Educational Game Scenario Model Based on Imperative Game Goal Typology

Rickman Roedavan
Multimedia Engineering Technology
Telkom University
Bandung, Indonesia 40286
rikman@telkomuniversity.ac.id

Yahdi Siradj
Multimedia Engineering Technology
Telkom University
Bandung, Indonesia 40286
yahdi@telkomuniversity.ac.id

Stella Stefany
Royal Melbourne Institute of Technology Australia
Melbourne, Australia 3000
stella.stefany@rmit.edu.au

***Abstract*— Educational games are digital products resulting from the application of game-based learning concepts. The main factors forming educational games include combining a learning subject with challenging elements and engaging visualization. Most educational games translate the challenge component of the game in the form of multiple choice quizzes, questions, answers, or puzzle solving. This result causes the mechanical structure of educational games less interesting than the mechanics of entertainment games. This paper proposes a scenario development model for educational games derived from the game goal typology commonly found in entertainment games. This model is expected to be a reference for developing educational game scenarios that can enrich the types of mechanics and increase the engagement of an educational game. The proposed model in the research has been tested on two educational games, both of which received high attractiveness scores of 1.632 and 1.542 respectively on the User Experience Question (UEQ) scale.**

Keywords—game-based learning, game scenario, game mechanic, game goal typology

I. INTRODUCTION

Game-based learning is a pedagogical approach to using games for explain or train a scientific field [1]. The term game-based learning is sometimes confused with game products used in applying game-based learning. Game-based learning is not a product; it's a concept [2]. While game-based learning products can consist of conventional games, such as classic card games or board games, or modern digital games, such as PC or mobile-based games. Some researchers use the term digital game-based learning to refer to the game-based learning product [3][4]. Some other researchers prefer to use more popular terms, namely educational games or serious games [5][6].

The contradiction between the use of the terminology of educational games and serious games is still being debated among researchers. Some argue that educational and serious games are different products [7]. Educational games only focus on conveying knowledge, while serious games have an assignment or assessment component that functions to improve user skills [8]. However, within the scope of this research, both are considered the same as the digital product that implements the game-based learning concept [9][10].

Many studies have empirically proven the effectiveness of educational games [11]. Most of the advantages of using educational games are increasing learner motivation, learning material delivered becomes more interesting, and learning progress can be easily seen visually. Game-based learning products are generally divided into two types of mechanics. The first mechanic is called the learning mechanic, and the second mechanic is the assessments mechanic [12][13][14].

Most educational games divide the gameplay into smaller scenarios [15][16]. The provision of teaching materials in educational games is generally packaged in the form of linear animated videos or interactive storytelling based on visual-novel mechanisms [17][18]. Meanwhile, most assessment techniques use multiple-choice patterns, fillings, or puzzles [19][20]. Educational games are usually only considered a complementary tool in the overall learning method and not the main learning tool [21][22]. This causes the variations of mechanics used in educational games to be monotonous and uninteresting.

Storytelling is an important aspect of game scenario because it provides players with a compelling and immersive experience. Games are not just about winning or achieving objectives; they are also about the journey that the player goes through. Currently, there have been numerous research studies conducted on various storytelling frameworks, which are summarized in the table 1.

TABLE I. SUMMARY OF STORYTELLING FRAMEWORK

No	Storytelling Framework	Phase
1	The Three-Act Structure	3 Phase (Setup, Confrontation, and Resolution) [23]
2	The Freytag's Pyramid	5 Phase (Exposition, Rising Action, Climax, Falling Action, Resolution) [24]
4	The Monomyth	12 Phase (Hero Journey Adventure) [25]

Based on the summary of models in table 1, it can be concluded that the majority of storytelling frameworks always begin with an introduction and end with a conclusion of an event. This concept is highly suitable for incorporating into a game scenario model that typically results in a win or loss condition at the end of a level [26].

Most Game Development Life Cycles (GDLC) or frameworks tend to focus more on the global aspects of game development without considering in detail how a single level development, both in terms of story and mechanics, is delivered to players. Table 2 provides a summary of patterns for each game development model.

TABLE II. SUMMARY OF GAME DEVELOPMENT LIFE CYCLE

No	GDLC	Phase
1	Heather Chandler	Pre-Production, Production, Testing, Post-Production [27]
2	Arnold Hendrick	Prototype, Pre-Production, Production, Beta Testing, Live [28]
3	Rido Ramadhan	Initiation, Pre-Production, Production, Testing, Beta Release [29]
4	Elaachak Lotfi	Need Analysis, Design, Prototype & Development, Validation, Evaluation [30]
5	Andre Barbosa	Requirement Design, Learning Mechanism, Testing, Release [31]

When developing a game, choosing the appropriate game goal typology is crucial as it will greatly influence the overall design, coding techniques, and implementation of the game. By selecting the right game goal typology, game developers can ensure that their game is more focused and directed towards achieving specific learning objectives or entertainment goals. The Imperative Game Goal Typology classification developed by Debus can be a reference point that can detail the process of level development within a digital game [32].

