

Design of the "CELL CHRONICLES" game as an educational Role-Playing Game (RPG) on the human organ system

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Abstract

This research aims to develop the educational game CELL CHRONICLES to help teenagers understand the structure and function of the human organ system. The main issue addressed is the lack of interest among teenagers in learning about health through conventional methods. To tackle this, the development method used is the ADDIE model, which consists of five stages: analysis, design, development, implementation, and evaluation. Analysis was conducted through a survey of 54 teenage respondents, revealing that many face health issues but are interested in learning through games. The game's design includes an engaging storyline and informative characters, providing relevant context. Development was carried out using RPG Maker MZ, resulting in interactive and educational gameplay. Evaluation through blackbox testing and expert assessments indicates that the game functions well and is suitable as an educational tool, achieving a score of 83% classified as "Very Feasible." This research significantly contributes to the development of educational media in health and opens avenues for further research.

1. Introduction

The human body is a complex entity governed by genetic information, forming various physical structures and functions of organisms (Gaiseanu, 2022). However, adolescents between the ages of 10 and 19 face a variety of health challenges. According to the World Health Organization (WHO), approximately 1.1 million adolescents per year die from various illnesses and injuries, many of which are attributable to poor diet, low physical activity, and risky behaviors (Jain et al., 2013; World Health Organization, 2019). This underscores the necessity for efficacious interventions aimed at enhancing health awareness among adolescents.

In this context, the development of educational technology, particularly in the form of role-playing games (RPG)-based educational games, is becoming increasingly relevant (Grande-de-Prado et al., 2020). Role-playing games (RPGs) have the capacity to offer an interactive and engaging learning experience, enabling students to exert control over avatar characters in imaginary environments and to engage with educational scenarios (Akhnaf et al., 2024). The objective of this research is to design and test an RPG-based educational game titled Cell Chronicles. The game has been developed with the intention of improving the public's understanding of the human organ system and promoting awareness of the importance of health.

A substantial body of prior research has demonstrated the efficacy of RPG in enhancing student performance and enriching the learning experience (Topîrceanu, 2017). RPGs have been demonstrated to offer a broad and immersive educational experience (Daniau, 2016; Deterding & Zagal, 2018). Utilizing an interactive approach enables students to assess their comprehension and introspect on the decisions made during the game (Rahman & Angraeni, 2020). The present study is founded on the theoretical premise that educational games have the capacity to enhance student engagement and fortify their comprehension of the subject matter (Khan et al., 2017).

The objectives of this research can be formulated as follows: The objective of this study is to design an effective Cell Chronicles game for health education. Secondly, it is imperative to ascertain the outcomes of the cell chronicles game trial in enhancing adolescents' comprehension of the human organ system. It is hypothesized that the results of this study will make a significant contribution to improving adolescents' understanding of the human organ system and overall health. Furthermore, the present study endeavors to furnish innovative learning methodologies with the potential to enhance health awareness and foster

independent learning among students. Furthermore, it is anticipated that the Cell Chronicles game will facilitate the development of players' cognitive and creative skills in addressing health-related challenges.

2. Method

The present study utilizes the ADDIE (Analysis, Design, Development, Implementation, and Evaluation) model as a framework for the development of game-based educational programs. The model employs a systematic approach, encompassing five distinct stages: needs analysis, program design, product development, implementation, and evaluation. The efficacy of this approach has been demonstrated in various fields, including education and training (Kurniawan et al., 2019).

The population under study comprised adolescents between the ages of 10 and 19 years. Samples were obtained through purposive sampling techniques, wherein researchers deliberately selected respondents who met specific criteria. The study's participants included 22 respondents aged 10-15 years and 30 respondents aged 16-19 years. The selection criteria for respondents are designed to ensure diversity in the collected data (Ames et al., 2019).

The data collection process is meticulously executed through three sequential stages of evaluation: blackbox testing, evaluation by media experts, and evaluation by material experts. Blackbox testing is a method that prioritizes the functionality of a program over its internal structure (Ningrum et al., 2019). The following instruments were utilized in the study: (1) The Blackbox Testing Instrument Table is the first component under consideration. The objective of this study is to assess various components of game functionality, including menus, gameplay, and user interaction. (2) Media Expert Instruments: The Guttman scale is a methodological framework that is employed to identify deficiencies and prospective hazards in games (Sugiyono, 2008). (3) Material Expert Instruments: The Guttman scale is also employed to ascertain the suitability of the game's content in relation to pertinent scientific knowledge. A questionnaire based on the Likert scale was utilized to collect data from respondents, with the objective of measuring their attitudes and perceptions towards the educational games that had been developed (Sugiyono, 2008).

