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Dungeon Code: Educational Game For Algorithm and Data Structure Courses by Applying The Game Development Life Cycle Method

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Abstract. Algorithm and Data Structure is a basic course in Informatics Study Program, at Khairun University. This subject needs to be mastered because it becomes the foundation that can support the learning process in the future. However, from the results of a survey conducted, as many as 40% of students felt bored with the teaching methods used by Algorithm and Data Structure lecturers in class. In addition, there were also 73.33% of students that even though they paid attention to the material presented in class, they still found it difficult to understand the material. To overcome this problem, new learning media is needed in the classroom, such as games. This study aims to design educational games that teach algorithms and data structures using the Game Development Life Cycle (GDLC) method. The GDLC is a game development method that is widely used to create educational games. The GDLC method has several development stages, namely initiation, pre-production, production, testing, beta, and release. Alpha test results show that all functionality is appropriate. While the results of beta testing show the number 3.43 of the total respondents' answers to the questionnaire related to game evaluation so they are included in the very good criteria.

Keywords: Educational Game, GDLC, Algorithm, Data Structure.

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1 Introduction

Programming is part of the basic curriculum in Informatics. The ability to understand and implement programming languages is important for students to master. The Informatics Study Program at Khairun University has an Algorithm and Data Structure course that teaches algorithms and algorithm representation in programming, namely the understanding of algorithms, the form of presenting algorithms both in the form of pseudocode and flowcharts, and their use. In this Algorithm and Data Structure course, students are required to think systematically in solving a problem such as problems in computing that students must develop in the course. This course is important to master as a basis or basis so that it can support the learning process for courses in the following semester. In addition, he is also required to be taught by students as a condition to be able to take conditional courses in the following semester.

However, students showed complaints and difficulties in learning Algorithms and Data Structures courses. Based on the results of a survey conducted using a questionnaire to Informatics study program students at Khairun University with a total of 30 respondents, as many as 40% of students felt bored with the teaching methods used by Algorithm and Data Structure lecturers in class. In addition, there were 73.33% of students, even though they paid attention to the material presented in class, still found it difficult to understand the material.

Apart from that, teachers must also be more creative in conveying material by way of examples or associating lecture material with everyday life which is easy to understand for students who are new to algorithms, and what students can fully rely on is their imagination in capturing the examples presented by the teacher. As a result, students fail to discover programming potential and lose interest in further learning [1]. Therefore, we need learning media or tools that can support the learning process to overcome these problems.

Currently, the game began to be used as one of the learning media or teaching and learning process aids. Of the many existing game genres, one that is suitable to be used as a learning medium is educational games. Educational games are an educational medium that is widely used to convey material, with interesting visual aspects, material that can be complex, in a fun way, so that people can easily find out the information they want to convey [2].

According to [3], the use of games in teaching can help increase student participation, encourage social and emotional learning, and motivate students to take risks. With participation, students can become more active in learning which is expected to eliminate feelings of boredom and drowsiness. In addition, the process that can be carried out with the concept of learning while playing can be an advantage for use as an interactive learning medium. Based on [4], a popular multiple-choice quiz game called Kahoot has been shown to develop students' attitudes toward learning and increase their academic scores. Other

benefits of using games as learning media have also been proven in several other studies [5-7]. The results of these studies show an increase in understanding, learning outcomes, learning motivation, and continuity to play the game increase learning potential.

The design of a game requires a rule or flow that is used to explain the design stages. Games are not purely system design and are also not purely about art, creativity, and imagination, but rather a combination of these elements [8]. Therefore, game design requires specific guidelines that are more specific than designing a system called the Software Development Life Cycle (SDLC). Game design has also undergone several changes because game design is not entirely system design, creativity, or imagination, but rather a combination of these things [9]. Therefore, the term Game Development Life Cycle (GDLC) appeared. GDLC is a game development process that applies an iterative approach in which there are 6 stages of development, starting from the initiation, pre-production, production, testing, beta, and release stages [10].

Based on this background, to achieve optimal learning objectives, it is necessary to design a game with an educational concept. Based on the survey results, 100% of respondents out of 30 agreed to use games as learning media in Algorithm and Data Structure courses in class. Therefore, by designing an educational game, it is hoped that it can become a learning support tool for lecturers and also make it easier for students to understand the material presented.

2 Literature Review

2.1 Educational Game

A game uses electronic media, which functions as entertainment in the form of multimedia, which is made as attractive as possible so that players can get something with inner satisfaction [11]. Games also have their charm because they can have a certain influence, depending on the players [10].