This study tries to formulate a model for developing educational game scenarios by utilizing the Three Act Structure, as a simplest storytelling structure, and The Imperative Game Goal Typology. This model is expected to contribute to science and enriches forms of interaction in the context of developing educational games.

II. METHOD ANALYSIS

A. *Three Act Structure*

The Three Act Structure model is a model that is commonly used for writing a fictional story, either in novels or films. This model usually consists of 3 main phases: Setup, Confrontation, and Resolution. The setup phase usually includes a world and character introduction phase. The confrontation phase contains the emergence of various challenges to the main character, which has an impact on increasing the action and climax in the story. The resolution phase is the closing phase which provides the conclusion in a report. Figure 1 shows the general pattern of the Three Act Structure Model.

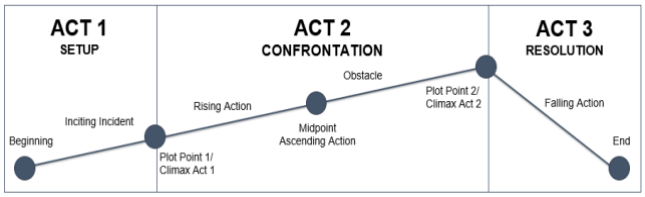

Fig 1. Three Act Structure Model

The most common pattern in a game scenario is the independent pattern. Each game scenario is made separately and can be completed in different time units. Meanwhile, another pattern is the integrated scenario pattern, in which a game scenario consists of several interrelated sub-scenarios that must be completed at once. In this case, the Three Act Structure model is the best form of the model to be used as a basis for a game scenario. Because this model has a simple framework and clear objectives at each stage, it can be used to build independent and integrated scenario patterns.

The setup phase in this mode can translate into an in-game tutorial mechanic. Players can be invited to understand in-game mechanics and interactions through simple visual commands. The confrontation phase can be translated into various forms of interesting game mechanic variations, not just quizzes or puzzles. The resolution phase can be implemented due to the overall player achievement. It can be shown as a scoring or recapitulation of a subject matter.

B. *Imperative Game Goal Typology*

Imperative game goal typology refers to the classification results of 10 types of game goals based on 126 variations of game goals from 34 game titles. A game goal is defined as a specific condition that causes a player to win a scenario or level in a game. The 10 types of game goals are Choose, Configure, Solve, Find, Reach, Create, Syncrhonize, Obtain, Optimize and Remove. Figure 2 shows the visual form of the game goal typology.

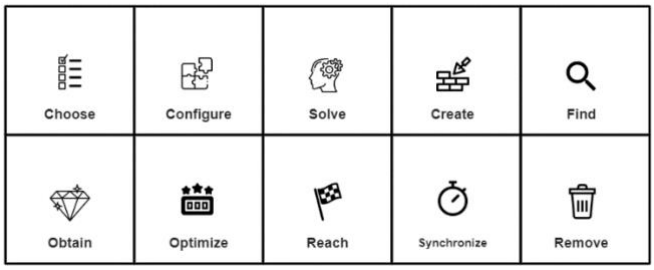

Fig 2. Imperative Game Goal Typology

Details of the conditions for each game goal typology are explained as follows:

1. Choose is a game goal condition in which players must choose the correct answer from a group of wrong answers. This typology is the most popular form and is often known as a quiz.
2. Configure is a game goal condition in which the player must arrange the correct answer from the answer pieces. Usually, this typology is in the form of a puzzle mechanic.
3. Solve is a game condition where players have to solve a quite difficult problem. Usually, the instructions are few or hidden, or the answers are not explicitly available in the game. This mechanic is commonly used for word-based or fill-in-based puzzle-type educational games.
4. Create is a game objective condition requiring players to create an object to win the game. The object created can be a visual object or a non-visual object.
5. Find is a game goal condition that trains the player's foresight to look for an object among a pile of other visually randomly arranged objects. Instead of using the typology Choose to find answers, using the typology Find will provide a more interesting challenge for players because players are faced with two challenges at once. They must know the answers and find out where is the answers location.
6. Obtain is a game goal condition to get a certain object whose location is clear. But to get these objects, there are usually special challenges. For example, the player must avoid enemies or traps in the game.

