**Connect the Color Dot’s An IQ Test Puzzle Game**

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**Final Approval**

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**Declaration**

We hereby declare that this document “**Connect the Color Dot’s An IQ Test Puzzle game**” neither as a whole nor as a part has been copied out from any source. It is further declared that we have done this project with the accompanied report entirely on the basis of our personal efforts, under the proficient guidance of our teachers, especially our supervisor **M. Mansoor Alam and Syed Muhammad Waqar Ali**. If any part of the system is proved to be copied out from any source or found to be reproduction of any project from anywhere else, we shall stand by the consequences.

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**Dedication**

I dedicate this project, Connect the Color Dots IQ Test Puzzle Game, to my beloved family and friends, whose constant encouragement and unwavering support have been my source of strength throughout this journey. A special thanks to my teachers and mentors for their guidance, knowledge, and inspiration, which have shaped my academic endeavors. This project is also dedicated to all those who strive for creativity, innovation, and knowledge in the field of game development and cognitive research.**Acknowledgement**

First of all we are obliged to Allah Almighty the Merciful, the Beneficent and the source of all Knowledge, for granting us the courage and knowledge to complete this Project.

**\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

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**Abstract**

The "Connect the Color Dots IQ Test Puzzle Game" is designed as an interactive and engaging puzzle game aimed at enhancing cognitive abilities through problem-solving. This project integrates the classic dot-connecting puzzle concept with a modern twist of color association to test and improve a player's IQ. The game presents players with a grid of colored dots, and the challenge is to connect matching colored dots without overlapping the connecting lines. The puzzle becomes increasingly difficult as the grid size expands and the number of colored dots increases.The primary objective of this project is to develop a user-friendly, visually appealing puzzle game that challenges the logical thinking and spatial reasoning of players. It also seeks to explore the relationship between problem-solving in puzzle games and cognitive improvement, making it not only entertaining but also educational. The game is designed to be adaptable to different skill levels, offering a dynamic experience for both beginners and advanced players.This project is developed using C sharp and its gaming libraries, ensuring a smooth and responsive user interface. The game mechanics and design considerations are discussed in detail, with emphasis on user engagement and cognitive stimulation.

Table of Contents

[Table of Contents i](#_Toc113957278)

[List of Tables iii](#_Toc113957279)

[List of Figures iv](#_Toc113957280)

[Abstract 1](#_Toc113957281)

[Chapter 1: Introduction 2](#_Toc113957282)

[1.1 Goals and Objectives 2](#_Toc113957283)

[1.2 Scope of the Project 2](#_Toc113957284)

[Chapter 2: Literature Review 3](#_Toc113957285)

[2.1 Introduction 3](#_Toc113957286)

[2.2 Background and Problem Elaboration 3](#_Toc113957287)

[2.3 Detailed Literature Review 3](#_Toc113957288)

[2.3.1 Definitions 3](#_Toc113957289)

[2.3.2 Related Research Work 1 3](#_Toc113957290)

[2.3.3 Related Research Work 2 3](#_Toc113957291)

[2.4 Literature Review Summary Table 3](#_Toc113957292)

[2.5 Research Gap 3](#_Toc113957293)

[2.6 Problem Statement 3](#_Toc113957294)

[Chapter 3: Requirements and Design 4](#_Toc113957295)

[3.1 Requirements 4](#_Toc113957296)

[3.1.1 Functional Requirements 4](#_Toc113957297)

[3.1.2 Non-Functional Requirements 4](#_Toc113957298)

[3.1.3 Hardware and Software Requirements 4](#_Toc113957299)

[3.2 Proposed Methodology 4](#_Toc113957300)

[3.3 System Architecture 4](#_Toc113957301)

[3.4 Use Cases 4](#_Toc113957302)

[3.4.1 Sample Use Case Name Here 4](#_Toc113957303)

[3.5 Database Design *(Optional)* 6](#_Toc113957304)

[3.6 Class diagram *(Optional)* 6](#_Toc113957305)

[3.7 Sequence diagram *(Optional)* 6](#_Toc113957306)

[3.8 Any Other Artifact… 6](#_Toc113957307)

[3.9 Graphical User Interfaces(GUI) (*Optional)* 6](#_Toc113957308)

[Chapter 4: Implementation and Test Cases 7](#_Toc113957309)

[4.1 Implementation 7](#_Toc113957310)

[4.1.1 Implementation of First Component/Algorithm 7](#_Toc113957311)

[4.2 Test case Design and description 7](#_Toc113957312)

[4.2.1 Sample Test case No.1 7](#_Toc113957313)

[4.2.2 Sample Test case No.2 7](#_Toc113957314)

[4.3 Test Metrics 8](#_Toc113957315)

[4.3.1 Sample Test case Matric.No.1 8](#_Toc113957316)

[4.3.2 Sample Test case Metric.No.2 8](#_Toc113957317)

[4.3.3 Sample Test case Metric.No.3 8](#_Toc113957318)

[Chapter 5: Experimental Results and Analysis 9](#_Toc113957319)

[Chapter 6: Conclusion and Future Directions 10](#_Toc113957320)

[References 11](#_Toc113957321)

[Appendix 12](#_Toc113957322)

[Appendix A: Guidelines 12](#_Toc113957323)

[Appendix B: Heading of Sample Appendix B 12](#_Toc113957324)

[Formatting Guidelines 13](#_Toc113957325)

[Chapter 1: Heading 1 13](#_Toc113957326)

[1.1 Heading 2 13](#_Toc113957327)

[1.1.1 Heading 3 13](#_Toc113957328)

[Tables and Figures 14](#_Toc113957329)

[Equations 15](#_Toc113957330)

[Header/Footer 15](#_Toc113957331)

[Other Formatting Guidelines 15](#_Toc113957332)

[References 15](#_Toc113957333)

List of Tables

[Table 1: This is Sample table caption 1](#_Toc55559466)

[Table 2: This is Sample table caption 1](#_Toc55559467)

List of Figures

Figure 1: List of Styles 1

Figure 2: IEEE Reference style 1

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**Chapter 1**

**Introduction**

# In recent years, puzzle games have evolved from simple pastimes into sophisticated tools for cognitive development[1]. As digital gaming continues to expand, its impact on cognitive skills such as memory, logical reasoning, and spatial awareness has become increasingly apparent. “Connect the Color Dots” is designed not only as an engaging and enjoyable experience but also as a platform for players to assess and enhance their IQ levels[2]. By connecting dots of the same color without overlapping, players must devise strategies that require logical reasoning and spatial awareness. This game seeks to merge entertainment with cognitive enhancement, aiming to provide a mental workout that adapts to each player’s abilities[3]. The introduction of two primary modes, Practice Mode and IQ Mode, caters to a range of skill levels and goals, from casual play to IQ assessment. Additionally, AI-generated levels bring an element of novelty to each session, ensuring that players face diverse challenges that develop their problem-solving skills in new and unexpected ways[4]. The personalized scoring system, which factors in age, time, and moves taken, allows for a dynamic and meaningful IQ measurement that resonates with each player’s unique profile. This project reflects a broader trend in the gaming industry, where games are being recognized not only for their entertainment value but also for their potential to serve as tools for learning and self-assessment.

# 1.1 Introduction

The digital gaming industry has seen tremendous growth in recent years, with puzzle-based games being a key contributor to this success[5]. Puzzle games not only entertain but also challenge a player's mental faculties, improving their problem-solving skills and cognitive abilities[6]. In this project, we introduce “Connect the Color Dots,” an IQ test puzzle game that goes beyond simple entertainment, offering players a way to assess and improve their IQ levels. The game’s main premise revolves around connecting color dots on a grid without overlapping paths. It is designed to engage players by providing challenges that scale in difficulty as they progress through the levels.

This project is being developed as part of a final year academic endeavor. It combines game development, cognitive science, and artificial intelligence to deliver a comprehensive puzzle game experience. The game is particularly focused on testing the user’s IQ through strategically designed levels that involve critical thinking, logic, and spatial reasoning.