According to [2], educational games are an educational medium that is widely used to convey material, with interesting visual aspects, material that can be complex, in a fun way, so that people can easily find out the information they want to convey. Educational games are very useful for reducing and eliminating student boredom when participating in the learning process because the characteristics of games are fun, motivating, and entertaining.

2.2 Game Design Document

According to [12], a game design document (GDD) is a document that contains detailed information about the game to be developed. This document was created to facilitate collaboration between game developer members, starting from game designers, game artists, sound engineers, game testers, and software engineers.

3 Research Method

The Game Development Life Cycle is a game development approach derived from the Software Development Life Cycle (SDLC) [13]. Starting from the stage of developing ideas and concepts about the game to be made, to the final stage, namely the game being released [14]. Game Development Life Cycle (GDLC) is a game development process that applies an iterative approach consisting of 6 phases, namely Initiation, Pre-Production, Production, Testing, Beta, and Release [14]. The stages of the GDLC method can be seen in more detail in Figure 1.

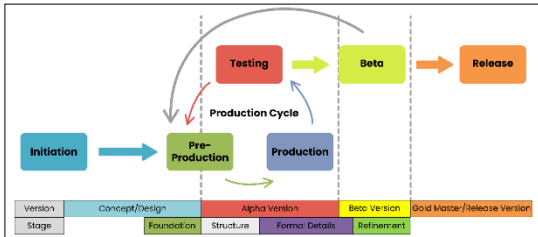


Fig. 1. GDLC Method

3.1 Initiation

The first step that must be taken in making a game is to make a rough concept of what the game will be made of. The output of this step is the game concept and a simple description of the game.

3.2 Pre-Production

This stage is one of the initial stages in the production cycle. The pre-production stage involves the creation and revision of game designs and the creation of game prototypes. The game design focuses on determining the genre, gameplay, mechanics, storyline, characters, challenges, fun factors, technical aspects, and the elements documented in the game design document (GDD). Once the GDD is created, a prototype is created to assess the game design and the overall idea.

3.3 Production

Production is the core process that revolves around creating assets, creating source code, and integrating these two elements. Formal details are enhanced structures with complete mechanics and assets. Production activities related to creating and refining formal details are balancing, adding new features, improving performance, and fixing bugs (related to functional and completion of internal quality criteria). Refinement is a complete prototype that is the subject of game polishing. The quality criteria at this stage regarding play should be fun and accessible.

3.4 Testing

Testing in this context means internal tests conducted to test operational functionality and gaming capabilities. The method for testing functional quality

criteria is through the playtesting feature. When testers encounter a gap, bug, error, or deadlock during playtesting, the causes and scenarios for making the error need to be documented and analyzed.

During testing, the fun aspect of the game is tested through playtests and direct feedback from fellow developers, whether it feels boring, frustrating, challenging, etc. The outputs from testing are bug reports, change requests, and development decisions. The results will determine whether it's time to advance to the next phase (beta) or repeat the production cycle.

3.5 Beta

Beta is the phase for testing by third parties or external parties which is called beta testing or beta testing. There are two types of tester selection methods: closed beta and open beta. Closed Beta only allows people who are invited to become testing participants, while open beta allows anyone who registers to become a testing participant.

The output of beta testing is bug reports and user feedback. From this stage, it can lead back into the production cycle again to refine the product or move on to releasing the game if the results are satisfactory.

3.6 Release

This is the phase where game development has reached its final stage and is ready to be released to the public. Release involves product launch, project documentation, knowledge sharing, post-mortem, and planning for game maintenance and expansion.

4 Result and Discussion

4.1 Initiation

Game Dungeon Code is a strategy and puzzle game that aims to introduce programming concepts using interesting coding exercises to provide basic materials such as Algorithms and Data Structures. Pre-Production

The following elements are the elements in the game design document (GDD):

4.1.1 Game Title

The title of the game to be made is "Dungeon Code".

4.1.2 Project Overview

This game is an educational game where players can train their understanding of algorithms as well as provide an initial introduction to programming using problem-solving strategies (pseudocode). Players strategize by designing an algorithm to complete the level using the available command blocks.

4.1.3 Genres

The game genres that will be made are education and puzzles.

4.1.4 Goals

Broadly speaking, the goal in this goal is to help the knight to escape the dungeon. Specifically, the goals that need to be completed are compiling algorithm instructions, completing level objectives, and advancing to the next level.

4.1.5 Control

The player needs to arrange the available command blocks into an instruction for the player to execute. Players can move the command blocks by drag-and-drop using the mouse.

