Designing a Game to Introduce and Educate Computational Thinking

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Abstract— To prepare for the industrial era 4.0, the education system in Indonesia needs to change, from only providing learning materials to learning that involves students' ability to think creatively. One way to change this learning system is to implement other learning techniques that hone one's ability to be able to think creatively in solving a problem. One of these learning techniques is Computational Thinking or commonly abbreviated as CT. In Indonesia, Computational Thinking techniques have not been widely used in the teaching and learning process, therefore this research is intended to introduce Computational Thinking learning techniques through game media.

"Take Me Home" is the name of the game developed to support this research, "Take Me Home" is a serious game created to hone and introduce players to Computational Thinking learning techniques, the game "Take Me Home" is made attractive as possible so that players want to play it continuously by using a procedurally generated map players will always get a different form of game level every time they play the game "Take Me Home", having an Endless level also makes players feel challenged to keep playing.

With "Take Me Home" it is hoped that players will learn how to solve problems using creative thinking and also get to know Computational Thinking techniques by designing games that are easy, interesting and educational researchers can also see whether the game "Take Me Home" will continue to be useful and players want to play "Take Me Home" in the future.

Keywords: *Computational thinking*, *Serious game*, *Creative*.

I. INTRODUCTION

Technological developments in Indonesia are currently very developed at this time, based on ICT (Information and Communication Technology) Indicators in Indonesia in 2021 the most rapid development of ICT can be seen, namely, the use of the Internet has reached 82.07% in households[1]. From this development, positive and negative effects emerged, and of course, this influence has more impact on children and adolescents [2], one of the effects that are feared is the loss of children's learning motivation and decreased child achievement due to dependence on the internet. This concern is also supported by data from PISA (Program for International Student Assessment) where Indonesia's education ranking is in the 74th position or the lowest 6th rank, the country of Indonesia is ranked 74th in reading ability, 73rd in mathematics ability, and ranks 74th in 71 in science ability[3].

With the development of technology, the industrial era 4.0 emerged where we were forced to change and require computerization in all fields, the OECD also stated that a person needs the ability to create new values through creative thinking processes [4].

With this influence on the teaching and learning process a new learning method

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is needed, one of the learning methods is computational thinking or often referred to as Computational Thinking. This method is a problem-solving technique that has a computer science basis, by applying this computer-like thinking method students are directed to have the skills to perform decomposition, pattern recognition, abstraction, and computer-like algorithms [5]. Computational thinking is really needed in solving everyday problems, ranging from small problems to more complex problems, but in Indonesia itself, computational thinking learning methods are still underdeveloped in schools, people more often connect computational thinking with programming that is whereas computational thinking has the goal of forming a mindset in solving a problem like a program on a computer.

In Indonesia, digital games or video games are in great demand by the public, with an average of 8.54 hours per week Indonesians spend time playing video games. This figure is higher than the global average which has 8.45 hours per week, this gives learning potential using video games [6].

With the high number of game enthusiasts in Indonesia and the positive effects of playing video games, researchers will design a video game about recognizing and honing one's computational thinking skills.

II. LITERATURE REVIEW

2.1 Computational Thinking

Computational Thinking is a method or process of someone's mindset that utilizes the basic concepts of computer systems to solve a problem. By using this mindset, it is hoped that someone can identify a problem, formulate it, manage existing data, represent it again, make a solution, and generalize so that the problem-solving process can be used for various other problems [7].

2.2 Game

A game is a toy object that has rules, challenges, and goals. Games can be divided into 2, namely physical and digital, physical games can be in the form of sports games, board games, and card games, and digital games or known as video games are computer software made using a special game engine using certain rules [8], From being interactive, nonlinear, and purposeful, games cannot be equated with puzzles, toys, or stories/fairy tales. Games are part of art, but games are also different from other works of art that have a passive audience, a game requires an audience that is active and able to participate [9].

2.3 Serious Game

A serious game is a non-computer or computer game that is intended to develop one's abilities [10].