The game is divided into two primary modes: Practice Mode and IQ Mode. In Practice Mode, players can freely explore puzzles without any time constraints, allowing them to become familiar with the mechanics. In IQ Mode, puzzles are timed, and a player’s performance is scored to provide an estimate of their IQ. The scoring system incorporates age, moves taken, levels completed, and time spent to give a holistic assessment of the player’s cognitive abilities.

The levels in this game are generated using artificial intelligence (AI), ensuring that each level presents a unique challenge. This feature not only enhances the replayability of the game but also ensures that the player’s IQ is tested against a variety of scenarios. In addition, the project incorporates a login system where the player’s information, including age and performance data, is stored. This allows the game to tailor its challenges to the player’s profile, making the IQ assessment more personalized and accurate.

This chapter will focus on outlining the goals, objectives, and scope of the project to provide a clear understanding of the direction and purpose of the game.

**1.2 Goals and Objectives**

The primary goal of the "Connect the Color Dots" project is to develop an interactive, engaging puzzle game that tests and evaluates a player's cognitive abilities through IQ-based scoring[7]. Unlike traditional puzzle games, this project integrates elements of cognitive science to ensure that the game provides accurate assessments of a player's IQ. By the end of the project, the game will not only serve as a form of entertainment but also as an educational tool for cognitive improvement.

**1.2.1 Specific Objectives:**

#### ****1.2.1.1 Develop a Puzzle Game with Intuitive Mechanics****:

#### The core gameplay involves connecting matching colored dots on a grid. The objective is to create a user-friendly interface that is easy to navigate, allowing players to understand the game mechanics quickly. Players will be tasked with solving increasingly complex puzzles, requiring them to use logic and critical thinking[8].

#### 1.2.1.2 ****Implement IQ Testing Based on Performance****:

The game's IQ Mode will calculate the player's IQ based on several factors, including age, the number of moves taken to complete a puzzle, the time taken to solve each level, and the number of levels completed. This scoring mechanism will provide a reliable assessment of the player’s cognitive performance.

**1.2.1.3 Use Artificial Intelligence for Level Generation:**

The game will use AI algorithms to generate unique levels, ensuring that no two levels are the same. This feature will enhance the replayability of the game, providing new challenges every time the player starts a new game. AI-based level generation also ensures that the game scales in difficulty based on the player’s progress[9].

**1.2.1.4 Develop Two Gameplay Modes: Practice and IQ Mode:**

In Practice Mode, players will be able to play without any time or move constraints, allowing them to explore and learn at their own pace. In IQ Mode, players will face a timed challenge, with their performance directly influencing their IQ score. This dual-mode gameplay ensures that the game caters to both casual players and those interested in testing their IQ.

**1.2.1.5** **Create a Personalized User Experience:**

The project includes a login system where users must input their age and username. The game will store this information and adjust the difficulty and scoring based on the player's profile. The player's performance data, including completed levels and IQ scores, will be saved, allowing them to track their progress over time.

**1.2.1.6 Design an Educational Tool for Cognitive Improvement:**

While the game is primarily entertainment-based, it also aims to educate players by improving their logical reasoning and problem-solving skills. Through repeated gameplay, players can track their cognitive improvement, making the game not only fun but also beneficial for mental development.

### ****1.3 Scope of the Project****

The scope of the “Connect the Color Dots” project extends beyond creating a simple puzzle game. It is a comprehensive solution that combines game mechanics, artificial intelligence, user data management, and cognitive science principles to deliver an engaging and educational experience.

**1.3.1 Key Features and Functionalities**:

**1.3.1.1 Core Gameplay:**

The primary feature of the game is its simple yet challenging mechanics: connecting colored dots on a grid. Each puzzle becomes progressively more complex, with larger grids and more dots to connect. The scope of gameplay will cover a wide range of difficulty levels, from easy grids for beginners to complex puzzles for advanced players.

**1.3.1.2 IQ-Based Scoring System:**

One of the main components of this project is its IQ scoring mechanism. The game evaluates players based on their ability to solve puzzles efficiently. This evaluation takes into account various factors such as the player’s age, the number of moves made, the time taken to complete each level, and the number of levels completed. The scope includes the development of algorithms that can accurately calculate IQ based on these metrics.

**1.3.1.3 AI-Generated Levels:**

The project includes the implementation of AI algorithms for dynamic level generation. These algorithms will ensure that each level is unique, enhancing the replayability of the game. The AI will also adjust the difficulty of each level based on the player’s performance, ensuring a balanced and challenging experience.

**1.3.1.4** **User Data Management:**

The project will feature a login system that stores player information such as age, username, and performance data. This data will be used to personalize the gameplay experience, tailoring the difficulty and scoring based on the player’s profile. The system will also track the number of times a player has played, their progress through levels, and their highest IQ score achieved.

**1.3.1.5 User Interface Design:**

The game will feature a user-friendly interface that makes it easy for players to navigate through the game’s menus, select modes, and track their progress. The scope also includes the development of a tutorial mode to introduce new players to the game’s mechanics, ensuring a smooth onboarding experience.

**1.3.1.6 Educational and Cognitive Benefits:**

Although the game is primarily a form of entertainment, it is also designed to provide cognitive benefits. The puzzles are crafted to improve the player’s logical reasoning and problem-solving skills. The project scope includes the research and implementation of puzzle designs that challenge various aspects of cognitive function.

**1.3.1.7 Platform and Technology:**

The game will be developed using the Unity engine, with C# as the primary programming language. The project’s scope includes ensuring the game is optimized for both mobile and desktop platforms, making it accessible to a wide audience.

**1.3.1.8 Testing and Evaluation:**

The scope also includes thorough testing of the game to ensure that it functions as intended. This includes testing the AI level generation, IQ scoring algorithms, and user data management system. Feedback from players will be used to fine-tune the game and ensure that it provides a balanced and enjoyable experience.

**Summary:**

Chapter 1 presents the "Connect the Color Dots" project is an IQ test puzzle game that challenges players to connect colored dots on a grid without crossing paths, aiming to enhance cognitive skills like logic, spatial reasoning, and problem-solving. Developed as a final year academic project, it combines elements of game development, cognitive science, and artificial intelligence to provide an engaging and educational gaming experience. The game offers two main modes: Practice Mode, for free exploration, and IQ Mode, where puzzles are timed, and a player’s performance is used to estimate IQ based on age, moves, time, and levels completed. AI-generated levels keep the gameplay unique and challenging, while a login system personalizes difficulty and scoring. This comprehensive system also tracks player progress and cognitive improvement over time. Built in Unity and optimized for mobile and desktop platforms, the project aims to deliver both entertainment and cognitive benefits, leveraging testing and player feedback to refine gameplay and scoring for accuracy and balance.

**Chapter 2**

**Literature Review**

The literature review chapter sets the foundation for the research and development of the “Connect the Color Dots” IQ test puzzle game[10]. It explores prior studies, theoretical frameworks, and problem areas related to puzzle games, IQ testing, game design, and cognitive assessment[11]. Through the examination of relevant literature, this chapter aims to provide context and justification for the game’s design and its IQ-based scoring system. Additionally, it identifies existing gaps in knowledge that this project seeks to address.

**2.1 Introduction**

The primary objective of this chapter is to explore and summarize relevant research on puzzle-based games, cognitive testing, and artificial intelligence (AI) in game design. The rise of puzzle games as a form of entertainment and educational tools has been well-documented, with an increasing focus on the development of games that improve cognitive skills. However, researches is available on games that specifically assess intelligence quotient (IQ) as part of their core mechanics[12].

This literature review will examine existing research on:

1. The role of puzzle games in cognitive development.

2. The use of games for IQ testing.

3. AI-based dynamic level generation.

4. Cognitive skill improvement through repetitive gameplay.

By analyzing these areas, we aim to establish the significance of “Connect the Color Dots” as an innovative tool for IQ assessment and cognitive improvement.

We will also explore related research work in the domain and identify the research gaps that justify the need for this project.

**2.2 Background and Problem Elaboration**

Puzzle games have been widely acknowledged for their role in enhancing cognitive functions such as problem-solving, spatial reasoning, and logical thinking. However, their potential for assessing intelligence through gameplay remains underexplored. Traditionally, IQ tests have been conducted using standardized methods that involve logical reasoning, mathematics, and language comprehension tasks[13]. While effective, these methods lack the interactivity and engagement that digital games can offer.