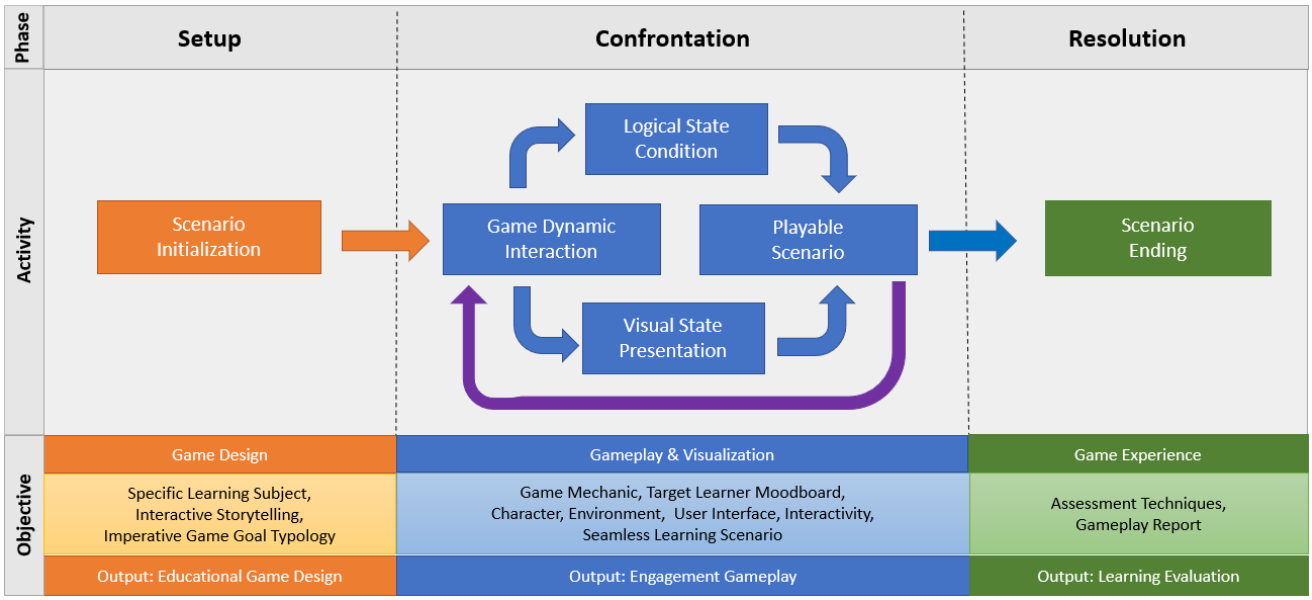

Fig 3. Educational Game Scenario Model Based On Imperative Game Goal Typology

7. Optimize is a game goal typology that challenges players to achieve the highest score possible within a specific time frame or by covering a certain distance.
8. Reach is a game goal condition to reach a certain location. An example of using this typology is the game Mario Bros and Need For Speed. Although visually, the genre and gameplay are both very much different. However, from a typology point of view, both have the same type: Reach because players will complete the game scenario if the main character has reached a certain finish point.
9. Synchronize is a game goal condition to train the speed and accuracy of player reactions to game object movements. This typology is usually used for dancing games that require players' speed and accuracy in predicting music and game object movements
10. Remove is a game goal condition that is the core of most entertainment games, namely, defeating the enemy. The term removes in a programming context is used to destroy a variable in memory. In the game context, the term remove is changed to kill, damage, or destroy.

III. Proposed Model

The model proposed in this study aims to raise the development of game scenarios in the application of game-based learning concepts. This model consists of 3 main layers: Phase, Activity, and Objective. This model can be read horizontally and vertically according to the focus of each phase. Figure 3 shows the proposed game scenario development model.

The layer Phase is taken from the Three Act Structure pattern, which consists of Setup, Confrontation, and Resolution. The output of the Setup phase is an educational game design. The result of the Confrontation phase is engaging gameplay, and the objective of the resolution phase is an evaluation of a game-based learning process.

Layer Activity consists of game scenario development activities starting from Scenario Initialization, Game Dynamic Interaction, Logical State Conditions, Visual State Presentation, and Scenario Ending. While the Objective Layer is a layer that contains the main references needed to compile such as Game Design, Gameplay, Visualization, as well as Game Experience.

1. Setup Phase

The Setup phase has one main activity, the Scenario Initialization. This phase developed a planned scenario based on a combination of Learning Materials, Interactive Storytelling, and Imperative Game Goal Typology. The output of this phase is a specific scenario design. The key to developing an challenging educational game scenario is choosing the right typology.

The first step in Scenario Initialization is to gather the necessary Learning Materials. These could include educational content, such as lesson plans, textbooks, or online resources, that are relevant to the game's educational objectives. The second step is to incorporate Interactive Storytelling elements into the game's scenario. The final step in Scenario Initialization is to incorporate Imperative Game Goal Typology into the game design process. The selection of different game goal typologies can have a significant impact on the overall design of the game and the player's experience.

As an example, if we were to create a chemistry education game that utilizes the Choose game goal typology, we would need to determine which material would be converted into digital form, what kind of narrative would be used in the game environment, and design the assessment mechanics based on the Choose typology. Figure 4 shows the sequence of design and the final result of the concept design from the Setup phase.