4.1.6 Losing

In this game, there are no defeat conditions. Players will advance to the next level when they have completed the level. But if not, then the player will not advance to the next level.

4.1.7 Music and Sounds

The music in this game is casual, calm, and relaxing when the game is running. For every action taken, there will be direct feedback in the form of a sound effect (SFX).

4.1.8 Competition Modes

This game is played single-player or played individually and is not online.

4.1.9 Progression Challenge

As the level is completed by the player, the next levels will open with a higher level of difficulty and more programming commands.

4.1.10 Target Audience

The target of this game application is students who are teaching Algorithms and Data Structure courses in the Informatics study program at the Faculty of Engineering, Khairun University.

4.1.11 Storyboards

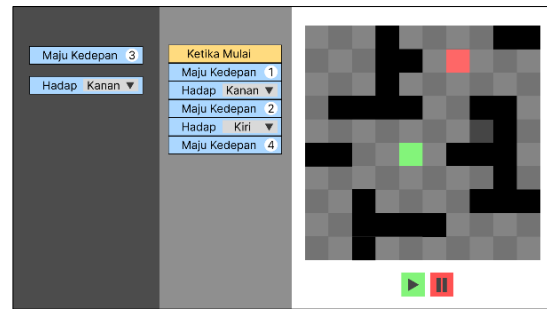


Fig. 2. In-Game Design

This is the design of the in-game page. Blocks of command are available on the left of the screen, along with an area to organize them. The player must arrange the block codes to form an instruction to fulfill a mission at that level.

4.1.12 Screen Flowchart

A screen flowchart is a direction or diagram of the movement of scenes or pages that occur in the game. More details can be seen in Figure 3.

