Σχεδιασμός και Ανάπτυξη Ψηφιακού Παιχνιδιού Μάθησης

Design and Development of Digital Learning Game

Θεοφίλου Στυλιανός
Αριθμός Μητρώου: 1072791

ΠΙΣΤΟΠΟΙΗΣΗ

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Σχεδιασμός και Ανάπτυξη Ψηφιακού Παιχνιδιού Μάθησης

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Υπολογιστών

Θεοφίλου Στυλιανού

Αριθμός Μητρώου: 1072791

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Ο Επιβλέπων   Ο Διευθυντής του Τομέα

Σιντόρης Χρήστος, Ε.ΔΙ.Π.

ΠΟΛΥΤΕΧΝΙΚΗ ΣΧΟΛΗ
ΤΜΗΜΑ ΗΛΕΚΤΡΟΛΟΓΩΝ ΜΗΧΑΝΙΚΩΝ & ΤΕΧΝΟΛΟΓΙΑΣ ΥΠΟΛΟΓΙΣΤΩΝ

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(Υπογραφή)

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Θεοφίλου Στυλιανός

Σύνοψη

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Λέξεις-κλειδιά: Κβαντική Υπολογιστική, Κβαντική Μηχανική, Παιχνίδι για κινητά, Εφαμρογή για κινητά, Flutter

Abstract

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Keywords: Quantum Computing, Quantum Mechanics, Mobile Game, Mobile App, Flutter

Ευχαριστίες

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Περιεχόμενα

Κατάλογος πινάκων

Κατάλογος σχημάτων

1 1 Introduction

1.1 Motivation

Quantum computers can solve complex problems in a minimum of time using a few quantum bits, at the same time as classical computers would take longer than the timescale of human civilization or require billions of classical bits and very expensive hardware.

The development and widespread use of quantum computing can help in fields such as pharmaceuticals, cryptography, artificial intelligence, materials science and more. Since quantum computing represents a new era for computer science, opening up new prospects for accelerating scientific discoveries, learning the basic principles of quantum computing is extremely important.

1.2 What is Game-Based Learning

https://decodoku.medium.com/why-we-need-to-make-quantum-games-6f8c7bc4ace7 https://elearningindustry.com/7-tips-game-based-learning https://www.gamedesigning.org/learn/game-based-learning/ https://bedrocklearning.org/lite blogs/the-pros-and-cons-of-game-based-learning/

Game-based learning is a very old practice; it did not start with the advance of modern technology. It can be defined as the technique of being educated by playing games. It integrates the characteristics and principles of games such as elements of competition, rewards and active user engagement, into learning activities. Games can be an interactive tool that can simplify challenging concepts and help learners understand complex ideas, engaging them into educational content.

1.3 Benefits of Game Based Learning

https://bedrocklearning.org/literacy-blogs/the-pros-and-cons-of-game-based-learning/ https://www.gamedesigning.or based-learning/

First, game-based learning is more appealing to children, as it appears to be a game on the surface, but in the background it has the ability to stimulate children's curiosity and capture their imagination.

It is a friendlier and more accessible mean of engaging young learners with a subject than traditional methods, as it is fun and motivating.

Game-based learning also has the ability to enhance critical thinking and problem-solving, as they involve human instinct to compete and desire to succeed. Because learners often compete with other players, they have to collaborate and share ideas. They must listen to and evaluate the opinions of other players and take into account the tactics of opposing teams.

Games often require users to react quicker to stimuli, make critical decisions in a short period of time and combine knowledge acquired during the game to solve complex problems. Due to their repetitive and interactive nature, they have the ability to improve retention and increase the brain's capacity to memorize things.

Also, as games are flexible, they can be adapted to different learning styles, levels and paces, meeting individual needs and can also give instant feedback about where gaps in knowledge are or provide specific tasks for the user to help cover these areas. In this way, they can further help learners to identify their strengths and weaknesses.

Comparing games to traditional textbooks, although the latter have been used for many years with success, their revision and renewal takes a long time and is difficult and costly. The cost of reprinting, redistributing and recycling or storing old textbooks must be taken into account. Even in the case of digital textbooks, there is a significant cost of disposal and renewal. By contrast, games are very versatile, their rules can be adapted easily, and their content can be changed quickly to keep pace with technological and scientific progress.

