Developing Educational Game Application for Chemistry Periodic Table

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Abstract— Chemistry is one of the elective subjects and cross-interest subjects taught at the high school level or equivalent secondary education. The periodic table is a chart that contains the names and types of chemical elements grouped according to their similarities and properties. In current learning, more than 75% of high school students still face difficulties in naming elements in the periodic table, especially in understanding the periodic system and the regularities of the chemical properties of these elements. Conventional teaching methods often bore students, and there is a need for engaging learning media to enhance the learning outcomes. With the increasing use of Android gadgets, where students use Android devices for classes, learning through games on Android can be effective. This game is designed using Unity in 2D format and is built for the Android platform, specifically for chemistry education in grade X of high school. The chosen game design method for this application is the waterfall method. The result of this research is the game "Chem Ball" for educating Group A periodic table elements for high school grade X students. The game was tested with five high school students, and the results indicate that students are assisted in learning the periodic table of chemistry (memorizing, understanding, and recalling the sequence of elements in the periodic table) through the attractive and interactive interface of the "Chem Ball" game. "Chem Ball" is also proven to be easy and practical for high school students to play. After playing the game, students feel that learning the periodic table of chemistry has become easier.

Keywords— android, education, game, periodic table, unity

I. INTRODUCTION

Chemistry is a beneficial subject for human life, contributing to various aspects such as food, clothing, shelter, medicine, cosmetics, and many more. One essential topic in the chemistry curriculum that students need to master is the periodic table of elements. When studying the periodic table, students encounter chemical element symbols that are not easy to memorize. According to Nancy, 75% of high school students face difficulties in naming elements in the periodic table [1]. In the digital era, many students enjoy playing games on their Android phones. The author seeks to offer a solution to the challenge of learning the periodic table of elements by introducing an educational game application for the periodic table on Android devices. Technology has rapidly advanced in various fields, and education needs to leverage technology to facilitate learning and capture students' interest. Currently, electronic devices such as Android phones are widely used to support distance learning. Android-based educational game applications can serve as a tool for teachers to maximize effective learning activities at home. By employing Game-Based Learning, the author has created a game with a unique gameplay experience. In the Chem Ball game, players must drag the elemental balls into slots with matching descriptions and names

The purpose of this research is first to design a game application that facilitates high school students in memorizing the periodic table of group A elements

sequentially. Creating a game application that can capture the attention of high school students and also effectively provide educational knowledge

II. METHOD

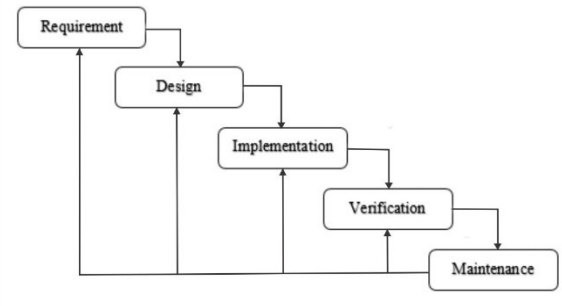

Figure 1.Waterfall method

Using the waterfall method in game development makes the workflow more structured and systematic. Based on this method, the following stages are used in this research:

First the requirement stage is where the discovery of many 10th-grade high school students facing difficulties in learning the periodic table of chemistry is found. Therefore, a more engaging learning media is needed for the students. Second the design stage, the author uses digitalization techniques in chemistry learning, employing a video game-based Android application to teach and assist in learning the periodic table of group A elements. Third is implementation In the implementation stage, the author utilizes the Game-Based Learning method and brings it to life using the Unity Engine with Android devices as the underlying platform. The level and challenge designs are similar, but each level focuses on different groups of elements. Fourth the verification validation is necessary to test whether the completed game is proven to be helpful using the author's chosen method. In this stage, the author and game developer also gather feedback from users to further enhance the game. Last is the maintenance stage involves fixing any discovered errors in the system and further developing the game based on user feedback."

III. RESULTS AND DISCUSSION

A. RESULT

The game "ChemBall" is an educational game designed to assist in memorizing the periodic table of chemical elements. It is crafted for players seeking an easier way to remember the modern chemical periodic table. "ChemBall" is a 2D puzzle and quiz genre game developed for Android devices. It is a single-player game with a primary focus on memorizing the periodic table.