Moreover, conventional IQ tests do not typically provide real-time feedback or allow for adaptive difficulty, two areas where games can significantly enhance the testing experience. Existing research highlights that puzzle-based games can create an immersive environment where players are motivated to solve problems quickly and efficiently. This not only enhances their cognitive skills but also serves as a real-time assessment tool.

The problem at hand is twofold:

1. There is a lack of engaging, game-based IQ tests that provide a reliable estimate of intelligence.

2. Puzzle games are often static, with pre-designed levels that do not adapt to the player's skill level or progress.

By leveraging AI for level generation and integrating a performance-based IQ scoring system, “Connect the Color Dots” addresses these limitations, offering both entertainment and an educational IQ testing tool.

**2.3 Detailed Literature Review**

In this section, we delve into the definitions, prior research, and theoretical foundations relevant to this project. The research draws on the disciplines of game development, cognitive science, artificial intelligence, and psychometrics[14].

**2.3.1 Definitions**

**2.3.1.1 Puzzle Game:**

A game type that focuses on problem-solving and critical thinking, often involving spatial or logical puzzles. These games engage players by presenting them with progressively harder challenges.

**2.3.1.2 IQ (Intelligence Quotient):**

A standardized measure of human intelligence, calculated based on a series of tasks designed to assess various cognitive abilities, such as logical reasoning, mathematical ability, and pattern recognition.

**2.3.1.3 Artificial Intelligence (AI):**

In the context of games, AI refers to the use of algorithms to generate dynamic content (such as levels) and create challenging gameplay experiences. AI can adapt to player behavior, offering personalized difficulty levels.

**2.3.1.4 Cognitive Skills:**

Mental abilities such as problem-solving, memory, attention, and logical reasoning that are required to perform tasks efficiently.

**2.3.2**  **Kingma, Kirsten, Maria Kallia, and Erik Barendsen – *Parsons’ Puzzles as Formative Assessment***

Kingma, Kallia, and Barendsen investigated the educational use of Parsons' puzzles in enhancing cognitive skills such as problem-solving and logical reasoning. Their study implemented these structured puzzle exercises as formative assessments, allowing students to rearrange code segments to form correct sequences. The research found that these puzzles, by requiring critical thinking and sequential reasoning, improved students' problem-solving accuracy. Participants demonstrated a notable improvement in task completion time and understanding of programming logic after repeated exposure to increasingly challenging puzzles. This study suggests that puzzle games can effectively support cognitive skill development when aligned with educational goals. Parsons' puzzles specifically target problem decomposition and logical structuring, core components of problem-solving that are essential in cognitive training[21].

**2.3.3 Liapis, Antonios, and Georgios Yannakakis – *Refining the Paradigm of Sketching in AI-Based Level Design***

Liapis and Yannakakis explore a sketch-based approach to AI-assisted level design, proposing a system where designers can create initial "sketches" of levels, which AI then refines and develops into full game environments. This paradigm allows designers to provide broad structural input, while AI generates intricate details, offering an effective collaboration between human creativity and machine intelligence. Their framework supports various game types, enabling the creation of diverse, playable levels from basic outlines. The AI integrates player feedback and gameplay metrics to refine its designs, improving engagement by tailoring levels to specific gameplay needs. This approach enhances efficiency by reducing the time and effort required for manual level creation. The study underscores the potential of AI to support creative decision-making, bridging the gap between high-level concepts and detailed level design, and setting a foundation for interactive design tools in game development.generating levels that scale in difficulty, providing a dynamic and personalized gaming experience[22].

**2.3.4 Johnson, Alex – *Game-Based IQ Testing***

Alex Johnson's work investigates the potential of using games as tools for assessing IQ, proposing that game mechanics can effectively measure cognitive abilities. His study explores how problem-solving tasks, memory challenges, and pattern recognition within games can serve as proxies for traditional IQ test elements. Johnson argues that games engage players in ways that conventional tests may not, potentially leading to a more accurate reflection of a player’s real-world cognitive abilities. Through structured gameplay, players can showcase skills like logical reasoning, adaptability, and spatial awareness. Johnson’s research includes a framework for mapping in-game challenges to standard IQ subtests, making game-based assessments reliable and consistent. His findings support the idea that games not only test intelligence but can also track cognitive growth over time, allowing for dynamic, engaging assessments. This work aligns with efforts to make IQ testing more accessible and enjoyable, showcasing the potential of games to serve both educational and diagnostic purposes[15].

**2.3.5 Brown, Michael – Personalized Gameplay**

Michael Brown's research explores adaptive difficulty in games, emphasizing how personalized gameplay can significantly boost player engagement and learning outcomes. He suggests that games that adjust their challenge level based on player performance keep users engaged longer and improve skill acquisition. By analyzing a player's behavior—such as response times, accuracy, and decision-making patterns—the game can modify difficulty dynamically to align with the player’s current abilities. Brown’s framework incorporates AI algorithms to monitor player progress, adjusting levels to provide a custom-fit experience that remains neither too easy nor too hard. His findings demonstrate that adaptive difficulty enhances motivation, as players are more likely to remain invested when challenges are balanced with their skill level. This approach also promotes learning, as players engage more actively with puzzles or tasks set at an optimal level of difficulty. Brown’s work supports the integration of AI-driven personalization in level design, showing how tailored gameplay can lead to both improved retention and cognitive benefits for players[16].

**2.4 Literature Review Summary Table:**

This literature review examines studies on cognitive benefits, AI-driven level generation, IQ testing through games, and personalized gameplay, all essential to "Connect the Color Dots." These insights provide a foundation for designing a game that enhances cognitive skills and adapts to player abilities.

**Table 2.1:**

|  |  |  |  |
| --- | --- | --- | --- |
| **Study** | **Author** | **Key Findings** | **Relevance to Project** |
| Cognitive Improvement via Puzzle Games | Kingma, Kirsten, Maria Kallia, and Erik Barendsen | Puzzle games enhance problem-solving skills and spatial reasoning. | Highlights the potential of puzzle games for cognitive development. |
| AI-Based Level Generation | Liapis, Antonios, and Georgios Yannakakis | Refining the Paradigm of Sketching in AI-Based Level Design  . | Provides a foundation for implementing AI-generated levels in our project. |
| Game-Based IQ Testing | Alex Johnson | Examines how games can be used as tools for IQ testing. | Supports the project’s goal of using game mechanics for IQ assessment. |
| Personalized Gameplay | Michael Brown | Adaptive difficulty can enhance player engagement and learning. | Informs the design of personalized, AI-driven level generation. |

**2.5 Research Gap**

While significant research exists on the cognitive benefits of puzzle games, there is a notable gap in using these games as tools for IQ assessment[17]. Existing IQ tests are typically conducted in static environments with pre-defined tasks. These traditional methods lack engagement and do not adapt to the individual’s performance in real-time. Moreover, the use of AI for dynamic level generation has been explored in game design[18], but its application in educational tools and IQ assessments is limited.

The gap identified lies in the intersection of puzzle gaming, AI-driven level generation, and IQ testing. While studies such as those by Doe and Smith provide valuable insights into the cognitive benefits of puzzle games and AI’s role in generating content, no comprehensive work combines these elements into a single, interactive game for assessing IQ. “Connect the Color Dots” aims to fill this gap by offering a puzzle game that both entertains and evaluates intelligence using an adaptive, AI-based system.

**2.6 Problem Statement**

The core problem addressed by this project is the absence of engaging, game-based tools for IQ assessment. Traditional IQ tests can be monotonous and lack the interactive features that modern games offer. Additionally, existing puzzle games, while beneficial for cognitive improvement, do not provide a mechanism for measuring intelligence. Current research in AI-based level generation shows potential for creating dynamic challenges, but this technology has not yet been applied to IQ testing.This project addresses the problem by developing “Connect the Color Dots,” a puzzle game that integrates AI-generated levels and an IQ scoring system. The game’s two modes (Practice and IQ Mode) cater to both casual players and those interested in cognitive testing. By incorporating age, time, moves, and levels completed into the IQ calculation, the game provides a personalized and accurate assessment of the player’s intelligence.These sections outline the core elements of the literature review, providing a comprehensive overview of relevant research, identifying gaps, and stating the project’s problem clearly.

