Implementation of Enhanced Re-Engineering on Trivia Game to Improve Immersion

Fathur Adryan Nur
Department of Informatics
Muhammadiyah Malang University
Malang, Indonesia
fnugiejunior3@gmail.com

Ilyas Nuryasin
Department of Informatics
Muhammadiyah Malang University
Malang, Indonesia
ilyas@umm.ac.id

Hardianto Wibowo
Department of Informatics
Muhammadiyah Malang University
Malang, Indonesia
ardi@umm.ac.id

Abstract*—Trivia games are one type of educational game that is in great demand and can be used as a medium of entertainment as well as a learning medium. In order to make a game in the same segment more unique and immersion, software re-engineering techniques are used in the trivia game. In re-engineering the trivia game, three methods are used: Enhanced Re-Engineering as a software re-engineering method; Game Development Life Cycle (GDLC) in the development of the Hidden Object Trivia game; and MEEGA+ as a testing method for the trivia game and the Hidden Object Trivia game to determine the increase in immersion value of the two games. The results of re-engineering the Tech Geek Quiz game led to the successful integration of trivia and hidden object genres, resulting in the creation of the Guess The Tech Tool game. The test results using MEEGA+ with 30 respondents showed an increase in immersion values of 50.26% from 1.89 to 2.84 in the usability factor and 30.29% from 2.08 to 2.71 in the player experience factor. The results were taken from all dimensions of the questions that had been asked.

Keywords— Trivia Game, Enhanced Re-Engineering, Immersion

I. INTRODUCTION

Games are one of the entertainment media that have its own characteristics when compared to other forms of media, namely their interactive nature which can provide quick feedback between the player and the system. Based on Clark(2016), games are activities that involve player decisions, trying to achieve goals within a specific context[1]. Nowadays for many people, games have become more than just a form of entertainment. However, games can serve as both a form of entertainment and a tool for learning for some people[2]. This type of game is commonly referred to as an edu-game. The terms 'edu-game' or 'educational game' are used in the field of education. An edu-game is a type of game that can be used as a learning media, aiming to enhance concentration and stimulate thinking through interesting and unique means[3], [4]. Gaming and learning have two opposing principles but can coexist if well-designed[5].

According to research by Michail et al., it shows that learning through games can increase motivation, engagement, and learning outcomes[6]. Players can benefit from mistakes made during play and acquire new knowledge[7]. Edu-games can encompass various types or genres, including simulation, puzzle, trivia, and more[2].

Trivia games are quiz games created specifically to test players' broad knowledge regarding certain topics or themes[8]. In general, trivia games consist of several questions with several answer options and only one correct answer. There are several research studies related to trivia games, including their impact on student satisfaction with the classroom environment, the management of the learning process, and their potential to promote tourism while helping players better know and understand the content[9]

A hidden object game, also known as a hidden picture game, is an English term referring to a genre where players engage with picture puzzles or hidden objects. In these games, players are tasked with finding objects listed and hidden within the picture. According to Ari Julianto, by using hidden object games allows players to distinguish objects around them and enhances their memory of the names of these objects[10].

According to Statista, the number of game downloads in the trivia games segment is projected to reach 1,297.5 million in 2022[11]. In terms of gameplay, Trivia Game exhibits high player involvement and interaction [12]. At certain levels and with specific game rules, Trivia Games can enhance cognitive, affective, and psychomotor learning domains [13]. Due to the large number of downloads and the benefits of Trivia Game, software re-engineering techniques were employed to make a game in the same segment more unique and immersion. Improving immersion can make learning through game media more interesting, satisfying, and effective. Several factors that can enhance game interest are challenge, interactivity, and the stimulation of curiosity. These elements contribute to increased motivation for playing and learning, which is crucial for successful and effective learning [14].

In general, software re-engineering is an economical and effective approach to enhance a software system. The essence of software re-engineering is to improve or modify existing software, enabling it to be understood, managed, and reused as if it were new software[15]. The entire process of software re-engineering involves analyzing the required requirements and their contents[16]. The challenging aspect of software re-engineering lies in understanding the traditional system. Many software re-engineering mechanisms are designed to achieve overarching goals, including improving software quality, reducing complexity, cutting maintenance costs, and enhancing reliability. As a result, certain traditional re-engineering mechanisms may fail to verify the performance of individual functionalities in existing software, leading to an increase in the complexity of the re-engineering process[15].