The collected data was then subjected to analysis through the implementation of percentage calculation techniques. This analysis was undertaken to ascertain the feasibility of the game. The formula employed is as follows:

$$\text{Feasibility Percentage (\%)} = \frac{\text{Expected score}}{\text{Observed score}} \times 100\% \quad (1)$$

The results of the analysis are categorized into qualitative criteria based on the percentage obtained, with the following interpretation: (1) 76-100%: Very Feasible, (2) 51-75%: Feasible, (3) 26-50%: Moderately Feasible, (4) < 25%: Less Feasible.

3. Results and Discussion

Cell Chronicles is an educational game designed to help players learn about the structure and function of the cells of the human body. This game was developed using RPG Maker MZ software and follows ADDIE's development model which consists of 5 stages, namely Analysis, Design, Development, Implementation, & Evaluation (Branch, 2009). The following is a description of each stage:

3.1. Analysis

At the analysis stage, researchers took a comprehensive approach to identify adolescent health problems. The study began with a literature review that included a variety of sources regarding adolescent health, including lifestyle, eating habits, and physical activity levels. Researchers distributed questionnaires online to 54 respondents consisting of two age groups: 10-15 years old and 16-19 years old. This data can be seen in more detail in Figure 1 below.

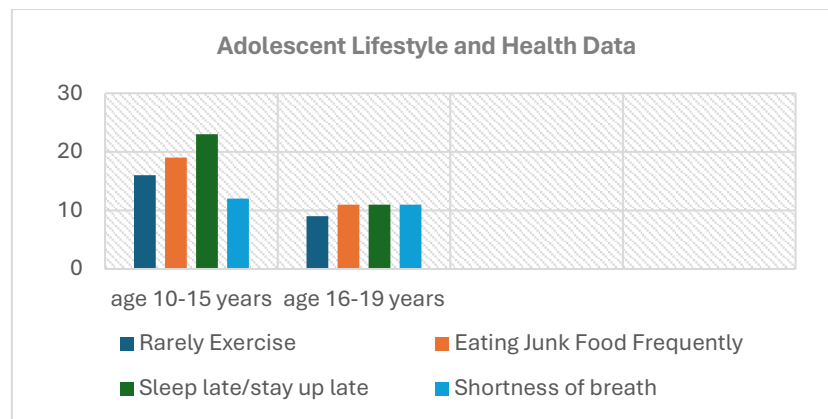


Figure 1. Adolescent Lifestyle and Health Data

Based on the results of the survey presented in Figure 1, it was found that most adolescents, especially in the age group of 10–15 years, experience various lifestyle problems that have the potential to interfere with health. A total of 23 respondents reported the habit of sleeping late at night (staying up late), which is one of the indicators of poor sleep quality. Poor sleep patterns in adolescents can impact cognitive function, mood, and immunity (Hirshkowitz et al., 2015). In addition, 19 respondents from this age group were also used to consuming junk food regularly. Consumption of foods high in fat, sugar, and salt has been shown to contribute to an increased risk of obesity, metabolic disorders, and other chronic diseases later in life (WHO, 2020). Meanwhile, 16 respondents admitted that they rarely do physical activity, which risks reducing physical fitness and lowering the function of the cardiovascular system and metabolism of the body (Hallal & Andersen, 2012). Complaints such as shortness of breath, indigestion, and weakness also appeared although not as many as the previous three main problems, but still showed the presence of early symptoms of health problems. These symptoms can be an indicator of an internal health burden rooted in an unhealthy lifestyle and low awareness of the importance of taking care of the body from an early age.