2.4 Game Design

Game design is a design of a game which contains important components in the game both in form and what rules are stated in the game [11].

2.5 Game Designer

A role in the game-making process that has responsibility for making decisions about the rules of a game, pacing, timing, risk-taking, and all the things that will be experienced by the player is called a game designer [12].

2.6 Unity Engine

Unity Game Engine or often called Unity is a multi-platform game engine developed by Unity Technologies in 2005. This game engine can develop augmented reality, virtual reality, two-dimensional and three-dimensional games[13].

III. RESEARCH METHODOLOGY

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3.1 Source of Data

1. Primary Data Source

Primary data sources are taken from questionnaires of at least 50 (fifty) respondents, data collection will be carried out online so the location cannot be specified. To be more specific, it is carried out for individuals aged 15-26 years.

2. Secondary Data Source

Secondary data sources are taken and obtained from journals or references from the internet, also from physical and non-physical books with topics related to game design and research topics.

3.2 Data Collecting

1. Initial Research Questionnaire

This technique is carried out by creating a questionnaire on Google form and distributing it to certain people who are considered qualified to become resource persons. The questionnaire will be distributed via social media so that it can be reached by Indonesian people who have a link to access the form. The survey will use an assessment using the Likert technique with a scale of 1 (one) to 5 (five). A scale of 1 is given to strongly disagree statements and a scale of 5 is given to strongly agree with statements

3.3 Testing

1. Game Testing

To get valid data, it is necessary to test this game. The method used to test the game is to distribute questionnaires and game download links to test the game. Games that have been built are distributed by uploading them on itch.io and Google Drive and then the download link is distributed to the testers.

2. Questionnaire Testing

The questionnaire testing method that will be applied is to test the validity, reliability test and correlation test to get valid results and have been filled in by the respondents.
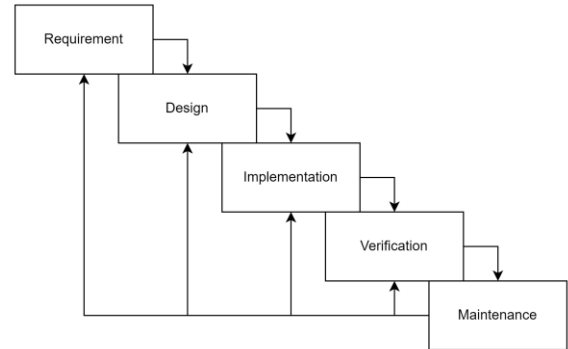
3.4 METHODOLOGY

Figure 3.1 Waterfall Methodology

The method to be used is the waterfall method. This method has stages and is systematic. Each stage must be completed first in order to proceed to the next stage. These stages are in the form of Requirement, Design, Implementation, Verification, and lastly Maintenance.

IV. RESULTS AND DISCUSSION
4.1 CT Implementation

In the game "Take Me Home" the aim is to introduce and hone thinking skills using Computational Thinking techniques. In making the game concept, the developer will take the basic components of CT. These components include Decomposition, Pattern Recognition, Abstraction, Algorithm Design, and Evaluation.

4.1.1 Scenario

Figure 4.1 CT Implementation Scenario

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- Decomposition

    In Figure 4.1 Players will make observations to get information about what is in the game area. This information is in the form of player character position, objective position, obstacle position, number of obstacles, food item position, number of food items, and remaining food points.

- Pattern Recognition

    From Figure 4.1 players must know and be able to separate each type of obstacle sprite, spite food, character sprite, and objective sprite.

- Abstraction

    At the abstraction stage, players must look at the problems from the scenario in Figure 4.1 and process them to be simpler. The problems in the scenario of Figure 4.1 can be processed into,

    - Guide the player's character to the objective.
    - The remaining food points are only 25 points.
    - 1 step costs 5 food points.
    - Destroying the barrier also costs 5 food points.
    - Food items give 25 food points.
    - Look for the path that has the lowest price.
    - Have a surplus of food to proceed to the next level.