In summary, game-based learning offers a modern, engaging and flexible approach to education. It is a great way to improve learners' critical thinking and problem-solving skills, boost their creativity and keep them engaged and motivated. Also, unlike traditional textbooks, it can be quickly and cost-effectively updated, in order to reflect new information and technological progress.

1.4 Research Objectives

The aim of this thesis is to familiarize the learners with the basic principles of quantum computing, such as quantum bits and quantum gates. They should not be distracted or get tired due to the complexity of the game. The aim is to design a simple and accessible educational game, with few rules and clear objectives.

In order to play this educational game, one does not need to have a university background in mathematics or a strong background in quantum physics. The game can be played by anyone who is interested in learning how quantum gates work and how they affect quantum bits.

In addition, it is desirable that the game could be played at any time and in any place, without the need of equipment or a computer. The aim is that the user can play even when he has limited time (e.g. travelling, waiting for public transportation, etc.), and for the game to be suitable for playing in a class, in the context of a lecture.

For these reasons, a classic digital game, for mobile devices, with simple mechanisms and low complexity should be chosen, whose rules and objectives should be adapted to the topic of quantum computing.

1.5 Thesis Structure

2 Literature Review

2.1 Computer Science Games for Higher Education

https://www.researchgate.net/publication/325046233_Games_for_Teaching_Computing_in_Higher_Education_-_A_Systematic_Review

2.2 Quantum Physics Games

2.2.1 Desktop and Web Games

:memo: **Name**: Name of the game :memo: **Created By**: Name of the creator (university or institution or student or individual) e.g. Student at University of Aalto :memo: **URL**: Where the game is hosted :memo: **Educational**: Was the game designed for educational purposes? True/False :memo: **Competition**: Was the game created for a competition? True/False :memo: **Course**: Was the game created in the scope of a course? True/False :memo: **Platform**: Desktop or Web

List Of Quantum Games

1) Finnish Game Jam

    - Competition for game developers.
    - Desktop games: User must download the source files and build the game.
    - Browser games.
    - Most of the games are available on itch.io:
    - Games created by Finnish Game Jam are not designed for educational purposes.
    - The target of this competition is to create games with limited time and resources but with unlimited creativity [link].

2) QPlayLearn

    - Platform with web-based educational games.
    - Uses interactive tools to make the learning process more effective and entertaining for different target groups [link].

3) Quantum Games Course by Aalto University

- Course offered by Aalto University
- Games are not designed for educational purposes.
- This course is designed to teach students how to design and develop games and also learn the basic concepts of quantum computing.

4) Science At Home

- Aarhus University
- Browser and desktop educational games
- Diverse team of scientists, designers and game developers that create scientific games, aiming at teaching by game-play [link]

5) github / gitlab

- Lots of desktop games. Most of them use Jupyter Notebooks.
- The majority of these games are not designed for educational purposes. They have been developed in the context of competitions or workshops.

6) Decodoku

- Has created a lot of quantum games. The games are hosted on itch.io.
- The games does not have an educational purpose.
- Most of them are designed to run on the IBM Quantum Platform
- Browser and desktop games

Conclusions: - Educational or not? - Quantum Computing or Particle Physics? - Designed by professionals, universities or just for fun? - Desktop or web? - Programming language - Technologies? Consider adding table

2.2.2 Mobile Games

2.2.2.1 Google Play Store (for android devices)

- Quantum
  - Educational app
  - 13 chapters
  - 4 tests - 60 different questions

- QuantumQ
  - Puzzle game with theory

  – Quantum gates and quantum circuits

- Learn Quantum Physics

  – Educational app
  – Designed for students and professionals

- Quantum Computing

  – Educational app

- Quantum 3:

  – Educational game designed by Michigan State University
  – Puzzle game
  – Particle physics

2.2.2.2 App Store (for iOS devices)

- Quantum Mechanics

  – Educational app
  – Particle physics

- Qika Quantum Game: Qika is a quantum game which you need to apply quantum gates to qubits in the grid. You need to change the states of qubits by applying gates in order to reach the target measurement.