Meanwhile, in the 16–19 age group, although the number of complaints is less, the pattern of problems that arise tends to be similar. The habit of eating junk food and rarely exercising were still the two main problems, reported by 10 and 11 respondents, respectively. Late sleep was also reported by 9 respondents, indicating that sleep quality is still a chronic problem. This emphasizes the importance of relevant and interesting technology-based educational interventions to increase adolescents' awareness and knowledge about the importance of maintaining healthy organs through a healthy lifestyle. Educational games such as *Cell Chronicles*, which is based on Role Playing Games (RPGs), have the potential to be an effective medium in conveying material about the human organ system in an interactive and fun way (Chiu & Churchill, 2016).

Support for this urgency is strengthened by the results of a survey showing that around 70.3% of respondents expressed interest in playing RPG-based educational games that discuss the human organ system. This finding is an important foothold in the development of *Cell Chronicles*, because it shows the need for learning media that is not only informative, but also visually and interactive (Nurmawati et al., 2020). Responding to this need, researchers then conducted an in-depth exploration of the organ system of the human body and the cellular structure that makes it up. This information not only becomes the basis for the preparation of educational content, but also ensures that the material presented in the game has academic value and is directly related to the biology curriculum. To realize game development that suits user preferences and learning content demands, RPG Maker MZ was chosen as the development platform. This decision is based on the software's ability to provide attractive visual features, flexibility in gameplay design, as well as ease of use even without advanced programming skills (Kosmadoudi et al., 2013).

3.2. Design

The design of the *Cell Chronicles* game is comprehensively designed to create an engaging, interactive, and highly educational learning experience. This design includes several key elements, namely the storyline, characters, location map, and gameplay mechanics. Each element is designed to support learning objectives, especially in understanding the structure and function of human body organs.

3.2.1. Storyline

The game's storyline is set in a fantasy world inspired by the Japanese anime "*Cell at Work*" which presents the concept of cells and the immune system visually and narratively. Players take on the role of Neutrophil cells, which are a type of white blood cell that has just been assigned to carry out the mission of maintaining the stability of *Organosia*. Players begin their adventure in *Vasculand City*, where they must protect red blood cells (Erythrocytes) from the attack of bacterial monsters. The involvement of other characters, such as the Memory

T cells, provides depth to the story with relevant information about the characters and their role in the immune system. Each character is designed to provide insight into their biological role in the human immune system. This narrative-based approach has been shown to be effective in increasing learning engagement and retention of scientific concepts through play (Mangione et al., 2013). The gameplay is designed with the flowchart presented in **Error! Reference source not found..**



Figure 2. Storyline Flowchart

The gameplay in the flowchart depicts the character's journey from one location to another, as well as interactions with supporting characters and enemies. Cutscenes at various key points in the story reveal the context, objectives, and missions that players must complete. Storyline design like this follows the principle of situated learning, where knowledge is constructed in a meaningful context through active interaction in an environment that resembles the real or imaginative world (Pérez-Sanagustín et al., 2015). Thus, games are not only a medium of entertainment, but also an effective learning instrument.

The characters in the game Cell Chronicles are designed to serve dual purposes: to reinforce the game's narrative and to function as visual representations of the elements in the human organ system. These characters can be categorized into two distinct groups: the primary character and the secondary character. The development of each character is informed by a dual approach, incorporating visual and functional considerations. This dual approach is undertaken with the objective of enhancing player engagement and facilitating the conveyance of biological concepts in a manner that is both contextual and engaging.

The main character who drives the storyline is Neutrophils (NRS-100), who is dubbed the "*Guardian of the Body*". The character was designed with inspiration from medieval knights, displaying the dominance of white as a symbol of his physiological role as a white blood cell. Each *Neutrophil* character comes with a unique code, which distinguishes him in the context of the narrative and reinforces his identity within the story. As a representation of granulocyte leukocytes, this character plays an important role in the body's non-specific defense system, being at the forefront of fighting threats that attack the human body (Fingerhut et al., 2020).

Furthermore, supporting characters (NPCs) are designed to reinforce the educational element while enriching the playing experience. *Memory T Cell* acts as a mentor who always provides important information and instructions to players along the way. *Macrophages* are present as characters who are in charge of caring for the body's cells while explaining their function in the immune system, strengthening the player's understanding of the body's defense mechanisms. *Erythrocytes* are depicted as workers who transport oxygen throughout the body, with a symbolic visual design according to their physiological role. On the enemy side, players must face *Bacterion* and *Virusite*, two types of monsters with a unique and sinister appearance, representing an infectious threat to the human body. The main challenge appears at the end of the level, when players face off against *Bronchion* the Breathless, the main boss who represents a disorder in the respiratory system, as well as being the ultimate test in understanding the material conveyed through the gameplay.