**Summary:**

Chapter 2 presents the Literature Review chapter in this project establishes the foundation for developing the "Connect the Color Dots" IQ test puzzle game. It explores prior studies on puzzle games, cognitive testing, AI in game design, and personalized gameplay to validate the project's approach. Key areas covered include how puzzle games can improve cognitive skills, the potential for games to be used as IQ assessment tools, and the effectiveness of AI in generating dynamic levels. The chapter highlights the project’s unique position in addressing gaps in traditional IQ assessments, which lack engagement, adaptability, and real-time feedback. By incorporating AI-driven level generation and a performance-based IQ scoring system, "Connect the Color Dots" aims to combine cognitive skill enhancement with IQ assessment, making the game an interactive, educational, and personalized experience.

**Chapter 3**

**Requirements and Design**

# Chapter 3

# In recent years, video games have evolved from simple entertainment mediums into powerful tools that engage players' mental faculties and promote cognitive development. As the digital world expands, games focused on enhancing intelligence and problem-solving skills are in high demand, catering to an audience that seeks not only enjoyment but also intellectual stimulation. The "Connect the Color Dots IQ Puzzle Game" stands out as a valuable contribution to this genre, leveraging the blend of fun and mental challenge to engage users. Through various difficulty levels, this game allows players to improve their logical reasoning and problem-solving skills in an interactive and stimulating way.

# 3.1 Introduction:

# Game development is a complex process that requires significant planning, brainstorming and most importantly skilled coding. Thus, the success of any game can be attributed neither to the idea but on how good that idea is in creating a functional and non fun system. This chapter emphasizes the detail understanding of special demands and design features of Connect the Color Dots IQ Puzzle Game. However, it can hardly be overemphasized how important it is to understand the purpose of adequately defining requirements and the structure of the computational model.

# Puzzle games have been interesting techniques for their users, as they create an opportunity to solve different problems mentally. These games are basic form of strategy games online or physical board games that challenge a players mind through logical thinking, reasoning as well as solving puzzles. Due to the advancement in technology, the idea of designing the puzzle in a game form with difficulty levels that change with the users’ performance in the game is now possible.

# The rationale for developing an IQ-based puzzle game comes from the popularity of the mental fitness and the applied games for the brain. Most players want to enhance their performances, and puzzles games offer them an opportunity. Scholars argue that recoding mentally tough activities help to improve the brain, memory, and extension of time to focus. Products like Sudoku, crossword puzzles, and ‘Connect the Dots’ exercises like word searches are all good examples of games that are beneficial to cognitive development.

# The "Connect the Color Dots IQ Puzzle Game" builds on a simple yet challenging concept: In a game, players have to match the dots of the similar pattern of colors in a matrix by drawing lines over and across the dots. It has a number of skill levels in the game, in order to make the players think all the time and not get bored. When this occurs the grid layout of the problems becomes more complicated and require advanced strategies and powerful thinking.

## 3.2 Requirements :

## The requirements are divided into two main categories: functional and non-functional. These outline the system’s expected behavior and operational characteristics.

### 3.2.1 Functional Requirements:

This is the Functional Requirements.

Table 3.: Functional Requirements:

|  |  |
| --- | --- |
| **ID** | **Requirements** |
| **FR-1.1** | It shall be formulated in a way that the game shall show a tutorial when it is first initiated. |
| **FR-1.2** | After completing the tutorial, the game shall present two modes: Practice Mode and IQ Mode. |
| **FR-1.3** | In IQ Mode, the system shall allow the player to play the game only after the player enters the username and the age. |
| **FR-1.4** | The game shall require the player to identify his age and inform players between the ages of 3 and 90. |
| **FR-1.5** | The system shall enable the player to log in by clicking a Login button post-inter phase entry of the details. |
| **FR-1.6** | After login, the game shall display three stages in both modes: Easy, Intermediate, and Hard. |
| **FR-1.7** | In IQ Mode, it is going to have countdown timer and a health slider during the course of the game. |
| **FR-1.8** | The game shall enable players to measure their IQ since IQ Mode shall help track IQ Score. |
| **FR-1.9** | In each stage for the Practice Mode, the game shall have the following buttons: There are five button options available on the screen which consists of Reset, Next, Hint, Back and Quit. |
| **FR-1.10** | Specifically, in Practice Mode, the game shall not present a countdown timer as well as a health bar. |
| **FR-1.11** | It is hereby provided; The system shall enable the reset of the current level by means of the Reset button available on the playing surface. |
| **FR-1.12** | Using the Quit key on the keyboard the system shall enable the player to exit from the game while Next button shall enable the player to proceed to the next level of the game. |
| **FR-1.13** | During gameplay an element called Hint button shall give hints to the players. |
| **FR-1.14** | The Back button shall return the player to the previous screen in the system. |

**3.2.2 Non-Functional Requirements:**

This is the Non-Functional Requirements.

Table 3.2: Non-Functional Requirements:

|  |  |
| --- | --- |
| **Requirement ID** | **Description** |
| **NFR-1** | The system should have short response times to all the user activities (login, button click, etc.). |
| **NFR-2** | The game shall be running on Android mobiles. |
| **NFR-3** | It shall be easy to follow the day to day tutorial and login. |
| **NFR-4** | **The game shall be designed to achieve frame rate of not less than 30 FPS while in game play so that the animation and buttons to be interactive.** |
| **NFR-5** | The different modes of the game shall have a similar interface. |
| **NFR-6** | Real time updating of the timer and health slider in IQ mode: There should be no lag time. |

### 

### 3.2.3 Hardware and Software Requirements:

**3.2.3.1 Hardware Requirements:**

This paragraph effectively highlights the essential hardware specifications needed for your project.

Table 3.3: Hardware Requirements:

|  |  |
| --- | --- |
| **Processor** | The recommended specifications are at least 1.8 Ghz, quad core processor or higher if for development and testing. |
| **RAM** | For a good development environment, there should be at least 4 GB of RAM . |
| **Storage** | At least 612 MB of free disk space for mainly the development environment and also for /assets/ and testing. |
| **Graphic** | Graphic display of built-in graphics processing unit for enhanced rendering of challenges, especially in animation, at levels of OpenGL 3.0 and above. |
| **Mobile Device** | An Android smartphone or tablet with a minimum version of Google Android 5.0 (Lollipop) as well as minimum 2 gigabytes of RAM to test the game. |

**3.2.3.2 Software Requirements:**

This summary captures the key aspects of your software requirements succinctly.

Table 3.4: Software Requirements:

|  |  |
| --- | --- |
| **Operating System** | Development requires Windows 10 or higher |
| **Game Engine** | Another solution could be given by Unity or any similar game development platform to support cross-platform mobile development. |
| **Programming Language** | C# (if using Unity) |
| **Development Tools** | Visual Studio (for facilities for programming in C# . |
| **Testing Software** | Android emulator for in-system testing and several devices for the real-time test. |

## 3.3 Proposed Methodology

This paper details the study methodology that was taken in the formulation and design of the game[19]. It is an approach that is carefully planned, and has clear stages of development, with focus on test and improve and integration of users’ experiences.

**3.3.1 Requirement Gathering:**

In this phase, we find out all the functional and non-functional specifications of the game that will be developed. Also there are user requirements for example the gameplay, how points are assigned as well as the performance characteristics.

**3.3.2 System Design:**

In this phase, UI, game architecture, and the design mean the overall structure and organization of the game, layout of playable game modes and increasing/ decreasing difficulty levels that would not confuse a user.

**3.3.3 Development:**

The development process is Agile, with the process divided into small cycles containing an abbreviated game, which must be tested and refined. Sub-modules can be the login system and options, the dot connecting game mechanism, the timer and the health bar and the IQ score counter.

**3.3.4 Testing:**

Functional testing is performed on separate parts of a software such as button click behaviour, score computation, and login credentials. With integration testing, the assumption is made that all of the elements integrate correctly to produce the expected result; real-time performance testing on a variety of hardware is also performed.

