*, 19-21 Oct. 2022, pp. 135-140, doi: 10.1109/SST55530.2022.9954814.
- [47] J. Craighead, J. Burke, and R. Murphy, "Using the unity game engine to develop sarge: a case study," in *Proceedings of the 2008 Simulation Workshop at the International Conference on Intelligent Robots and Systems (IROS 2008)*, 2008, vol. 4552.
- [48] I. Buyuksalih, S. Bayburt, G. Buyuksalih, A. Baskaraca, H. Karim, and A. Rahman, "3d modelling and visualization based on the unity game engine-advantages and challenges," 2017.
- [49] D. McGowan, "Cuphead: Animation, the Public Domain, and Home Video Remediation," *The Journal of Popular Culture*, vol. 52, no. 1, pp. 10-34, 2019.
- [50] B. Horn, "Of Insects, Wisps, and Uncertainty: A Hermeneutical Comparative Analysis of Ori and the Blind Forest and Hollow Knight," in *25th International Symposium on Electronic Art (ISEA 2019): LUX AETERNA (Eternal Light)*, 2019.
- [51] C. S. Ofner, "Play me a story: storytelling in the Metroidvania game" Hollow Knight"/vorgelegt von Claudia Susanne Ofner."
- [52] A. Limmanee, "Review of Esports and Video Game Research With Analysis of "Among Us" Game Casting," *International Journal of Industrial Education and Technology*, vol. 2, no. 1, pp. A1-A11, 2020.
- [53] J. K. Raulji and J. R. Saini, "Stop-Word Removal Algorithm and its Implementation for Sanskrit Language," *International Journal of Computer Applications*, vol. 150 – No.2, no. -, p. 3, September 2016.
- [54] "Samskrita Bharati kerala " Baashaa. https://play.google.com/store/apps/details?id=com.baashaa.samskritabharati.app&hl=en_US (accessed Sep 13, 2018).
- [55] M. A. Kulkarni, N. Joshi, S. Khare, H. H. Redkar, and P. Bhattacharyya, "Introduction to Sanskrit Shabdmitra: An Educational Application of Sanskrit Wordnet," 2019.
- [56] S. R. Warhade, P. R. Devale, and S. H. Patil, "English-to-Sanskrit Statistical Machine Translation with Ubiquitous Application," *International Journal of Computer Applications*, vol. 51– No.1, no. -, p. 6, August 2012.
- [57] P. Mishra¹ and J. Shukla, "Research Proposal Paper on Sanskrit Voice Engine: Convert Text-to-Audio in Sanskrit/Hindi," *International Journal of Computer Applications*, vol. 70– No.26, no. -, p. 5, May 2013.
- [58] G. É. R. A. R. D. HUET, "G. É. R. A. R. D. HUET, "A functional toolkit for morphological and phonological processing, application to a Sanskrit tagger," *Journal of Functional Programming*, vol. 15, no. 4, pp. 573–614, 2005," *Journal of Functional Programming*, vol. 15, no. 4, no. -, pp. 573–614, 2005.
- [59] M. Kulkarni, "Sanskrit WordNet at Indian Institute of Technology (IITB) Mumbai," SpringerLink, MUMBAI, 2016.
- [60] A. Martinez, "5 Best Apps to Learn Sanskrit for Beginners and Beyond," ed, February 21, 2023.
- [61] A. M. C. Rivera, W. Wu, and C. Xue, "An Augmented Reality Update of a Classic Game: "Where in the World is Carmen Sandiego?", Case Study," in *International Conference on Human-Computer Interaction*, School of Mechanical Engineering, Southeast University, SEU, Santo Domingo, República; School of Mechanical Engineering, Southeast University, SEU, Nanjing, China, 16 June 2022: SpringerLink.
- [62] N. S. Dash, P. Bhattacharyya, and J. D. Pawar, *The WordNet in Indian Languages*. MUMBAI: Springer Singapore, 2017.
- [63] B. Cook and P. Twidle, "Increasing Awareness of Alzheimer's Disease through a Mobile Game," in *IEEE*, Nottingham, UK, 26-27 October 2016.
- [64] M. Ismail, N. M. Diah, S. Ahmad, N. A. M. Kamal, and M. K. M. Dahari, "Measuring usability of educational computer games based on the user success rate," in *IEEE*, Kuala Lumpur, Malaysia, 06-07 June 2011: IEEE.
- [65] C. P. Schultz and R. D. Bryant, *Game testing: All in one*. Mercury Learning and Information, 2016.