3.2.2. Map Design

The map design in the game *Cell Chronicles* includes five main locations that each have a different visual theme and educational challenge. The map is designed as a linear plot that depicts the player's journey from the initial stage to facing the main boss, while also gradually introducing the biological concepts that can be seen in Figure 3.

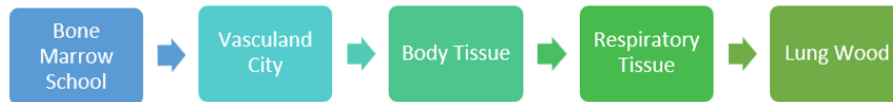


Figure 3. Map Game Plot Design

The design of the adventure game line begins at the Bone Marrow School, a place that represents the bone marrow as a place of blood cell production. Here, players are introduced to the basics of the game as well as receive initial missions and training regarding the immune system. After completing this initial stage, the player proceeds to Vasculand City, a city that depicts the circulatory system. The streets of this city resemble blood vessels, and players are tasked with rescuing red blood cells (erythrocytes) from bacterial attacks, while learning the basic concepts of blood flow and oxygen distribution.

The journey continues to Body Tissue, a maze that depicts the tissues of the human body. This location not only presents challenges in the form of enemies to face, but also multiple-choice quizzes that test players' knowledge of the functions and structures of internal organs. Next, players enter the Respiratory Tissue, an area that focuses on the respiratory system. The visualization of this area mimics the structure of the alveoli and bronchioles, introducing the importance of the lungs in gas exchange through exploratory and educational gameplay.

The highlight of the game takes place in Lung Wood, which is the setting for the final fight against the main boss named Bronkion the Breathless. The location is designed to resemble a misty forest, depicting the complexity of the respiratory system and creating a tense atmosphere. This battle is the final test both strategically and the player's understanding of the scientific concepts that have been learned throughout the game. The map connecting these five locations is visualized in Figure 3, showing the narrative journey as well as the educational flow in the game.

3.2.3. Gameplay Mechanic Design

The gameplay in *CELL CHRONICLES* is designed to balance educational and entertainment elements. Players can level up their characters through the Level Up system, where EXP is earned from completing missions and defeating enemies, which in turn unlocks new abilities. Interaction with non-player characters (NPCs) allows players to choose dialogue and get important information that supports missions. Additionally, in-game environments encourage exploration through students' interactions with objects such as treasure chests and hidden puzzles (Lester et al., 2014). The educational element is strengthened by the integration of a quiz system, where players must answer questions about the body's organ systems in order to continue the game (Wilkinson et al., 2020). Challenges are augmented by random encounters, which are random encounters with enemies while exploring the map, which increases the dynamics and surprises in the game (Lopes & Bidarra, 2011).

3.3. Development

The development phase in the *Cell Chronicles* project involves translating all the designs that have been created into a functional game application. This process is essential to ensure that all the elements that have been designed can function properly in the context of the game. At this stage, developers start building game elements such as maps, characters, and gameplay mechanics. In addition, initial testing was also carried out to ensure the stability and effectiveness of each feature implemented. This approach is in line with the principles in the ADDIE model, where the development stage acts as a bridge between concepts and real implementation (Branch, 2009).

3.3.1. Map Development

The map development process is carried out using RPG Maker MZ software. This device was chosen because it has complete features that support the development of Role-Playing Games (RPG)-based games, as well as ease of use for beginner and advanced developers. The maps in *CELL CHRONICLES* are built on the initial sketches and flowcharts of the storyline that have been designed at the design stage. The game environment is designed to create an atmosphere that supports learning and adventure. Each location has a different theme and level of challenge, representing parts of the human body such as blood vessels, body tissues, and lungs. Visualization of the map in Figure 4. made attractive in order to increase player immersion and support the educational goals of the game (Carbonell-Carrera et al., 2021).