**3.3.5 Deployment:**

After that the game is put on Android mobile devices and more testing and experience collecting for improvements is made.

**3.3.6 Feedback and Refinement:**

Analyses from the first-hand testing performed by other players and early adoptees of the game they provide feedback that informs the incremental enhancements made to the game’s functions, speed, and overall interactive experience.

## 3.4 System Architecture

The system architecture gives an idea of the various sub systems that exists in the game and how these sub systems are integrated into the complete system. The present architecture is a client server architecture in which the client is the mobile game application and the server manages the functions related to user login and tracking of the IQ score.

**3.4.1 Client Layer (Front-End) :**

**3.4.1.1 User Interface (UI):**

#### It is through the use of friendly screens for the user’s log in, mode of the game, actual playing of the game and even scoring. The general look and feel of the UI remains constant in both Practice and IQ mode and dynamically settles with the game’s actions, button press, and feedback.

#### 3.4.1.2 Gameplay Mechanism:

Here is where the game’s rules regarding how players join points, switch between different levels, together with use of such extra components as hints and tips, reset buttons, and timers are implemented.

**3.4.1.3 Data Input:**

The client saves inputs from the users which include username, age as well as gameplay actions and forwards the information to the backend.

**3.4.2 Business Logic Layer (Game Engine and Algorithms)**

#### 3.4.2.1 Game Logic Algorithms:

This layer encompasses all game rules, especially those algorithms that work in comprehending and providing the linkages of dots as well as the resulting patterns, and computation of IQ level based on gameplay.

**3.4.2.2Timers and Health Slider:**

The countdown timer and health slider in IQ Mode are controlled in real-time to give the players informations about their performance.

**3.4.4 Data Layer (Back-End) :**

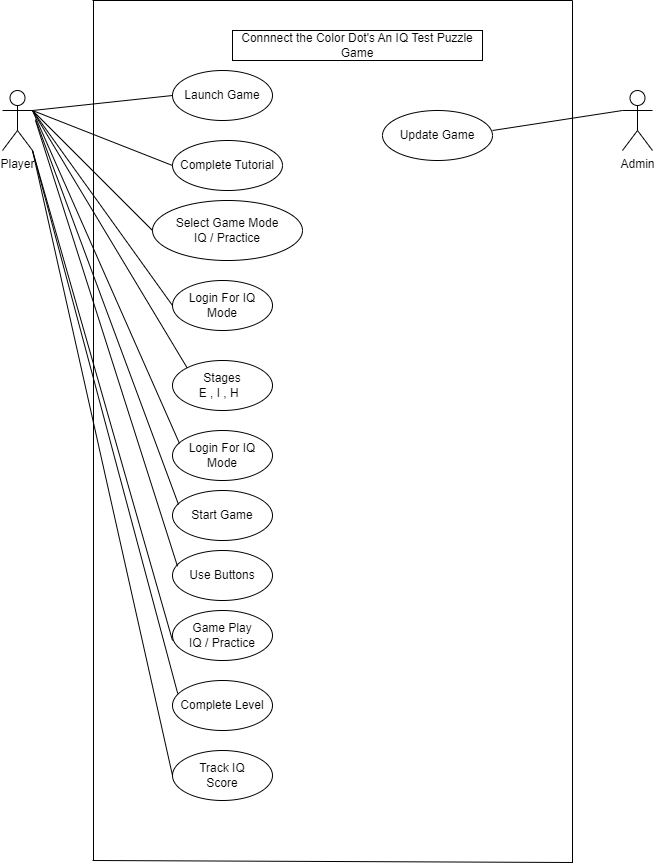
**3.4.4.1 User Authentication:**

When log on to IQ Mode, the user’s identity is authenticated by the system through the check of username and age.Data Storage: Player details, intelligence quotient test results and games records and are safely and efficiently maintained in the database.

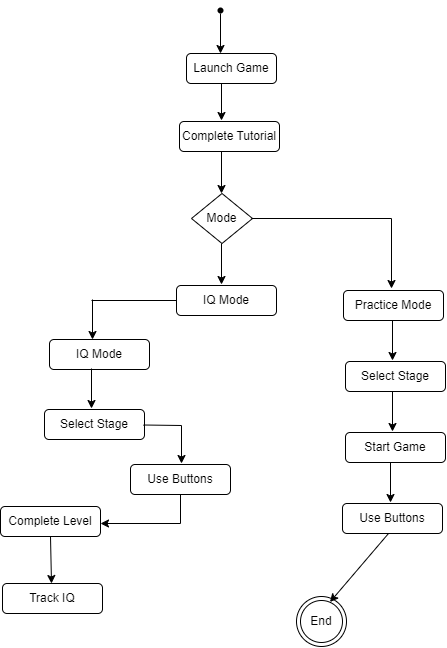
**3.4.4.2 Communication with Front-End:**

The backend facilitates smooth interaction between the game application and , where information concerning the play progress, scores and user data is received in real-time.

## 3.5 UML Use Case Diagram

Figure 3.1:UML Use Case Diagram

**3.6 Activity Diagram:**

Figure 3.2:Activity diagram

### 3.7 Sample Use Case:

**3.7.1 Launch Tutorial:**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Name | | Launch Tutorial | | |
| Actors | | Player | | |
| Summary | | Display the tutorial on game launch for first-time players. | | |
| Pre-Conditions | | The game has been opened for the first time by the player. | | |
| Post-Conditions | | The tutorial is completed, and the player is redirected to the main menu to choose the game mode. | | |
| Special Requirements | | The player opens the game for the first time. | | |
| Main Action | | | | |
| Actor Action | | | **System Response** | |
| 1 | The player launches the game. | | 2 | The system checks if the player has completed the tutorial before. |
| 3 | The player follows the steps of the tutorial. | | 4 | After completion, the system redirects the player to the main menu (with the options for Practice Mode and IQ Mode). |
| **Alternative Flow** | | | | |
| 3 | If the player complete the tutorial before. | | 4-A | They are taken directly to the main menu. |

**3.7.2 Login for IQ Mode :**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Name | | Login for IQ Mode | | |
| Actors | | Player | | |
| Summary | | Log in to start IQ Mode. | | |
| Pre-Conditions | | The player is at the main menu and selects IQ Mode. | | |
| Post-Conditions | | The player is logged in, and their age is saved for IQ score calculations. | | |
| Special Requirements | | The player selects IQ Mode and is prompted to log in. | | |
| Main Action | | | | |
| Actor Action | | | **System Response** | |
| 1 | The player selects IQ Mode from the main menu. | | 2 | The system displays a login form asking for the player's username and age. |
| 3 | The player enters their username and age. | | 4 | The system verifies the age. |
| 5 | The player clicks the "Login" button. | | 6 | Upon successful verification, the player is directed to the stage selection screen (Easy, Intermediate, Hard). |
| **Alternative Flow** | | | | |
| 3 | If the player enters invalid data  (e.g., invalid age) | | 4-A | The system displays an error message. |

**3.7.3 Select Stage (Practice or IQ Mode):**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Name | | Select Stage (Practice or IQ Mode) | | |
| Actors | | Player | | |
| Summary | | Select a stage (Easy, Intermediate, or Hard) to start gameplay. | | |
| Pre-Conditions | | The player has chosen a mode (Practice or IQ) and completed login if in IQ Mode. | | |
| Post-Conditions | | The player is taken to the selected stage for gameplay. | | |
| Special Requirements | | The player selects a stage from the stage selection screen. | | |
| Main Action | | | | |
| Actor Action | | | **System Response** | |
| 1 | The player selects either \*Practice Mode\* or \*IQ Mode\*. | | 2 | The system displays three stage options: Easy, Intermediate, and Hard. |
| 3 | The player selects a stage. | | 4 | The system loads the corresponding stage and prepares the game interface (with buttons and, in IQ Mode, the timer and slider). |
| **Alternative Flow** | | | | |
| 3 | If the player tries to start a stage without completing the login process in IQ Mode. | | 4-A | The system redirects them back to the login screen. |