Previously, a similar study was conducted by A. Cathereen Graciamary & Dr. Chidambaram[17] , focusing on re-engineering for medical diagnosis and prediction

applications using the enhanced re-engineering method. The results demonstrated that their proposed system increased software reliability and enhanced service quality with minimal development efforts.

To reduce the complexity in software re-engineering, the method applied to the Trivia Game is called Enhanced Software Re-Engineering. This approach introduces a new idea: before rebuilding the software, the developer ensures the performance of specific functions in the existing system. A comparison is then made with the proposed new algorithm. Based on these results, a software re-engineering process is undertaken, aiming to reduce complexity in the software re-engineering procedure[15].

The purpose of employing Enhanced Software Re-Engineering is to alter the combination of abstraction methods and levels in transitioning from traditional software to a new software system. In this research, it is anticipated that the application of Enhanced Software Re-Engineering to the Trivia Game can result in more immersion game updates[15].

In this research, the game selected for re-engineering is 'Tech Geek Quiz,' a trivia game featuring technology-related questions. The re-engineering process involves integrating elements from Hidden Object games to create a new gaming experience while retaining the core element of the original game—answering questions. The re-engineered game, named 'Guess the Tech Tool,' will incorporate Hidden Object elements within the answer section of each question.

Both games, namely 'Tech Geek Quiz' and 'Guess the Tech Tool,' will undergo testing using the MEEGA+ method (A Method for the Evaluation of Educational Games for Computing Education). MEEGA+ is an evaluation method designed for educational games, commonly known as edu-games. Specifically, the Trivia Hidden Object game, included in the edu-game category, will be subject to testing[18], [19]. In this research, the expectation is for significant immersion changes to be observed through the comparison of MEEGA+ testing on the two games.

Immersion correlates with the gameplay experience, albeit its impact varies depending on the individual gamer's characteristics. This suggests that while immersion can engender highly enjoyable gameplay experiences for certain gamers, it may result in less appealing experiences for others[20].

II. Research Method

In this research, three methods will be applied: the first being software re-engineering, followed by game development, and concluding with the testing method.

A. Software Re-Engineering Method

The re-engineering methodology employed in this research is Enhanced Re-Engineering, which utilizes a novel approach. This method is chosen for its advantages in reducing complexity and enhancing the overall quality of the re-engineering process[15]. This method will subsequently be applied to the game 'Tech Geek Quiz'. The goal is to acquire the Software Requirement Specification (SRS) along with a detailed description of various aspects of the game. The findings from the prior re-engineering process will serve as foundational material for the subsequent game design.

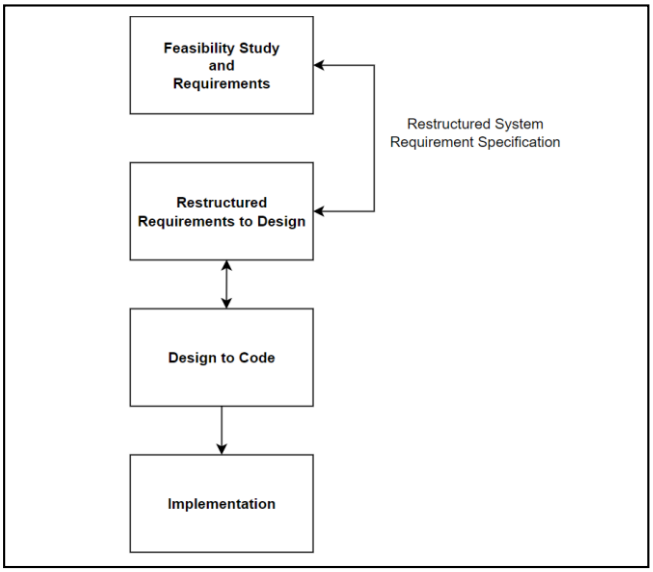

Fig. 1. Flow of the Enhanced Software Re-Engineering Method

The process of Enhanced Re-Engineering Software has five main phases, namely:

1) Feasibility Study and Requirements

During this phase, an analysis of the feasibility and requirements for the 'Tech Geek Quiz' game is conducted. Once the game analysis is complete, the results are tailored to meet the user's needs. The outcome of this process is a Software Requirement Specification (SRS) containing the specifications for the 'Tech Geek Quiz' game[15]. Based on the results of the Software Requirement Specification, the next step involves Reverse Engineering, which is the process of converting an executable file back into source code [21].