Figure 4. Game Map

3.3.2. Character Development

The character development in the CELL CHRONICLES game is an important stage in building a narrative depth and immersive experience for players. This process includes creating sprites, animating movements, and writing dialogues that match the characteristics of each character. The characters in the game are developed using a combination of the built-in assets of the RPG Maker MZ software and costume modifications specifically designed to reflect the biological identity as well as educational roles of each character. The results of the development of various characters can be seen in Figure 5.



Figure 5. Character Assets

Based on Figure 5, the main characters such as Neutrophils (NRS-100) are designed to resemble a knight with a predominance of white as a symbol of the function of white blood cells in the immune system. Other supporting characters such as Memory T Cell, Macrophage, and Erythrocytes are displayed in a visual style that is friendly and easily recognizable to the player, making it easier to associate with their original biological roles. Meanwhile, antagonists such as Bacterion, Virusite, and the main boss Bronkion the Breathless are designed with a creepy and contrasting look, reinforcing the conflict element in the game. The importance of character design in educational games lies not only in the aesthetic aspect, but also in its function as a medium for conveying learning messages. Engaging and consistent visualization of characters can increase cognitive engagement as well as strengthen information retention by players (Choo, 2024). Therefore, each character in this game is not only a narrative tool, but also a strategic educational tool.

3.4. Implementation

The implementation of the game is carried out by involving a group of users to conduct *playtests*. This test aims to find out how well the game invites players to learn. This process includes testing the material by experts to ensure that the educational content is accurate and relevant. Validation by subject matter experts is carried out to ensure that all in-game learning content, especially related to the structure and function of the human organ system, is delivered accurately, in accordance with the curriculum, and has relevance to the real-world context (Thahira & Jayanti, 2024). Meanwhile, black-box testing is used to detect bugs or system errors that can interfere with the game's run.

In addition to the technical aspect, the user experience aspect is also an important concern. Researchers collected feedback through interview sessions and questionnaires to gain insights into players' perceptions of

gameplay, narrative, and the effectiveness of information delivery. This feedback became a major basis in the process of iteration and refinement of the game's design before it was finally released widely to the public.

The implementation stage in the development of the educational game CELL CHRONICLES is an important step to test the technical functionality as well as the effectiveness of the learning offered by the game. At this stage, the researcher involved a number of players from the target group to conduct playtesting, with the aim of evaluating the extent to which the game was able to attract the interest of players while delivering educational material effectively.

3.5. Evaluation

The evaluation stage is a crucial part of the development process of Cell Chronicles, as it aims to measure the effectiveness of the game from a technical and pedagogical perspective. The evaluation stage is carried out at the same time as the implementation stage. The main purpose of this evaluation is to obtain the results of *blackbox testing*, as well as to obtain input from media experts, subject matter experts, and responses from adolescents. By carrying out the evaluation stage, the researcher can formulate conclusions about the effectiveness of the *games* that have been developed.

Evaluation is carried out through technical testing using the black-box testing method and validation of content and media by experts. Black-box testing is done first by a game developer to identify whether all features in the game are working according to their function. The main focus of this test is to assess the integrity of the system, such as transitions between scenes, button responses, interactive dialogue, and a quiz system integrated into the gameplay. Before validating to media experts, the researcher conducted *Blackbox Testing* on the Cell Chronicles *game*. This test is carried out by a *game developer* to test every look and function in the *game*. The results of the *Blackbox Testing* test can be seen in Table 1.

Table 1. Blackbox Testing Results

Testing	Information	Result
<i>Title Menu</i>	Contains New Game, Continue, Option, & Game End buttons	Succeed
<i>Option Menu</i>	Contains music settings, UI, and gameplay	Succeed
<i>Play Game</i>	When the New Game button is pressed, it will start to the beginning of the game story	Succeed
<i>Game Menu</i>	When the Continue button is pressed, the game will start in the player's last save Menu display while in-game when pressing the reverse arrow key in the upper right corner or pressing the Escape button, which displays the item, skill, equip, option, etc.	Succeed
<i>Gameplay</i>	buttons and displays the player's character status Characters can move and interact with other characters/objects. During battle, there are attack buttons to attack, special buttons to attack special attacks, guards to defend, and items to use items.	Succeed
<i>Quit Game</i>	When the Game End button is pressed it will exit the game	Succeed

From the results of Blackbox Testing in Table 1, it can be concluded that all the main features in the game have run functionally and according to the expected design. This test is done with a focus on user interaction with the interface and gameplay elements without looking directly at the program's source code. The goal is to test the system's response to the input provided by the user. After conducting Blackbox Testing, the researcher proceeded with testing to media experts to get validation of whether the game was worth publishing or not. Test media experts using the Guttman scale. The following are the results of the media expert test can be seen in Table 2.