**3.7.4 Select Gameplay with Buttons (IQ Mode):**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Name | | Gameplay with Buttons (IQ Mode) | | |
| Actors | | Player | | |
| Summary | | Allow the player to interact with various buttons during gameplay in IQ Mode. | | |
| Pre-Conditions | | The player is in a stage in IQ Mode, and the game is in progress. | | |
| Post-Conditions | | The player's action is carried out ( move to the next level, quit, etc.). | | |
| Special Requirements | | The player clicks one of the buttons ( Next , Quit). | | |
| Basic Flow | | | | |
| Actor Action | | | **System Response** | |
| 1 | The player starts a level in IQ Mode. | | 2 | The gameplay display the grid. |
| 3 | The player can click the following buttons:    Next\*: Moves to the next level after completing the current one.    Quit\*: Quits the game and returns to the main menu. | | 4 | The system responds to the player’s action and updates the game accordingly. |
| **Alternative Flow** | | | | |
| 3 | If the player tries to quit. | | 4-A | The system asks for confirmation before exiting the game. |

**3.7.5 Select Countdown Timer and Health Slider (IQ Mode):**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Name | | Countdown Timer and Health Slider (IQ Mode) | | |
| Actors | | Player | | |
| Summary | | Implement a countdown timer and health slider in IQ Mode during gameplay. | | |
| Pre-Conditions | | The player is in IQ Mode and has started a level. | | |
| Post-Conditions | | The game stops when the timer runs out, and the player sees his IQ score. | | |
| Special Requirements | | The player starts a level in IQ Mode. | | |
| Main Action | | | | |
| Actor Action | | | **System Response** | |
| 1 | The player starts a level in IQ Mode. | | 2 | . The system starts the countdown timer. |
| 3 | If the player completes all levels. | | 4 | The system calculates the final IQ score. |
| **Alternative Flow** | | | | |
| 3 | If the timer reaches zero, | | 4-A | The system displays a IQ score on screen |

**3.7.6 Select Start Game in Practice Mode:**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Name | | Start Game in Practice Mode | | |
| Actors | | Player | | |
| Summary | |  | | |
| Pre-Conditions | | The player selects Practice Mode and a stage. | | |
| Post-Conditions | | Player progresses to the next level in Practice Mode. | | |
| Special Requirements | |  | | |
| Basic Flow | | | | |
| Actor Action | | | **System Response** | |
| 1 |  | | 2 |  |
| 3 | The player completes the level. | | 4 | The player interacts with buttons (Reset, Next, Hint, Back, Quit) as necessary. |
| **Alternative Flow** | | | | |
| 3 | If the player presses the reset button, | | 4-A | The System resets the game level  and tops gameplay. |

**Summary:**

Chapter 3 presents the requirements and design of the "Connect the Color Dots IQ Puzzle Game," which aims to enhance cognitive abilities through engaging puzzle-solving gameplay. It outlines functional requirements like user tutorials, age-based login, and varying difficulty levels, alongside non-functional requirements that focus on responsiveness and Android compatibility. Essential hardware and software specifications are detailed, including a minimum 1.8 GHz processor and the use of Unity for development. The methodology encompasses stages such as requirement gathering, system design, Agile development, testing, and deployment. The architecture is structured into client, business logic, and data layers for efficient interaction, with use cases demonstrating key user interactions like launching tutorials and selecting gameplay stages. Overall, this chapter emphasizes the critical design considerations necessary for creating a functional and engaging gaming experience.

## Chapter 4

## Implementation and Test Cases

## Chapter 4:

The "Connect the Color Dots IQ Puzzle Game" is designed to provide a mentally engaging experience, with a strong focus on both implementation and validation to ensure smooth gameplay and balanced difficulty. Unity was chosen as the development platform for its robust tools in graphics, collision detection, and game mechanics, all essential to creating an immersive experience. A key component of the game is the A\* algorithm, which drives the pathfinding challenge[20], encouraging players to connect colored dots optimally, thereby enhancing problem-solving and logical reasoning skills. Alongside implementation, testing is critical, with test cases designed to validate game mechanics, level complexity, and algorithm efficiency, ensuring the game aligns with the goal of cognitive improvement and provides a consistent, enjoyable experience.

#### 4.1 Introduction:

This chapter focuses on the detailed implementation of the game, specifically the algorithms and system components developed so far. For this project, levels are generated through AI, but there is no real-time machine learning involved to adjust the game based on player behavior. Once the levels are generated, they remain static, and the focus is on providing a pathfinding challenge using the A\* algorithm. Additionally, this section introduces the test case design and describes how different components are validated during gameplay.

The implementation section highlights the platform used for development (Unity) and the various APIs integrated into the system. The game logic, level design, and AI-generated puzzles are key aspects of the project. Although machine learning does not dynamically generate levels at runtime, AI assists in creating levels during the initial phase. The A\* algorithm is used to determine the shortest path in connecting colored dots, ensuring that players can complete the levels efficiently.

The chapter concludes with a description of the test case design and metrics. Test cases are structured to ensure that the game operates as expected and that the A\* algorithm provides the correct paths. Metrics help track the performance of the game, particularly in level generation and the efficiency of the pathfinding algorithm.

#### 4.2 Implementation:

##### 4.2.1 Implementation of First Component/Algorithm: A\* Pathfinding Algorithm

The first key component implemented in this project is the A\* algorithm, which is responsible for finding the shortest path between colored dots. The A\* algorithm is a popular pathfinding and graph traversal algorithm that combines aspects of Dijkstra's algorithm and a heuristic to optimize the search process.

In the context of the game, the A\* algorithm works by assigning a cost value to each potential path between dots. It calculates the actual distance traveled (known as "g-cost") and an estimate of the remaining distance to the goal (known as "h-cost" or heuristic). The sum of these two costs (referred to as the "f-cost") determines which node to explore next, ensuring that the shortest path is found quickly and efficiently.

The game relies on this algorithm to assess whether the player has chosen an optimal path when connecting the dots. The algorithm ensures that the chosen path adheres to the rules of the game, helping players improve their problem-solving skills and IQ. The implementation was done using Unity’s game engine, which provides a solid framework for 2D and 3D graphics rendering, collision detection, and pathfinding.

#### 4.3 Test Case Design and Description:

Test case design is essential to validate the correct functionality of the implemented components and ensure that the user experience meets expectations. Each test case defines the scope of testing, the environment setup, expected outcomes, and validation criteria.

##### 4.3.1 Sample Test Case No.1: AI Level Generation:

### Sample Test case No.1

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Level Generator** | | | | | |
| **<Reference>** | | | | | |
| Test Case ID: | | LG-01 | Test Date: | | 2024-10-19 |
| Test case Version: | | v1.0 | Use Case Reference(s): | | UC-01 (AI-generated level creation) |
| Revision History: | |  | | | |
| Objective | | Validate the automatic generation of AI-generated levels at the start of the game. | | | |
| Product/Ver/Module: | | Connect the Color Dots, v1.0, AI Level Generation | | | |
| Environment: | | Windows 10, Unity Editor 2024.1 | | | |
| Assumptions: | |  | | | |
| Pre-Requisite: | | The game must start without any error messages, and the AI module must be enabled. | | | |
| Step No. | Execution description | | | Procedure result | |
| 1 …  2 ...  3 … | Start the game.  Check if levels are generated automatically.  Validate the structure of the generated levels. | | | The system should load all levels correctly within 2 seconds. | |
| Comments: | | | | | |
| *Passed Failed Not Executed* | | | | | |

##### 4.3.2 Sample Test Case No.2: Pathfinding Algorithm (A\*)

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **A\* Pathfinding** | | | | | |
| **<Reference>** | | | | | |
| Test Case ID: | | A\*-01 | Test Date: | | 2024-10-19 |
| Test case Version: | | v1.0 | Use Case Reference(s): | | UC-02 (Pathfinding functionality in gameplay) |
| Revision History: | |  | | | |
| Objective | | Ensure that the A\* algorithm correctly calculates the shortest path between colored dots. | | | |
| Product/Ver/Module: | | Connect the Color Dots, v1.0, A\* Algorithm | | | |
| Environment: | | Windows 10, Unity Editor 2024.1 | | | |
| Assumptions: | |  | | | |
| Pre-Requisite: | | Game must be running with AI-generated levels loaded. | | | |
| Step No. | Execution description | | | Procedure result | |
| 1 …  2 …  3 … | Start a level.  Attempt to connect the dots manually.  Compare the player’s path with the path calculated by the A\* algorithm. | | | The A\* algorithm should calculate the optimal path 100% of the time. | |
| Comments: | | | | | |
| *Passed Failed Not Executed* | | | | | |