2) Restructured System Requirements Specification

During this phase, a system structure is developed based on the previously created Software Requirement Specification (SRS). The final result of this process is a blueprint that describes the re-engineering steps taken. Additionally, system comparisons will be conducted, comparing the old system with the new system using the established Software Requirement Specification[15].

3) Design to Code

From the redesign document created in the previous stage, a typical practice involves comparing the algorithms in the old system with those to be created. If an algorithm or code is found to be no longer suitable, it will be replaced with a more modern algorithm[15].

4) Implementation

In the final phase of Enhanced Re-Engineering, the game 'Trivia Hidden Object' was implemented, building upon the foundation of the previous game, namely 'Tech Geek Quiz.' During the implementation process, specific parts were replaced using the results of the previous phase. During this phase, the project transitions to the game development stage, utilizing the Game Development Life Cycle (GDLC).

The transition from Enhanced Re-engineering to GDLC was initiated upon achieving the primary objective of obtaining SRS. Consequently, we proceeded to GDLC at the implementation stage.

B. Game Development Method

The game development methodology employed in this research is the Game Development Life Cycle (GDLC), developed by Dr. Heather Chandler. GDLC is preferred due to certain stages that are uniquely suited to its methodology compared to SDLC (Software Development Life Cycle). For instance, GDLC offers better asset management capabilities during game design and production phases. Haddad & Kanode elucidate that a game emerges from the synergy of various disciplines, with creativity being one of them. They highlight the significance of assets, noting that while software prioritizes functionality, games prioritize both functionality and user engagement[22].

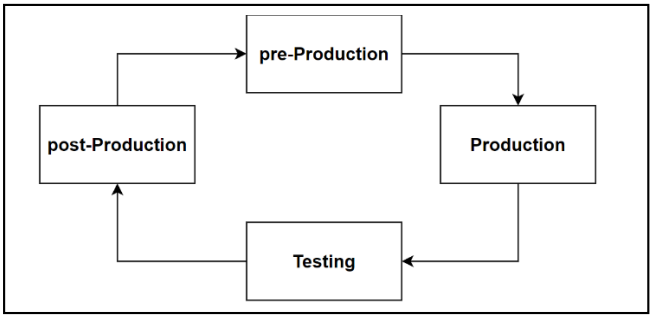

Fig. 2. Flow of the Game Development Life Cycle (GDLC) Method

The Game Development Life Cycle comprises four main phases, namely:

1) Pre-Production

This phase is conducted to determine the game design and project planning, encompassing elements such as the game concept. This includes the game title, genre, target market, gameplay, challenges, as well as game mechanics and aesthetics[23], [24].

2) Production

This phase is the core of the process related to creating technical and artistic aspects that implement the concepts, designs, and plans outlined in the Game Design Document (GDD). During this phase, assets are created, source code is developed, and the integration of these two elements takes place[23].

3) Testing

This phase occurs when game development has completed one cycle. Testing in this context aims to assess the usability of the game and evaluate the functionality of features, as well as game difficulty and balance. The methods employed to test usability and assess functionality include playtesting, along with function tests and gameflow tests. When testers encounter bugs, gaps, or unexpected game terminations during playtesting, it is essential to document the cause and the scenarios needed to reproduce the issues[23].

4) Post-Production

This phase is conducted to present the final documentation and engage in post-mortem activities. The primary goal of post-production is to compile a closing report and complete the post-mortem [25]. In this research, post-production involves submitting relevant assets and Game Design Documents for subsequent game development[23].

C. MEEGA+

The proposed testing method in this study is MEEGA+ (A Method for the Evaluation of Educational Games for Computing Education). MEEGA+ is an evaluation method specifically designed for educational games or edu-games[18], [19]. In specific contexts, applying the MEEGA+ model involves the use of questionnaires to facilitate the collection of data on participants' reactions after interacting with the game[18], [26], [27]. As shown in Table 1, MEEGA+ offers an instrument for measuring participants' perceptions regarding user experience and perceived learning based on various criteria.