Table 2. Media Expert Test Results

Aspects	Indicator	Answer	
		Yes	Not
Gameplay Aspects	<i>The game</i> can be opened and run	√	
	<i>Game</i> no errors	√	
	<i>Games</i> don't interfere with the performance of other apps	√	
	Ease of running <i>games</i>	√	
	<i>The game</i> runs on <i>other</i> devices	√	
Multimedia Content Aspects in Games	Audio usage suitability	√	
	No distracting audio	√	
	Color selection suitability	√	
	Interesting <i>game</i> interface	√	
	Text readability	√	
	Language Ease when interacting	√	
	Function of using the button	√	
	Animation compatibility	√	
	Compatibility of topics with <i>RPG genres</i>	√	
	Functions of <i>in-game features</i>	√	

Based on the results of the media expert test presented in Table 2, it can be concluded that the CELL CHRONICLES game has met the eligibility criteria in terms of gameplay and multimedia content. This test was carried out using the Guttman scale, which makes it easier to evaluate in binary (yes/no) certain indicators that reflect the quality and functionality of educational digital media (Ariesta et al., 2023).

From the gameplay aspect, all the indicators tested such as the ease of running the game, the absence of errors, the lack of interference with other applications, and compatibility with different devices were declared successful. This shows that the game has been developed with the stability and comfort of the user in mind in the gaming experience, in accordance with the principles of reliable software development (Kosmadoudi et al., 2013).

Meanwhile, in the aspect of multimedia content, indicators such as the suitability of audio use, clarity of display, ease of interactive language, and consistency of animations and RPG themes also showed positive results. This indicates that the media elements displayed in the game have been designed effectively to support the learning process in an interesting, fun, and appropriate educational context. This aspect is especially important in educational games because appropriate visuals and audio can increase students' cognitive engagement as well as learning motivation (Clark & Mayer, 2012). With no significant obstacles found in the test, and all indicators found to be suitable, Cell Chronicles was declared worthy of publication. Validation from media experts is proof that this game is not only visually appealing, but also effective as an interactive learning medium. The researchers conducted an expert evaluation of the material to ascertain its relevance to the human body system. A comprehensive evaluation of the material reveals that the game effectively conveys information regarding the human brain in a satisfactory manner. The outcomes of the material tests are presented in Table 3.

Table 3. Material Expert Test Results

Assessment Criteria	Evaluation	
	Yes	Not
Do the characters <i>Neutrophils</i> in the <i>game</i> accurately represent the function and role of white blood cells in the body?	✓	
Is the information about the organs presented in the <i>game</i> in accordance with the accepted scientific knowledge?	✓	
Does the way the material is delivered in the <i>game</i> reflect the relevant biological concepts?	✓	
Do supporting characters like <i>Memory T Cells</i> and <i>Erythrocytes</i> in the <i>game</i> function correctly according to their roles?	✓	
Are the quizzes and puzzles in the <i>game</i> relevant to the functions and roles of the organs discussed?	✓	
Does this <i>game</i> provide enough understanding of diseases that can attack human organs?	✓	

Based on the results of the test of the subject matter experts shown in Table 3, it can be concluded that the Cell Chronicles game has succeeded in delivering educational content about the human organ system in an accurate and relevant manner. This validation is carried out by an expert in the field of biology or science education to ensure that the content of the material in the game is in accordance with generally accepted scientific knowledge. All indicators in the table are rated with an answer of "YES", which indicates that various game elements such as the representation of Neutrophils characters, the presentation of organ information, and the delivery of materials have accurately reflected biological concepts. This positive assessment indicates that games not only present information, but also convey it in a way that is easy to understand and relevant to the student's learning context.