The game features two modes: puzzle and quiz. The puzzle mode consists of 8 stages, while the quiz mode includes 10 randomly generated questions. "ChemBall" is categorized as a 2D casual, puzzle, and quiz game. It has been tailored for Android devices, allowing players to enjoy it anytime and anywhere. The target audience for this game is high school students from grade X and above who have covered the topic of the periodic table in their chemistry curriculum.

The game flow in this game involves players placing the periodic balls into slots with names matching those on the balls. Each time a row of the periodic table is completed, the game advances to the next stage, up to stage 8.

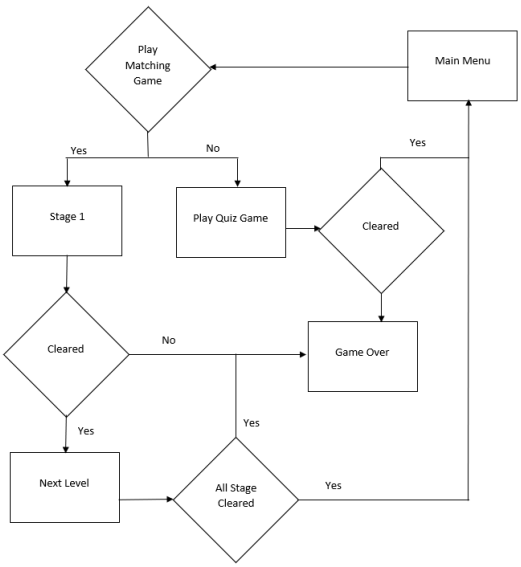

Figure 1.Flow Chart Gameplay

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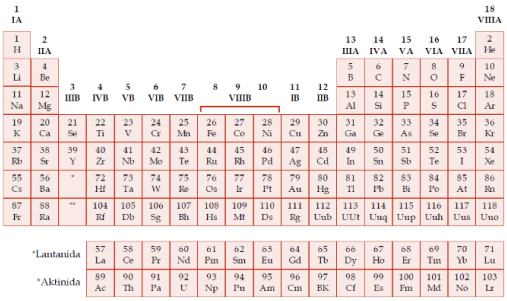

Figure 2.Flow Chart Gameplay

Figure 3.Puzzle Game ChemBall Stage 1

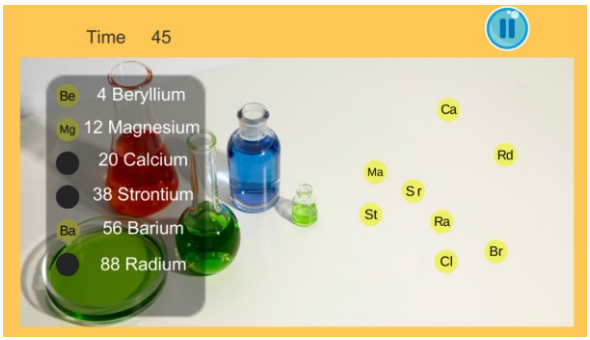

Figure 4.Puzzle Game ChemBall Stage 2

Figures 4.2 and 4.3 depict the puzzle gameplay interface. To play, the player must drag the element ball and place it into an empty slot. If the element ball is placed correctly, it will stay in its slot; however, if it is placed in the wrong slot, the element ball will return to its initial position. Stages 3 to 8 feature a similar interface with different chemical element balls.

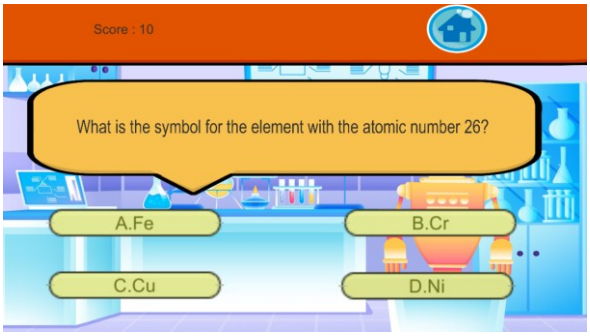

Figure 5.Quiz Game ChemBall

In Figure 4.8, a quiz game is presented with four options: a, b, c, and d. If the player selects the correct answer, the button changes color.

B. DISCUSSION

Students are confronted with chemical element symbols that are not easily memorized. According to Nancy, 75% of high school students experience difficulties in naming elements in the periodic table[1].

The periodic table of elements is a subject in chemistry. One of the goals of the chemistry subject is for students to have the ability to understand the concepts, principles, laws, theories of chemistry, as well as their interrelationships and applications to solve problems in daily life and technology [2].