TABLE I. MEEGA+ METHOD MEASUREMENT INDEX

Quality Factor	***Dimension***	***Q***	***Item Description***
Usability	*Aesthetics*	*Q1*	*The game design is attractive (interface, graphics, sounds, object)*
	Learnability	*Q2*	*Learning to play the game is easy and straightforward*
	Operability	*Q3*	*The game is easy to control (moving from one scene to another)*
	Accessibility	*Q4*	*The font and colors are good to read and understand the text*
	Error Prevention and Recovery	*Q5*	*The game prevents me from making mistake (button highlight, wrong answer warning, confirmation dialogue)*
Player Experience	*Focused Attention*	*Q6*	*The player can feel relaxed and would like to improve her/his score*
	Fun	*Q7*	*The player enjoys playing with game*
	Challenge	*Q8*	*The game challenges are moderated without frustration and boring*
	Social Interaction	*Q9*	*The games promote cooperation or competitiveness among the player*
	Confidence	*Q10*	*When player first looked at the game, player had impression that it would be easy for him/her*
	Relevance	*Q11*	*The player prefers to learn through the game rather than traditional learning method*
	Satisfaction	*Q12*	*The player recommends it to friends*
	Perceived Learning	*Q13*	*The game contributed to player learning course*
		Q14	*The game allowed for efficient learning compared with traditional learning course*

From all measurements conducted using MEEGA+, the immersion value of the two games will be calculated following the Arikunto Questionnaire calculation standard [28]. The calculation scale used is as follows:

TABLE II. QUESTIONNAIRE CALCULATION SCALE

Scale	Remarks
2,28 – 3	Good
1,68 – 2,27	Enough
0 – 1,67	Less

III. RESULTS AND DISCUSSION

In this section, we will elucidate the process of re-engineering the 'Tech Geek Quiz' game using the Enhanced Re-Engineering method, detail the game development process, and present the test results obtained through the MEEGA+ method.

A. Enhanced Re-Engineering

1) *Feasibility Study and Requirements*

In the trivia game called 'Tech Geek Quiz,' tests were conducted on several computers to identify the Software Requirement Specification (SRS) needed for the game. This includes requirements such as the Windows Operating System, at least a dual-core CPU, 2GB or more of memory, a graphics card, Graphic Card API, and a minimum of 400MB storage available.

After verifying the system requirements, the subsequent step involves assessing the game's performance through Reverse Engineering. By examining the existing source code, it becomes easier to comprehend the game's functionalities, including gameplay mechanisms, scene movements, music playback, and other elements. Reverse Engineering is conducted using the dnSpy v6.1.8 (64-bit) application.

After conducting reverse engineering on the game 'Tech Geek Quiz,' the obtained results manifest as detailed descriptions of various aspects of the game. These reverse engineering findings are delineated below:

a) Gameplay
- Core Gameplay
  The game is a trivia-based challenge where players answer given questions. For each question, players are presented with four options to choose from.
- Game Rules
  Players are granted three error tolerances in a single game. Correct answers automatically increase the player's points, displayed as a progressive number, for example, 2/10, indicating that the player has answered 2 out of 10 questions correctly. If a player makes three mistakes, the game ends. Each game provides players with a one-minute time limit; if time runs out, the game concludes even if lives remain. During gameplay, pausing or exiting the game is not permitted. The game concludes either when all questions have been answered or when time expires.
- User Interface
  The gameplay features a progressive score display, three lives, a timer, a question panel, an image panel, and an answer panel. Upon completing the game, the 'Game Complete' panel will appear, accompanied by a retry button. Clicking the retry button directs players to the stage selection.

b) Scene
In this game, there are two methods for transitioning between scenes. The first utilizes SceneManager. LoadScene to move from MenuScene to GameScene (Stage Selection). The second employs boolean values (true/false) on displayed game objects. For instance, in MenuScene to OptionMenu, the objects in OptionMenu can be positioned within MenuScene. Similarly, when transitioning from GameScene (Stage Selection) to Gameplay, this approach is used.

c) User Interface Menu
On the Main Menu, three buttons are available: Play, Option, and Exit. Clicking 'Play' directs users to StageScene, 'Option' toggles the display of the OptionMenu, and 'Exit' closes the game. The OptionMenu features a 'Reset HighScore' button to reset the entire score and a 'Back' button to return to the Main Menu. In StageScene, users can select stages and use a 'Back' button to return to the Main Menu.

d) Audio
- Backsound
  The background music will start playing when the game is initially launched. Subsequently, the background music will pause briefly as the game enters Gameplay, making way for the Gameplay Background Music.
- SFX
  During gameplay, sound effects accompany both correct and incorrect answers. When the game concludes, the Gameplay Background Music ceases, and the previously paused Background Music resumes.