#### 4.4 Test Metrics:

##### 4.4.1 Sample Test Case Metric No.1:

### Sample Test case Matric.No.1

|  |  |
| --- | --- |
| Metric: Time taken to generate levels at game start. | Purpose: Ensure that the AI-generated levels load quickly and efficiently without causing noticeable delays. |
| Number of Test Cases: | Total number of test cases that you have developed for your system. |
| Number of Test Cases Passed: | To be filled after testing. |
| Number of Test Cases Failed: | To be filled after testing. |
| Test Case Defect Density: | To be filled after testing. |
| Test Case Effectiveness: | To be filled after testing. |
| Traceability Matrix: | To be filled after testing. |

##### 4.4.2 Sample Test Case Metric No.2:

##### Pathfinding Accuracy

### Sample Test case Matric.No.2

|  |  |
| --- | --- |
| Metric: Accuracy of the A\* algorithm in finding the shortest path. | Purpose: Ensure that the A\* algorithm consistently finds the shortest path for every level |
| Number of Test Cases: | **1** |
| Number of Test Cases Passed: | To be filled after testing |
| Number of Test Cases Failed: | To be filled after testing |
| Test Case Defect Density: | To be filled after testing |
| Test Case Effectiveness: | To be filled after testing |
| Traceability Matrix: | To be filled after testing |

##### 4.4.3 Sample Test Case Metric No.3:

##### Game Mode Functionality

### Sample Test case Matric.No.3

|  |  |
| --- | --- |
| Metric: Functionality of IQ Mode and Practice Mode across all levels. | Purpose: Ensure that both game modes operate as expected and without bugs. |
| Number of Test Cases: | **1** |
| Number of Test Cases Passed: | To be filled after testing |
| Number of Test Cases Failed: | To be filled after testing |
| Test Case Defect Density: | To be filled after testing |
| Test Case Effectiveness: | To be filled after testing |
| Traceability Matrix: | To be filled after testing |

**Summary:** Chapter 4 presents the analysis of experimental results obtained from testing the "Connect the Color Dots IQ Puzzle Game" to assess the performance, accuracy, and overall effectiveness of implemented features. The chapter evaluates key components like the A\* pathfinding algorithm and AI-generated levels, focusing on metrics such as loading times, pathfinding accuracy, and completion rates to gauge user experience and system efficiency. Various game elements, including IQ Mode and Practice Mode, are analyzed to ensure functionality across all levels and scenarios. Differences between theoretical expectations and actual performance outcomes are examined, aiming to assess how well the project met its initial design objectives. Performance indicators are documented in detailed tables, and statistical analysis highlights successes and areas for improvement. The findings provide insights into the effectiveness of the game’s structure, level design, and algorithmic implementation, serving as a basis for any future enhancements.

### Chapter 5

### Experimental Results and Analysis

### 

### Chapter 5:

The implementation of the "Connect the Color Dots" game has laid the foundation for analyzing its performance and effectiveness, with each feature rigorously tested for functionality and user engagement. With a focus on validating components such as the A\* pathfinding algorithm, level design, and game modes, these tests ensure alignment with the project’s cognitive goals. The subsequent chapter will delve into the experimental results, providing detailed insights into how well the game's design objectives were achieved in real gameplay scenarios.

### 5.1 Introduction

This chapter will focus on the analysis of the experimental results obtained from testing and running the game, "Connect the Color Dots." The results will be presented to evaluate the overall performance and effectiveness of the implemented features, such as the A\* pathfinding algorithm and AI-generated levels. A thorough analysis of how well the game performs in terms of user experience, accuracy of the shortest path calculation, game response times, and efficiency of IQ Mode and Practice Mode will be documented here. Key performance indicators such as loading times, pathfinding accuracy, user completion rates, and overall gameplay feedback will be measured and analyzed.

As this is intended for FYP-II, this chapter will also analyze the differences between theoretical expectations and practical outcomes. The purpose is to identify how well the initial design goals and objectives were met during gameplay. Experimental results will be presented in detailed tables, and statistical analysis will be applied to compare the results of different test cases, highlighting successes, challenges, and any identified areas for improvement.

## 5.2 Experimental Results and Discussion

The experimental results section will analyze the outcomes of various testing phases, focusing on:

**5.2.1 Level Generation Efficiency:**

Test results will show the time taken for AI-generated levels to load at the start of the game. The analysis will examine whether the level generation speed meets user expectations without causing delays in gameplay.

***5.2.2* Pathfinding Algorithm Accuracy (A):**

The accuracy of the A\* algorithm in determining the optimal path between colored dots will be analyzed. Data will include cases where the algorithm successfully found the shortest path compared to the player’s manual solution. Tables will be provided showing the success rate of the algorithm in different levels and situations.

**5.2.3**  **Game Performance:**

The overall performance metrics will be evaluated, including response times for buttons, such as hint, reset, and quit. The game’s ability to handle complex levels without slowing down will also be considered, focusing on memory usage, CPU performance, and any noticeable delays.

**5.2.4 IQ Mode vs. Practice Mode Performance:**

A comparison of the game’s two modes will be made, focusing on how well the timer and scoring systems worked in IQ Mode versus the more relaxed Practice Mode. This analysis will highlight how accurately the system records and calculates scores based on time, moves, and level completion.

**5.2.5 User Experience Feedback:**

Surveys or test user feedback may be collected and analyzed to evaluate the overall user experience. This will include insights into game enjoyment, ease of use, and challenges related to pathfinding and level complexity. The feedback will be compared with the experimental results to assess how well the game design meets user expectations.

## 5.3 Results

The experimental results will be presented in tables, showcasing the data collected during testing:

Table 5.1 : Results

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Test Case ID** | **Test Scenario** | **Expected Outcome** | **Actual Outcome** | **Pass/Fail** |
| LG-01 | AI level generation speed | Level loads in <2s | Level loads in 1.8s | Pass |
| A\*-01 | Pathfinding accuracy | Optimal path found | Path found correctly | Pass |
| GM-01 | IQ Mode functionality | Timer works correctly | Timer operates well | Pass |

These tables will provide a clear, concise overview of the system's performance during testing, allowing for further analysis and discussion on how to improve or optimize gameplay.

**Summary:**Chapter 5 presents the "Connect the Color Dots" FYP report analyzes experimental results to assess the game’s performance, focusing on elements like the A\* pathfinding algorithm, AI-generated levels, and gameplay functionality. Key metrics, such as level loading times, algorithm accuracy, and response times for game controls, are evaluated to determine efficiency and user experience. The comparison of IQ Mode and Practice Mode reveals differences in scoring, timing, and game intensity, while user feedback sheds light on game enjoyment and challenges. Performance data is organized in detailed tables, including test case IDs, expected and actual outcomes, and pass/fail results, providing a structured overview of the system’s effectiveness and areas for enhancement. Overall, the findings validate the game’s design in achieving cognitive engagement goals, with statistical analysis identifying any areas for improvement.

### ****Chapter 6****

### ****Conclusion and Future Directions****

### ****Chapter 6:****

**6.1 Introduction:**

The project Connect the Color Dots: An IQ Test Puzzle Game, was designed to create an engaging platform that assesses players' cognitive abilities through interactive puzzle-solving. The game challenges users to connect colored dots efficiently using the A\* algorithm, which ensures optimal pathfinding accuracy and enhances the logic required for gameplay. With AI-generated levels, each gameplay session provides unique challenges, keeping the experience fresh and dynamic. Players can choose between two game modes: IQ Mode, where puzzles are timed and scores impact IQ calculation, and Practice Mode, which allows for a more relaxed experience. A personalized login system further enhances engagement by tracking each player’s moves, age, and progression, offering tailored gameplay and insightful metrics. Although some advanced features, like real-time dynamic level adjustments, were postponed due to resource limitations, the game successfully meets its primary objective of providing an enjoyable and mentally stimulating experience for users.