The periodic table of elements displays chemical elements in a table based on their electron structure, so the chemical properties of the elements change regularly along the table. Each element is listed with its atomic number and symbol [3].

The periodic table of elements is a table that contains chemical elements, where the elements are arranged according to their atomic number (the number of protons in the atomic nucleus) and periodic configuration [4].

In the mid-20th century, Moseley's periodic table was still recognized as the modern periodic table until in 1940, Glenn Seaborg successfully discovered new elements, namely the transuranium elements with atomic numbers 94-102 [5].

Learning is a process of change in human personality that can be observed in the form of improved qualities and quantities of behavior, such as increased knowledge, characteristics, habits, understanding, abilities, skills, thinking, and other capabilities[6].

Learning difficulties are one of the external factors that lead students to underperform in their studies. These difficulties can be caused by various factors, one of which is students' lack of clear understanding of the function and purpose of the learning material. Another factor is the lack of motivation among students, making them less enthusiastic about delving into the subjects taught at school, which makes learning challenging [7].

Students experiencing difficulties in the periodic table of elements in chemistry learning may face challenges such as difficulty in concentrating, low learning awareness, easy to forget of what is studied, low learning motivation, difficulty memorizing symbols, and other factors. Therefore, the author proposes an educational game for the periodic table of elements [8].

According to recent research on memory, we have more than one type of memory. Each memory is connected to one another through different mechanisms to store data. Activating one type of memory will trigger another type of memory. Data can be stored in different memory storage locations for the same thing. If this data can be stored in multimemory, it will be very easy to access when needed. The three types of memory we know in data storage are short-term memory, working memory, and long-term memory. The difference between these three types of memory lies in the location and duration of data storage. Short-term memory stores data for 15 to 30 seconds, while working memory can store data for several hours and memory[9].

Game or play can be interpreted as an activity usually done for fun. A game is something that is done with specific rules; each game has different winning and losing conditions. Games are played with the aim of being a source of entertainment and for refreshing [10].

Educational games are games that have features and content that can educate players and have the goal of sparking the interest of players in learning. Gamifying learning materials makes it easier for students to understand the presented material [11].

Games-based learning, when translated into Indonesian, means learning based on games. Games-based learning is one of the game-based learning methods that can help teachers achieve learning objectives used by teachers. According to Astuti (2017), the games-based learning method "can make the learning process exciting and stimulate the enthusiasm for learning, thus motivating and encouraging learners to be more creative" [12].

According to the research, using information technology media can increase the interest in learning among high school students. The experimental results in the X-grade IPA class at Watampone High School showed an increase in learning interest from 67.34% to 83.19%, along with increased student activities [13].

Information technology makes tasks faster and easier. In the field of education, it can assist in data management processes. Modern technology enables the quick, timely, and accurate fulfillment of organizational needs. Currently, advancements in information technology have permeated various aspects of human life. Therefore, it is undeniable that information technology has the potential to enhance organizational efficiency and productivity[14].

Android is an operating system used on Linux-based phones. Android provides an open platform for developers to create unique applications for various mobile devices. Android Inc., a new company that created software for phones, was initially acquired by Google Inc. The Open Handset Alliance, a consortium of 34 hardware,

software, and telecommunications companies, including Google, HTC, Intel, Motorola, Qualcomm, T-Mobile, and Nvidia, was later formed to assist in developing Android. Google purchased Android in July 2005 and officially released it on November 5, 2007. The Android SDK helps developers create Android applications using the Android platform with tools and APIs. Java is the programming language for Android[15].

IV. CONCLUSION

Based on the research results, the following conclusions can be drawn: The game "Chem Ball" is designed with the concept of Game-Based Learning, making it attractive and interactive. 'Chem Ball' is proven to be easy and practical for high school students to play. After playing the game, students feel that learning the periodic table of chemistry becomes easier. 'Chem Ball' makes 10th-grade high school students more capable of memorizing the 8 group A elements in the periodic table sequentially, with a total of 8 stages for group A elements.

"Chem Ball" is a 2D game created using Unity Engine based on Android. This game implements Game-Based Learning. Testing the game with 5 high school students indicates that students are assisted in learning the periodic table of chemistry, including memorizing, understanding, and recalling the sequence of elements in the periodic table through the attractive and interactive interface of "Chem Ball".

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