2) *Restructured System Requirements Spesification*

At this stage, an analysis is conducted on the outcomes of the Software Requirement Specification (SRS) and Reverse Engineering, with the goal of crafting a new system that preserves the essence of the original game.

Feedback garnered from testers, including developers and respondents, serves as a basis for integrating additional features into the game under development. Drawing from a paper authored by Curtiss Murphy et al., enhancing gameplay experience can be achieved through various strategies, including managing flow, minimizing

distractions, simplifying interface design, addressing the paradox of choice, optimizing opportunity costs, progressively increasing difficulty, boosting motivation, incorporating baseline rewards, introducing achievements, leveraging in-game currency systems, and providing timely feedback[29].

The re-engineering results for the game system are outlined below:

a) Gameplay
- Core Gameplay
  The game will seamlessly blend two types of gameplay: Trivia and Hidden Object. Players engage by answering questions posed to them. The unique twist in answering questions involves players searching for the referenced object within the image provided on each stage, akin to the mechanics in hidden object games.
- Game Rules
  In the game, players are given 2 minutes for each stage. Correct answers are rewarded with updated scores based on the following rules:
  1. If the time is above 1 minute 50 seconds, players receive 50 points.
  2. If the time is above 1 minute 20 seconds, players receive 40 points.
  3. If the time is above 1 minute, players receive 30 points.
  4. If the time is above 20 seconds, players receive 20 points.
  5. If the time is under 19 seconds, players receive 5 points.
  6. Incorrect answers result in a time reduction of 10 seconds for each wrong object pressed.

  The game concludes when all questions have been answered or when time runs out. The HighScore will be visible in StageScene, displaying only the highest score achieved for each stage.
- User Interface
  In gameplay, there is a display featuring the score, time, question panel, pause button, and game progress. The PauseMenu panel includes options for Resume, Retry, and Exit buttons. Upon completion of the game, the GameOver panel appears, showcasing all objects along with their names and the corresponding scores obtained.

b) Scene
In this game, there are two methods for transitioning between scenes. The first utilizes SceneManager. LoadScene, moving from MenuScene to StageScene, StageScene to GameScene, and GameScene back to MenuScene. The second employs boolean values (true/false) on displayed game objects. For instance, in MenuScene to OptionMenu, the objects in OptionMenu can be positioned within MenuScene.

c) User Interface Menu
On the Main Menu, the 'Play' button transitions to StageScene, the 'Option' button leads to OptionMenu, and 'Exit' exits the game. In the OptionMenu, there are two buttons: 'Reset Highscore,' which erases all scores stored across all stages, and 'Back' to return to the Main Menu. StageScene features buttons for entering GameScene for each stage and a 'Back' button to return to the Main Menu.

d) Audio

3) Design to Code

In the 'Tech Geek Quiz' game, questions are originally generated using Scriptable Objects, facilitating the retrieval of questions based on the Stage. However, following gameplay changes from the previous Re-Engineering results, question creation will be directly embedded in an empty game object with attached question scripts. In the scripts, each question and object image will be assigned a corresponding number for linkage. Consequently, when a question with the number 2 appears, the player must search for the image with the number 2. This concept ensures that, upon application, the player must find the correct answer corresponding to the displayed question.

4) Implementation

At this stage, nearly all of the re-engineering has been completed. The overall results obtained will now be implemented into a new game. The transformation is from a Trivia Game named 'Tech Geek Quiz' to a Trivia Hidden Object game, featuring a new name. This process will be continued in the Forward Engineering Game Development Life Cycle stage.

B. Game Development Life Cycle

1) Pre-Production

The results of Enhanced Re-Engineering yield the information needed to create a new game. The Trivia Hidden Object game, titled 'Guess the Tech Tools,' features an educational theme. The mechanics of this game combine elements from both trivia and hidden object genres, divided into 5 stages, each with its own scoring feature.

Each stage follows the same gameplay, involving answering questions by locating the object mentioned in the question. As the stages progress, the level of difficulty for both questions and sought objects increases. To advance to the next stage, players must achieve a minimum score set for each stage. The minimum scores required to unlock the next stage are as follows:

a) Stages with 5 question objects require a minimum score of 100 points.
b) Stages with 7 question objects require a minimum score of 150 points.