In addition, supporting characters such as Memory T Cells and Erythrocytes are considered to have carried out educational roles according to their functions in the human body. The elements of quizzes and puzzles in the game are also considered to be able to strengthen players' understanding of the functions of organs, as well as increase interactivity that contributes to cognitive engagement. This game is stated to have succeeded in providing sufficient understanding of diseases that can attack human organs, making it a learning medium that is not only informative but also applicable to improve science literacy, especially in the field of biology of the human body.

After conducting *Blackbox Testing*, media expert validation, and material expert validation, the researcher evaluated the respondents. This evaluation aims to determine the level of feasibility and user satisfaction with the educational games that have been developed. The evaluation instrument uses a Likert Scale with a value range of 1 to 10, where a value of 1 indicates dissatisfaction and a value of 10 indicates very high satisfaction. The following data on respondent results can be seen in Figure 6.

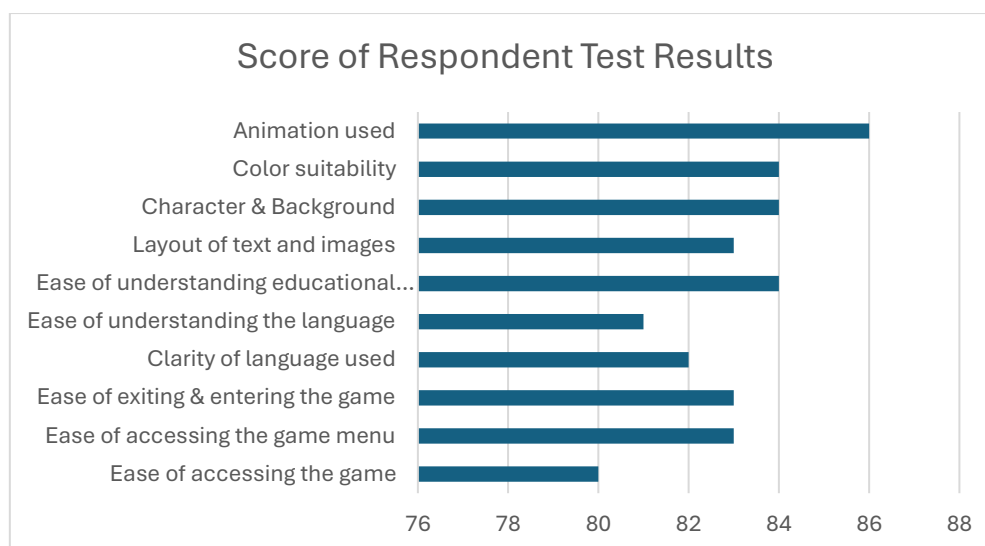


Figure 6. Respondent Test Results Data

From the data obtained, the total score obtained was 830. Using the following eligibility percentage formula:

$$\frac{830}{1000} \times 100\% = 83\%$$

The results showed a score of 83%, which belongs to the "Very Feasible" category. These results show that the educational game *Cell Chronicles* show a score of 83% so that it obtains the category of "Very Worthy" based on user perception. Therefore, it can be concluded that this game is effective and suitable for use as a learning medium about the human organ system, especially for teenagers. However, further development is needed in terms of language and accessibility to improve the overall user experience.

4. Conclusion

This research aims to develop an educational *game* *Cell Chronicles* that can help adolescents understand the structure and function of the human organ system. Following the ADDIE development model, the research includes five stages: analysis, design, development, implementation, and evaluation. The results of the analysis show that many adolescents experience health problems such as lack of sleep and poor diet. Despite this, the majority of respondents showed an interest in learning through educational *games*. This is an important foundation in designing relevant and engaging games. Game Design manages to create an engaging storyline, informative characters, and challenging maps. This *game* combines educational elements with entertainment, offering a gaming experience that is not only fun but also educational. Game Design manages to create an engaging storyline, informative characters, and challenging maps. This *game* combines educational elements with entertainment, offering a gaming experience that is not only fun but also educational.

From these findings, it can be concluded that *Cell Chronicles* not only serve as a means of entertainment, but also as an effective educational tool in increasing adolescents' knowledge of health. This *game* is expected to encourage positive health-related behavior change among adolescents, by combining education and fun interactions. Thus, this research makes a significant contribution to the development of educational *games* in the health sector, as well as opening up opportunities for further research and development in the future

Author Contributions

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