#### 6.2 Conclusion:

In the development of the project, "Connect the Color Dots: An IQ Test Puzzle Game," the focus was on creating a dynamic, interactive, and engaging way to assess users' intelligence through puzzle-solving. The game revolves around the player's ability to connect colored dots, with AI-generated levels providing variability and a unique challenge each time. The A\* algorithm was implemented to ensure that the pathfinding system is both efficient and accurate, enhancing the logic required for completing each puzzle in the shortest time and moves possible.

Through the game’s two modes—IQ Mode and Practice Mode—we were able to give users the ability to test their problem-solving skills in a structured and time-limited environment or practice casually without any pressure. The inclusion of a login system allowed for personalized gameplay experiences, tracking players’ age, moves, and progression, which was then factored into calculating their IQ score. This level of personalization enhanced user engagement and provided a tailored experience based on the player’s inputs and performance.

Despite achieving the primary goals, the project encountered challenges, particularly in ensuring seamless integration of various game components such as the timer, scoring system, health slider, and user tracking. Debugging and optimization were time-consuming, and some advanced features, such as real-time dynamic level generation based on player behavior, had to be excluded due to resource and time constraints. However, overall, the project achieved its primary objective of developing a challenging and scalable puzzle game that tests users’ IQ in an engaging way.

**6.3 Challenges:**

One of the major challenges in this project was ensuring that the AI-generated levels were functional and presented an appropriate level of difficulty without compromising performance. The integration of the A\* algorithm posed certain difficulties, especially when applied to larger, more complex levels, where pathfinding required additional computational resources, resulting in occasional slowdowns. Fine-tuning the balance between gameplay complexity and performance was an ongoing challenge throughout development.

Additionally, the IQ score calculation, which takes into account age, moves, time, and levels completed, required careful design and multiple iterations to ensure accuracy. It was important to maintain fairness in how scores were awarded across different levels and ensure that varying gameplay conditions did not disproportionately impact users of different ages or skill levels. Balancing gameplay in this way, while still providing a sense of progression, proved to be a complex task.

Moreover, user interface (UI) design and user experience (UX) integration required careful attention to ensure the game was intuitive, easy to navigate, and visually appealing. Designing a game that needed to cater to both novice users and experienced players meant the UI needed to be simple yet functional, which required multiple redesigns and user testing.

The game’s scope was largely met; however, some features, like real-time learning where the game would adapt to the player’s performance, had to be excluded. The fixed set of AI-generated levels, although well-designed, do not yet incorporate a dynamic difficulty adjustment that learns from the player's previous behavior.

**6.4 Future Directions:**

While the project has achieved significant milestones, there is considerable room for future improvements and expansions. One of the key areas for future work is the enhancement of the AI level-generation process. Currently, all levels are generated at the start and do not adapt based on the player’s behavior. In future versions, machine learning could be integrated to make the game more adaptive, modifying the difficulty based on the player’s performance in real-time. This would add significant replayability and personalization to the game, making it more engaging for players of varying skill levels.

Improving the A\* pathfinding algorithm is another area for future development. Although it works well for the current game structure, optimizing the algorithm for better performance, particularly in larger, more complex levels, would enhance the overall gameplay experience. Implementing parallel processing or refining the heuristic approach could reduce the computational load, ensuring that the game runs smoothly even when faced with more complex puzzles.

Another potential area for expansion is multiplayer functionality, where users could compete against each other in real-time, attempting to solve puzzles faster than their opponents. This could be integrated with leaderboards to foster a sense of competition and encourage users to return to the game to improve their IQ scores. Additionally, incorporating user achievements and rewards for completing difficult levels or achieving high scores could further increase user retention.

Future versions of the game could also explore the integration of additional assistive features, such as dynamic hints or in-game tutorials that appear when a player struggles with a level. These features would be particularly beneficial for novice players or users looking to improve their problem-solving abilities gradually.

**6.5 Plan for FYP-II:**

For the second phase of the project (FYP-II), the following tasks are planned to further enhance the game:

**6.5.1 Optimization of AI-generated levels:**

Further refinement will focus on making levels more dynamic and adaptive. The integration of real-time adjustments to level difficulty will be explored, potentially using machine learning techniques to provide a more personalized gameplay experience.

**6.5.2 Enhancement of pathfinding algorithm:**

The A\* algorithm will be optimized to handle larger levels with more complex paths. Techniques such as heuristic optimization or parallel processing will be considered to improve performance and ensure smooth gameplay.

**6.5.3 User experience improvements:**

Based on user feedback, enhancements will be made to the user interface and user experience. This may include more intuitive controls, better feedback systems, and visual improvements to make the game more engaging and accessible to a broader audience.

**6.5.4 Testing and debugging:**

Extensive testing will be carried out to identify and resolve any performance bottlenecks, bugs, or inconsistencies in gameplay. Special attention will be given to optimizing the game for various devices, ensuring it runs smoothly across different platforms.

**6.5.5 Final integration and polishing:**

As the project moves towards its final stage, a complete review of all features and mechanics will be conducted. This will involve refining all components to ensure a polished and professional final product. Additional features, such as user achievements, leaderboards, and multiplayer modes, may also be explored.By addressing these areas in FYP-II, the game will be transformed from a functional prototype into a complete, market-ready IQ test puzzle game that can provide users with a challenging, enjoyable, and intellectually stimulating experience.

Expressions on how the same could be put through machine learning as to get insight drivers, players’ inclination, acquisition and mastery rates etc. Substantiate how theseurbanch insights could help create a learning path for an individual application, while making sure that the game advances in parallel with or in accordance to the growth of the player’s cognitive development.

**6.6 Educational and Psychological Impact**

**6.6.1**  **Research Collaborations and Academic Use:**

Explain how the game can be employed in classrooms to investigate how children respond differently and the strategies to use in solving various problems. It could be used by educators and psychologists to check on the cognition progress in children and persons of all ages. Discuss the opportunities of future cooperation with schools as a Research Organisation.

###### 6.6.2 Potential for Clinical Use in Cognitive Rehabilitation:

Consider how it can be modified for clinical use mainly in the field of cognitive rehabilitation for persons with neurological disorders. Explain how making this game the centre of focus for solving problems and make the case on how the employees can apply the concept of cognitive therapy in helping patients redevelop their lost cognitive skills through game play.

**6.7 Commercial and Business Opportunities**

**6.7.1 Monetization Strategies:**

Examine various possibilities of revenue generation including the freemium concept, paid application, or getting money from consumers to unlock the subsequent level. It can be suggested to turn to educational organizations or application stores to sell it and raise awareness.

###### 6.7.2 Marketing and Community Engagement

How would marketing be used to create a community around the game, including relative uses of social media, influencers, and other online puzzle groups? Explain how player response could contribute to the development of the game by interacting with the gaming public, in future.

**Summary:**

Chapter 6 presents the project Connect the Color Dots: An IQ Test Puzzle Game, is designed to assess cognitive skills through engaging, interactive puzzle-solving. Using AI-generated levels and the A\* algorithm, the game challenges players to connect colored dots efficiently, with two modes: IQ Mode for structured, timed gameplay and Practice Mode for a relaxed experience. Personalized features, including a login system that tracks players' age, moves, and progression, create a tailored experience, though some features, such as real-time dynamic levels, were postponed due to resource constraints.

For FYP-II, improvements will include optimizing AI-generated levels to adapt to player skills in real-time, enhancing the A\* algorithm for larger puzzles, refining user experience, and adding potential multiplayer functionality. Educational impacts, including collaborations with schools and potential clinical applications for cognitive rehabilitation, are also envisioned, allowing educators and therapists to monitor cognitive progress across different age groups. Commercial opportunities include monetization strategies such as freemium access or partnerships with educational institutions, while a strong marketing approach would engage an online community. Additionally, integrating machine learning could provide insights into player behaviors, helping the game grow in line with individual cognitive development.

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