- Algorithm Design

    After the players make observations and know the problems they have, the players must determine how to solve the scenario in Figure 4.1, here's one example of paths that players will see,

Figure 4.2 Correct Path

Figure 4.2 is an example of paths that the player might see, from the example above the player must find the path that eats the least food points and will have leftover food when completing the scenario.

on this path the player will take 7 steps which cost a total of 30 food points, players can complete the puzzle by only taking 5 steps and taking 1 food item, but here players take 2 food items this is because players think about the remaining food points when the player takes 5 steps and takes only 1 food item, the remaining food points, the player only has 25 points left, but if the player takes the second food item, the player will have 45 food points left

Players also need to write down the paths that must be made using the command so that the player's character can move towards the objective.

- Evaluation

    When the player has finished writing the Command the player will see the player character moving according to the Command that has been given, if the player makes a mistake when writing the Command the player will see the player character is not where the player has predicted, therefore the player must re-observe and see the alternative

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path to completing the scenario with the remaining food points.

4.2 Game Design

"Take Me Home" is a 2D game that has a Top-Down View perspective, and has an Endless Game, Typing Game, and Procedural Generated types. By using the command prompt the player needs to guide his character so he can get out of the stage.

4.3 Game Development Implementation

1. Tutorial Implementation

At the start of the game the player will be shown how to play the game "Take Me Home", the display of this guide is in the form of a slide show tutorial popup that will appear when the player presses the Help button or types "Help" at the command prompt.
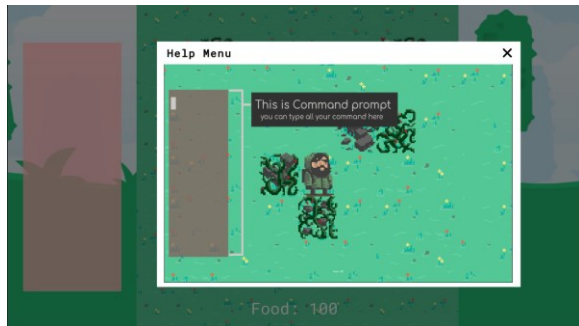
Figure 4.6 Tutorial Pop Up

2. Gameplay

Figure 4.7 Gameplay Area

Figure 4.7 is a display of the gameplay of the game "Take Me Home",

with on the middle side is the game area, then the left side where players can enter input commands, and on the right side is a list of available commands

2. Technical Side

In Figure 4.9 it can be seen that the input player will be processed first before the system determines what commands will be executed.

By converting the input to a string and taking the initial letter from the variable, we will match this first letter to the provided enum, in this case, there is an enum that holds the variables "R", "L", "U", and "D", these variables is the first letter of the words Right, Left, Up, and Down directors, if player input is not found in the enum then the command will be ignored. After the type of command is found the algorithm will look for whether the player adds input numbers to the command, when the player adds input numbers then the number written by the player will be the number of steps the player character moves, but if the player does not input numbers, then the player character will only run once.
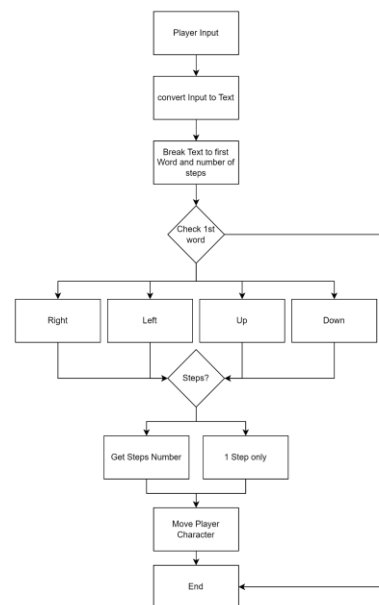
Figure 4.9 Command System Flow