In the game, players are allotted 2 minutes for each stage. Correct answers result in score updates according to the following rules:

a) If the time is above 1 minute 50 seconds, players receive 35 points.
b) If the time is above 1 minute 20 seconds, players receive 25 points.
c) If the time is above 1 minute, players receive 20 points.
d) If the time is above 20 seconds, players receive 15 points.
e) If the time is under 19 seconds, players receive 10 points.
f) Incorrect answers incur a time reduction of 10 seconds each time the wrong object is pressed. The game concludes when all questions have been answered or when time runs out. The High Score is visible in StageScene, displaying only the highest score achieved for each existing stage

2) Production

Next, at this stage, a new game was developed, titled 'Guess The Tech Tools' can be accessed here: https://s.id/GuessTheTechTools.

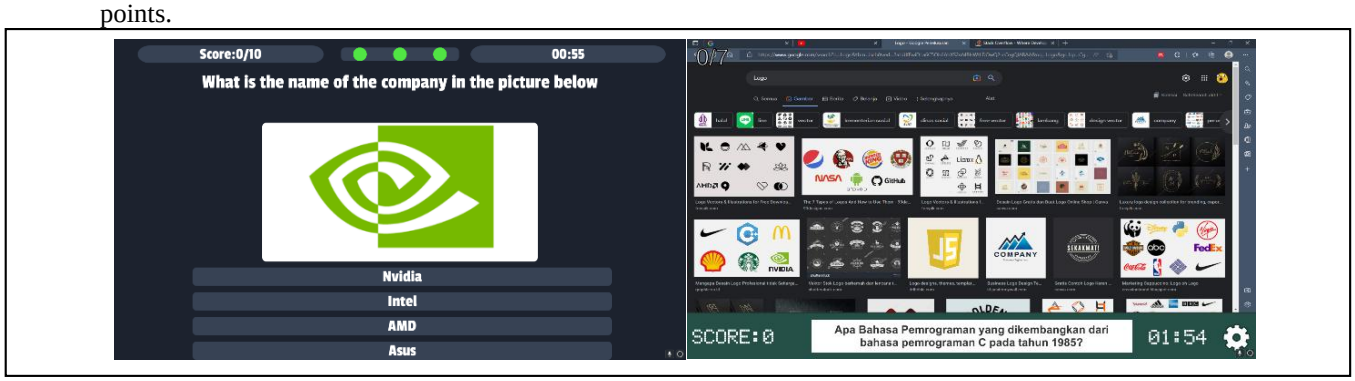

Fig. 3. shows a gameplay comparison, arranged from left to right, between Tech Geek Quiz and Guess the Tech Tool

Figure 3 provides a comparison of gameplay between 'Tech Geek Quiz' and 'Guess the Tech Tool.' 'Tech Geek Quiz' utilizes trivia gameplay with answer choices presented in the form of options. On the other hand, 'Guess the Tech Tool' maintains trivia gameplay but introduces a change in the answering process, requiring players to select the object referenced in the question.

Fig. 4. Showcases an example of the GalleryMenu implementation in the Guess the Tech Tools game

Figure 4 depicts the implementation of the GalleryMenu in the game 'Guess the Tech Tools.' This menu offers detailed information about the technological devices featured in the game. It was designed with the intention of providing players with additional knowledge or more comprehensive information about the devices they are guessing during gameplay.

3) Testing

At this stage, Black Box Testing is conducted for software testing. Testing was conducted by the developer team, and respondents through feedback from MEEGA+ respondents was gathered to evaluate the functionality of the 'Guess The Tech Tool' game. The results of the conducted tests can be observed in Table 3.