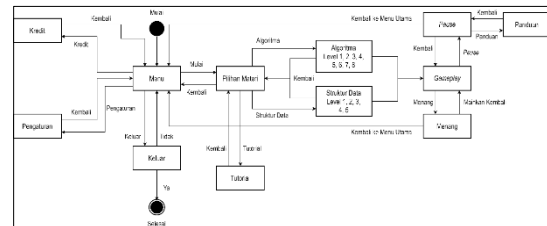


Fig. 3. Screen Flowchart

4.2 Production

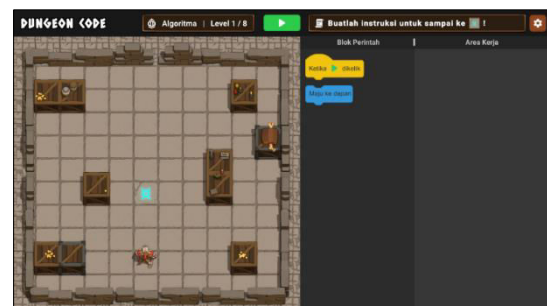


Fig. 4. Algorithm Level 1

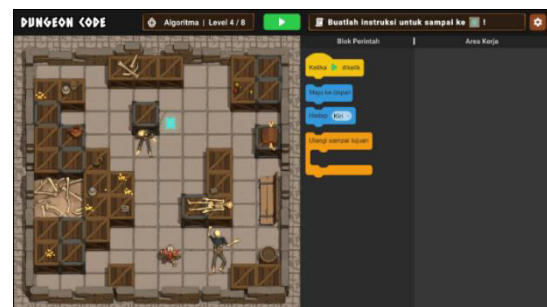


Fig. 5. Algorithm Level 4

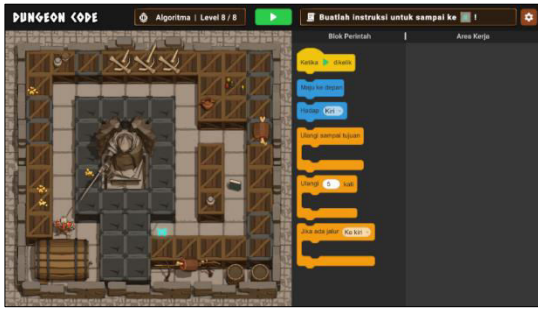


Fig. 6. Algorithm Level 8

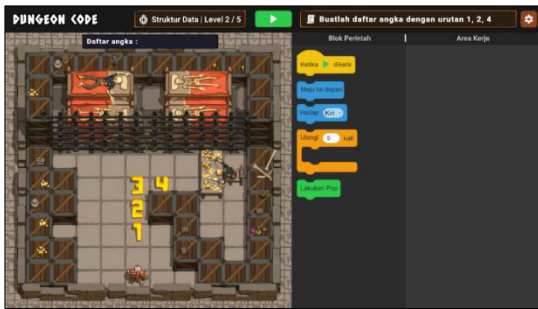


Fig. 7. Data Structure Level 2

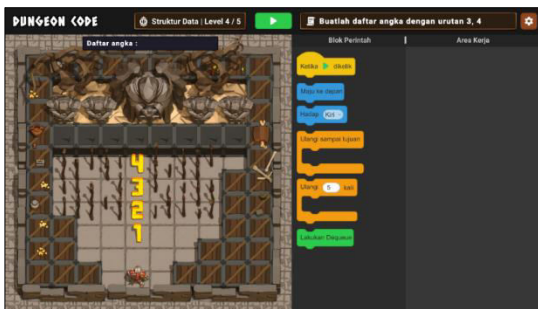


Fig. 8. Data Structure Level 4

4.3 Testing

Table 1. Black Box Testing Result

No	Test Scenario	Expected Results	Test Result
Menu Page			
1	Pressing the start button	Enter the material level selection page	Success
2	Pressing the setting button	Display the setting page	Success
3	Pressing the credit button	Display the credit page	Success
4	Pressing the exit button	Display the exit window	Success
In-Game			
5	Pressing the settings button	Display settings window	Success
6	Pressing the play button	Run the game	Success
7	Pressing the stop button	Stop the game	Success
8	The player character arrives at the destination	Display the win window	Success

9	The player character hit the numbers	The number is added to the list of numbers	Success
10	The player character hit the wooden boxes	Character dies	Success
11	The player character hit the fence	Character dies	Success
12	Pressing the ok button	Close the guide window	Success

4.4 Beta

The beta testing method is carried out using the closed beta with a total of 30 students from the class of 2022.

Table 2. List of Questions

No	Questions
1.	This game helps me to understand programming concepts
2.	This game helps me to learn problem-solving skills
3.	This game helps me to understand the algorithm
4.	This game helps me to understand the data structure
5.	I feel the level of difficulty in this game is appropriate (the level of difficulty according to the level)
6.	I don't feel bored when playing this game to learn
7.	I don't feel sleepy when I play this game to study
8.	I can more easily understand Algorithms and Data Structures material when playing this game to learn
9.	I prefer using games to study over traditional methods in class
10.	I would like to have the opportunity to learn using a game-based learning approach in the future.

Table 3. The Questionnaire Result

No	Questions (Q)	Respondent's Answer				Average
		Strongly Agree	Agree	Disagree	Strongly Disagree	
1.	Q1	14	16	0	0	3,47
2.	Q2	15	15	0	0	3,5
3.	Q3	16	14	0	0	3,53
4.	Q4	14	14	2	0	3,4

5.	Q5	18	10	2	0	3,53
6.	Q6	14	15	0	1	3,4
7.	Q7	14	16	0	0	3,47
8.	Q8	11	19	0	0	3,37
9.	Q9	6	19	5	0	3,03
10.	Q10	18	12	0	0	3,6

The results of the questionnaire above show that the Dungeon Code game has succeeded in educating users about Algorithm and Data Structure material to users as evidenced by a value of 3.53 in algorithm material and a score of 3.4 in data structure material. Both values are included in the very good criteria. The results of the questionnaire also showed that Game Dungeon Code also succeeded in teaching programming concepts and problem-solving well. In addition, the results of the questionnaire also prove that the Dungeon Code game has a difficulty level that is appropriate for the level indicated by the score of 3.53.

The results of the questionnaire also show that by playing the Dungeon Code game for learning, users don't feel sleepy and bored and it's easy to understand Algorithm and Data Structure material. Some respondents indicated that they prefer to use games in learning rather than traditional methods in class with a score of 75.75% which is in the criteria of strongly agree. In addition, users also show interest in using the Dungeon Code game to be used in the learning process in future classes. Therefore, based on the processed questionnaire data, an overall average score is 3.43 that which is included in the very good criteria.

4.5 Release

Finally, the game is released on the Itch platform as it is figured in Figure 17.



Fig. 9. Dungeon Code on Itch Platform

5 Conclusions

This study succeeded in applying the concept of the GDLC method used in the game development process.

Game Dungeon Code was successfully created with training simulation content on Algorithms and Data Structures material with material containing while loops, for loops, if conditions, stacks, and queues with a total of 13 levels.

Game Dungeon Code succeeded in educating users about Algorithm and Data Structure material to users as evidenced by a value of 3.53 in algorithm material and a value of 3.4 in data structure material from questionnaire results. So that both values are included in the very good criteria.

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