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4.4 Respondent's Profile

1. Respondent's Gender

From Figure 4.10 it can be seen that the majority of respondents were male, with a total of 41 out of 54 respondents, while as many as 13 respondents were female.
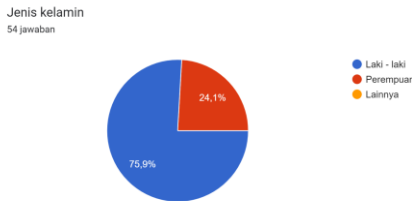

Figure 4.10

2. Respondent's Current Educational Status

From Figure 4.11 the majority of respondents have student status with a lot of 32 out of 54 respondents, 13 out of a total of 54 respondents have undergraduate status, then 5 respondents have educational status still pursuing high school, and finally, 4 respondents have educational status outside of their choice which has been specified.
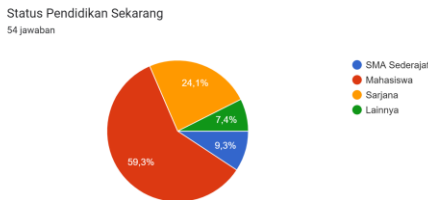

Figure 4.11

4.5 Reliability Test

In Table 4.1 it can be concluded that the PE, EE and HM variables have Acceptable internal consistency, BI variable has Good internal consistency.

Table 4.1 Reliability Test Result

Variable	Cronbach's Alpha	Internal Consistency
PE	0.726	Acceptable
EE	0.716	Acceptable
HM	0.745	Acceptable
BI	0.884	Good

4.6 Correlations Test

Table 4.2 are the results of the correlation test. Correlated data is marked with a significant value (2-tailed) which has a value less than 0.05, so it can be concluded that:

a. Variables PE and BI variables have a good correlation with a correlation value above 0.4 and marked.
b. Variables EE and BI have a good correlation with a correlation value above 0.4 and marked.
c. Variables HM and BI have a good correlation with a correlation value above 0.4 and marked.

Correlations

		RPE	REE	RHM	RBI
RPE	Pearson Correlation	1	.498**	.499**	.464**
	Sig. (2-tailed)		.000	.000	.000
	N	54	54	54	54
REE	Pearson Correlation	.498**	1	.542**	.422**
	Sig. (2-tailed)	.000		.000	.001
	N	54	54	54	54
RHM	Pearson Correlation	.499**	.542**	1	.768**
	Sig. (2-tailed)	.000	.000		.000
	N	54	54	54	54
RBI	Pearson Correlation	.464**	.422**	.768**	1
	Sig. (2-tailed)	.000	.001	.000	
	N	54	54	54	54

**. Correlation is significant at the 0.01 level (2-tailed).

Table 4.2 Correlations Test Result

V. CONCLUSIONS

The application of Computational Thinking to the game "Take Me Home" is found in the gameplay itself, by utilizing a procedurally generated map, each level of the game will always be different from the previous one. different players will see a pattern and can determine the function of each asset, and when players are familiar with the puzzle situation players can use a simple command system to complete puzzles at that level, this command system is made limited, this is intended to require players to think creatively in finding the most efficient way to solve the puzzle, players can also stack orders where players can make their way before executing.

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By utilizing the procedurally generated map the game "Take Me Home" has almost unlimited levels, this makes every time a player plays the game "Take Me Home" the player will find a different map shape from the previous form, Using a gameplay design that contains important components in Computational Thinking learning techniques such as observing problems, pattern recognition, abstracting, and making paths to complete puzzles players can learn and hone their Computational Thinking skills while playing.

The game "Take Me Home" is easy to understand, interesting and also useful to play as evidenced by the correlation test between the variables PE (Performance Expectancy), EE (Effort Expectancy), and HM (Hedonic Motivation) on the BI variable (Behavioral Intention) with each value, PE with BI has a value of 0.464, EE with BI has a value of 0.422 and HM and BI variables with a value of 0.768.

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