TABLE III. BLACK BOX TESTING

#	Testing	*Test Case*	Expected Results	Test Result	Conclusion
1	When clicking on the executable file	Click on the executable file	Enter the game and the main menu appears	aligns with expectations	Valid
2	Select 'play' in the menu	Click on the 'play' button	Enter stage selection	aligns with expectations	Valid
3	Choosing stage	Click on the 'stage' button	Entering the stage	aligns with expectations	Valid
4	Opening the Information	Click on the 'info' button	Opening information	aligns with expectations	Valid
4	Choosing the correct object	Click on the correct object	Points add up and objects disappear	aligns with expectations	Valid
5	Choosing the wrong object	Click on the wrong object	Time decreases	aligns with expectations	Valid

6	Select the 'Retry' button	Click on the 'retry' button	Repeating stages	aligns with expectations	Valid
7	Select the 'Next' button	Click on the 'next' button	Entering the next stages	aligns with expectations	Valid
8	Select the 'Menu' button	Click on the 'menu' button	Return to the main menu	aligns with expectations	Valid
9	Select the 'Gallery' button	Click on the 'gallery' button	Enter the gallery section	aligns with expectations	Valid
10	Select the 'Option' button	Click on the 'option' button	Enter the option section	aligns with expectations	Valid
11	Select the 'Reset Highscore' button	Click on the 'reset highscore' button	Reset the Highscore	aligns with expectations	Valid
12	Select the 'Back' button	Click on the 'back' button	Return to the main menu	aligns with expectations	Valid
13	Select the 'Exit' button	Click on the 'exit' button	Exit to the desktop	aligns with expectations	Valid

Table 3 shows the test results for the game 'Guess the Tech Tool,' conducted through black box testing. The objective of this test is to assess the functionality of all buttons in the game to ensure they operate as expected.

4) Post-Production

At this stage, archiving is conducted, encompassing game assets, game source code, and documentation results. The archive is securely stored for future use, including purposes such as updating content, fixing bugs, or game development.

C. MEEGA+

The MEEGA+ test used in this article consists of 13 question dimensions with a total of 28 questions. These questions were distributed to multiple respondents for their responses. The respondents comprise individuals between the ages of 15 and 45 who have a keen interest in games and technology.

The results of all the answers will be calculated as an average value, with positive answers assigned a value of 3, neutral answers a value of 2, and negative answers a value of -1. The average results for each question dimension will be recalculated based on the quality factor. Subsequently, the average results from each game test will be compared to observe changes in immersion.

TABLE IV. QUALITY FACTORS: USABILITY

Dimension	Q	Question Details
Aesthetics	Q1	**Q1.1** Is the in-game display attractive and easy to understand? **Q1.2** Does the UI arrangement of the game menu look attractive? **Q1.3** Does the UI arrangement in the gameplay look attractive? **Q1.4** Are the background sounds and sound effects suitable for the game?
Learnability	Q2	**Q2.1** Is the gameplay provided easy enough to understand? **Q2.2** Does the UI help in understanding the mechanics in the game?
Operability	Q3	**Q3.1** Are you aware that the cursor is within the range of the answer object? **Q3.2** Do you know the function of all the buttons in the game? **Q3.3** Do you know you are choosing the correct/wrong answer?
Accessibility	Q4	**Q4.1** Is the font selection good enough so that the text is easy to understand? **Q4.2** Is the button design good enough so that its function is easy to understand?

TABLE V. QUALITY FACTOR: PLAYER EXPERIENCE

Dimension	Q	Question Details
Error Prevention and Recovery	Q5	**Q5.1** Can you differentiate the function of the buttons based on the given button design? **Q5.2** Does the game have mechanisms in place to prevent accidental presses of the wrong button? **Q5.3** Do you have confidence that you are pressing the intended button?
Focused Attention	Q6	**Q6.1** Do you experience a sense of relaxation every time you play this game? **Q6.2** Every time you play, do you feel challenged to increase your score?
Fun	Q7	**Q7.1** Do you experience a sense of happiness every time you play this game?
Challenge	Q8	**Q8.1** Does this game have a good level of challenge? **Q8.2** Does playing this game remain engaging and enjoyable, avoiding boredom and frustration?
Social Interaction	Q9	**Q9.1** Can playing this game increase your sense of competitiveness? **Q9.2** Can this game be played with friends?
Confidence	Q10	**Q10.1** When you saw the game, did you have the impression that the game would be easy to play? **Q10.2** Do you find this game easy to play after playing it a few times?
Relevance	Q11	**Q11.1** Do you feel that learning through this game is more suitable than traditional learning? **Q11.2** Is it easier for you to gain knowledge through this game compared to traditional learning?
Satisfaction	Q12	**Q12.1** Do you feel like recommending this game to others?
	Q13	**Q13.1** Do you think this game can contribute to the academic field?