- [66] A. Hejlsberg, M. Torgersen, S. Wiltamuth, and P. Golde, *The C# programming language*. Pearson Education, 2008.
- [67] A. Okita, *Learning C# programming with Unity 3D*. CRC press, 2014.
- [68] J. Liberty, *Programming C#: building .NET applications with C.* "O'Reilly Media, Inc.", 2005.
- [69] L. Powers and M. Snell, *Microsoft visual studio 2008 Unleashed*. Pearson Education, 2008.
- [70] W. Durant, *The Case for India*. Simon and Schuster, 1930.
- [71] G. Cannon, "Sir William Jones's Indian Studies," *Journal of the American Oriental Society*, vol. 91, no. 3, pp. 418-425, 1971, doi: 10.2307/600260.
- [72] R. Cordone, *Unreal Engine 4 Game Development Quick Start Guide: Programming professional 3D games with Unreal Engine 4*. Packt Publishing Ltd, 2019.
- [73] J. Xie, "Research on key technologies base Unity3D game engine," in *2012 7th international conference on computer science & education (ICCSE)*, 2012: IEEE, pp. 695-699.
- [74] V. Cosentino, J. L. C. Izquierdo, and J. Cabot, "A systematic mapping study of software development with GitHub," *IEEE Access*, vol. 5, pp. 7173-7192, 2017.
- [75] R.-L. Valijärvi and L. Kahn, "THE ROLE OF NEW MEDIA IN MINORITY-AND ENDANGERED-LANGUAGE COMMUNITIES," *Endangered Languages in the 21st Century*, 2023.
- [76] D. S. Chahal, "RELATIONSHIP AMONG YUGA, VEDAS, BANI OF GURU NANAK, AND THE EVOLUTION OF HUMANS."
- [77] E. YILDIRIM and K. L. GÖKŞEN, "HARAPPA-İNDUS MEDENİYETİNDE MÜHÜRLER," *History Studies (13094688)*, vol. 15, no. 1, 2023.
- [78] F. Oya, N. Jusnita, and S. U. Ali, "STUDENTS' ATTITUDES OF USING ONLINE GAME IN ENGLISH LEARNING AT THE ENGLISH LANGUAGE EDUCATION STUDY PROGRAM OF KHAIRUN UNIVERSITY," *Cakrawala Bahasa*, vol. 11, no. 2, pp. 77-83, 2023.
- [79] Z.-W. Hong, W.-W. Shen, K.-Y. Chin, and Y.-L. Chen, "The Impact of a Hidden Object Game on English Vocabulary Learning and Motivation," 2022, vol. 23, no. 1, p. 6, 2022-01-01 2022. 2022.
- [80] A. M. Wainwright, "Teaching historical theory through video games," *The History Teacher*, vol. 47, no. 4, pp. 579-612, 2014.
- [81] A. Alok *et al.*, "New insights into the geological evolution of palaeorivers and their relationship to the Indus Civilization and Early Historic settlements on the plains of Haryana, NW India," *Geological Society, London, Special Publications*, vol. 515, no. 1, pp. 233-249, 2023.
- [82] J. Feng, Y. Ni, J. Dong, Z. Wang, and S. Yan, "Purposive Hidden-Object-Game: Embedding Human Computation in Popular Game," *IEEE Transactions on Multimedia*, vol. 14, no. 5, pp. 1496-1507, 2012, doi: 10.1109/TMM.2012.2198801.
- [83] W. Pedrycz and K.-C. Kwak, "The development of incremental models," *IEEE Transactions on Fuzzy Systems*, vol. 15, no. 3, pp. 507-518, 2007.
- [84] B. Dobing and J. Parsons, "How UML is used," *Communications of the ACM*, vol. 49, no. 5, pp. 109-113, 2006.
- [85] B. Ray, D. Posnett, V. Filkov, and P. Devanbu, "A large scale study of programming languages and code quality in github," in *Proceedings of the 22nd ACM SIGSOFT international symposium on foundations of software engineering*, 2014, pp. 155-165.
- [86] R. Barrera, *Unity 2017 Game AI Programming-: Leverage the power of Artificial Intelligence to program smart entities for your games*. Packt Publishing Ltd, 2018.
- [87] A. S. Kyaw, C. Peters, and T. N. Swe, *Unity 4. x Game AI Programming*. Packt Publishing, 2013.
- [88] P. P. Kumar, "Effective use of Gantt chart for managing large scale projects," *Cost engineering*, vol. 47, no. 7, p. 14, 2005.