  – Puzzle game
  – Applying quantum gates to qubits on order to reach a target measurement !!! Basic concept of our game !!!

- Quantum 3:

  – Same as android game
  – Educational game designed by Michigan State University
  – Puzzle game
  – Particle physics

- Quantum Kate AR:

  – Educational game
  – Casual -> Simulation -> Adventure game
  – Particle physics

Conclusions: - Educational or not? - Quantum Computing or Particle Physics? - Designed by professional, Universities or just for fun? - Android or iOS? - Programming language - Technologies? Consider adding table

2.3 Why a mobile game?

https://www.ncfe.org.uk/all-articles/how-educational-games-are-changing-the-way-we-learn/

https://www.researchgate.net/figure/Core-educational-value-of-mobile-games_fig5_360277617

https://www.linkedin.com/pulse/top-7-reasons-using-mobile-apps-education-e-learning-industry-ved-raj

2.4 Mobile Games Development Technologies

Short description of the technologies.

web based (js) OR android based (?) OR iOS based (consider also developing 3 separate apps for web/android/iOS?) cross-platform game: Use a cross-platform framework like flutter or react-native

2.5 Why Flutter

Why we selected flutter? - cross-platform: Υπήρχαν πιο πολλές εφαρμογές android. Εμείς θέλουμε όλοι οι χρήστες να μπορούν να παίξουν, ανεξάρτητα από τη συσκευή που έχουν. - Άλλα πλεονεκτήματα flutter π.χ. απόδοση/ταχύτητα σε σχέση με τις άλλες επιλογές??? - Επιπλέον της υποστήριξης από android και iOS, η εφαρμογή μπορεί εύκολα να διατεθεί και ως desktop ή web app. - Βιβλιοθήκες για κβαντικούς υπολογισμούς (συμβατές με το Dart version 3) * https://pub.dev/packages/qartvm * https://pub.dev/packages/quantools - Βιβλιοθήκες για πίνακες * https://api.flutter.dev/flutter/vector_math/vector_math-library.html * https://pub.dev/packages/advance_math (supports complex numbers and matrices)

3 Mobile Game Categories, Genres and Subgenres

https://docs.gamerefinery.com/en/collections/112330-game-categories-genres-subgenres https://docs.gamerefinery.com/en/articles/what-are-categories-genres-and-subgenres

Gamerefinery [2278730] has developed a flexible three-layer classification that allows games to be easily grouped under distinctive genres. Each game is classified into a subgenre, according to its features and mechanics. This subgenre belongs to one genre, which in turn belongs to one category. This three-layered approach acts as a helpful taxonomy for market and game research, as it provides game developers a singular unified approach to categorizing games.

Casual

AR/Location Based
AR/Location Based

Arcade
Platformer
Idler
Shoot/Beat 'em Up
Other Arcade
Tower Defense
Board Games

Lifestyle
Customization
Interactive story
Music/Band

Puzzle
Action Puzzle
Match3 Puzzle
Other Puzzle
Word Games
Trivia Games
Coloring Games
Hidden Objects
Solitaire / Mahjong

Simulation
Adventures
Breeding
Tycoon/Crafting
Sandbox
Time Management

Hyper Casual
HC – Puzzle
HC – Tap
HC – Steer
HC – Swipe/Drag
HC - .io
HC - Other

Casino

Casino
Bingo
Poker/Cards
Slots

Mid-core

Shooter
Battle Royale
Classic FPS / TPS
Snipers
Tactical Shooter

Card Games
Card Battler

RPG
Action RPG
Turn-based RPG
Fighting
MMORPG
Puzzle RPG
Idle RPG
Survival

Strategy
4X Strategy
Build & Battle
MOBA
Tactical Battler

Sports & Driving

Sports
Arcade Sports
Realistic Sports

Driving
Arcade Driving
Realistic Driving

Εικόνα 3.1. Game Categories, Genres and Subgenres according to GameRefinery

4 Βιβλιογραφία