Perceived Learning	Q14	**Q14.1** Does this game provide an efficient learning experience compared to traditional learning?

In Table 4 and Table 5 are the questions distributed to several respondents. The testing carried out was divided into 2 stages, namely the usability and player experience testing stages, where testing was carried out on each game to determine the increase in immersion value of the two games.

TABLE VI. MEEGA+ TEST RESULTS

Quality Factor	***Dimension***	***Q***	***Average Tech Geek Quiz***	***Average Guess The Tech Tools***	
				V1	***V2***
Usability	*Aesthetics*	Q1	1.51	2.62	2.77
	Learnability	Q2	2.04	2.67	2.95
	Operability	Q3	2.00	2.63	2.78
	Accessibility	Q4	2.00	2.73	2.87
	Average		**1.89**	**2.66**	**2.84**
Player Experience	*Error Prevention and Recovery*	Q5	2.23	2.72	2.71
	Focused Attention	Q6	1.97	2.50	2.82
	Fun	Q7	2.13	2.40	2.53
	Challenge	Q8	1.73	2.48	2.65
	Social Interaction	Q9	1.63	2.52	2.63
	Confidence	Q10	2.40	2.75	2.72
	Relevance	Q11	2.00	2.15	2.68
	Satisfaction	Q12	2.56	2.78	2.70
	Perceived Learning	Q13	2.40	2.57	2.93
		Q14	2.17	2.37	2.77
	Average		**2.08**	**2.51**	**2.71**

In Table 6, are the test results using the MEEGA+ method for the two games are presented. The results indicate that the average test value for the game 'Guess the Tech Tools' has increased compared to the average test value for the game 'Tech Geek Quiz'.

In the Quality Factor Usability assessment of Tech Geek Quiz, the Aesthetics Dimension attained the lowest score, registering at 1.51, while other dimensions like Learnability, Operability, and Accessibility averaged 2.01. Considering the feedback received from respondents and the obtained values, the developer opted to enhance the Aesthetics dimension. This involved refining the appearance and incorporating background music. As a result, in Guess the Tech Tools v1, the Aesthetics Dimension achieved a score of 2.62, marking an increase of 1.12.

In the Quality Factor Player Experience assessment of Tech Geek Quiz, the Social Interaction Dimension obtained the lowest score, at 1.63, while the other dimensions in Player Experience averaged a score of 2.18. Following the scores and feedback from respondents, the developer chose to bolster the Social Interaction dimension by implementing a high score feature. Consequently, in Guess the Tech Tools v1, the Social Interaction Dimension achieved a score of 2.52, reflecting an increase of 0.34.

After that, a second GDLC was conducted to enhance the immersion value in the deficient areas. The results obtained after the second cycle showed an increase in immersion scores across several dimensions of questions.

In the Quality Factor Usability assessment of Guess the Tech Tools v2, the Aesthetics Dimension achieved a score of 2.77, marking a 0.15 increase. This enhancement was accomplished by incorporating a gallery display feature to showcase revealed objects in one stage.

In the Quality Factor Player Experience evaluation of Guess the Tech Tools v2, the Social Interaction Dimension achieved a score of 2.63, reflecting a 0.11 increase. This improvement was achieved by introducing a feature that allows players to showcase their collected objects to others, facilitating comparison of each player's collection and high score.

IV. CONCLUSION

The Enhanced Re-Engineering method, originally a software re-engineering approach, was applied in this research to re-engineer a game. The results indicate that the Enhanced Re-Engineering method can successfully transform the Trivia Game 'Tech Geek Quiz' into the Trivia Hidden Object game 'Guess the Tech Tools' without omitting crucial elements of the game.

After the re-engineering process, testing was conducted on both games using the MEEGA+ method to assess user experience, usability, and learning outcomes. This test aimed to identify the changes that occurred during the game software re-engineering.

The results indicate a rise in the immersion value across all dimensions of the questions asked. The usability factor of the game 'Tech Geek Quiz' averaged 1.89, while for 'Guess The Tech Tools,' it averaged 2.84, reflecting an increase of 50.26%. Similarly, the experience factor of the game 'Tech Geek Quiz' averaged 2.08, whereas for 'Guess The Tech Tools,' it averaged 2.71, signifying an increase of 30.29%.

From this research, it is hoped that it can help developers in developing games to make them more attractive to players.

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