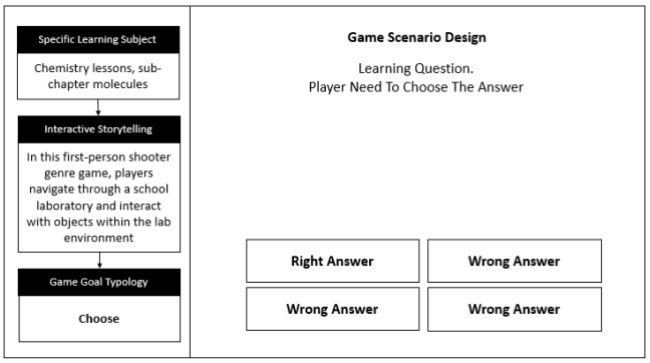

Fig 4. Concept from the Setup Phase using Choose Typology

Using the same case example, if we were to change the game goal typology from Choose to Find in the Setup phase, the design for the assessment mechanics would also change accordingly. This design change would affect the implementation technique and also the player experience. Figure 5 illustrates the schematic of the same case example with the change in typology.

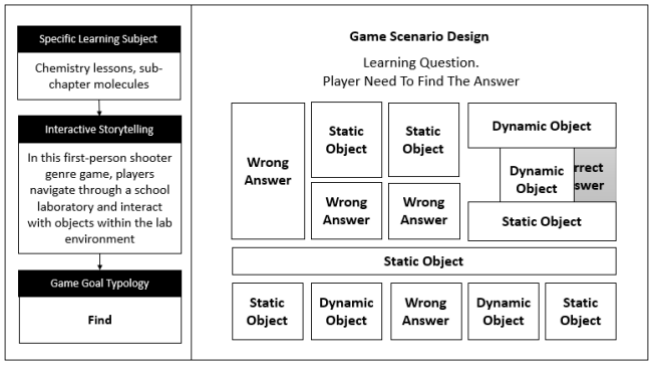

Fig 5. Concept from the Setup Phase using Find Typology

The choice of game goal typology plays a crucial role in determining the overall design and gameplay of the educational game. By selecting the appropriate typology for the learning objectives and the target audience, developers can create a game that effectively promotes learning and provides an engaging and enjoyable experience for the player.

The proposed model aims to simplify the design process of an educational game scenario by recommending the use of one game typology per scenario. However, the model can also adopt more than one game typology to create more complex mechanics. For instance, by combining the Choose and Find typologies, a multiple-choice quiz mechanic can only appears once the player has successfully found the correct object.

2. Confrontation

The Confrontation phase has four main activities: Game Dynamic Interaction, Logical State Conditions, and Visual State Presentation. Game Dynamic Interaction activities divide into two parallel activities: Logical State Conditions and Visual State Presentation.

The Logical State Condition activity is a direct translation of the selected game goal typology and is part of the work that a game programmer must implement. For example, if using the Choose-typology, the game programmer will simply develop the mouse click or tap touch interaction. Meanwhile, if the Synchronize-typology was chosen, game programmers must consider timeliness and music synchronization, even though they both use the same mouse click or tap touch interactions.

Visual State Presentation activity is part of the work that a game artist must implement by considering the psychological aspects of the target player. Educational games for players under 13 years will certainly have a different visual form and mood color than educational games for players over 18 years. Combining all these activities is expected to produce a Playable Scenario that can be tested independently. In a technical context, Playable Scenario activities do not require the entire game to be completed. Still, it is enough to try one game scene focusing on the level of challenge in the game, whether it is interesting enough for players or not.

3. Resolution

The Resolution phase is the final phase in developing educational game scenarios with one main activity, namely, Scenario Ending. In this activity, the scenarios that are created must be able to generate value from the assessment activity as well as feedback for players. This activity is expected to be show information for players to measure their understanding of learning material.

This activity can also provide an integrated report to the teacher in a more complex learning context. The game result can help the teacher understand students' characteristics and capacities before and after playing the games. It can be achieved by creating a function in each scenario so the teacher can have all student progress for analysis.

IV. Result

The research team tested the proposed model on two different game prototypes. First is the Chemical Labs, an educational game for basic chemical materials developer for SSR Polytechnic. Second is Kitchen Labs, an educational game for SOP cooking training for Telkom University hospitality students.

Chemical Labs is an educational game that adopts a minigame pattern by applying several types of typology. For choose-typology, this game features a classic quiz mechanism commonly used by most educational games. Figure 6 shows the implementation of choose-typology in this game.

Fig 6. Implementation of Choose Typology in the Chemical Labs Game

This game also adopts a configure-typology that utilizes the player's visual illusions to answer questions about molecular composition. Figure 7 shows the implementation of the configure-typology in this game.

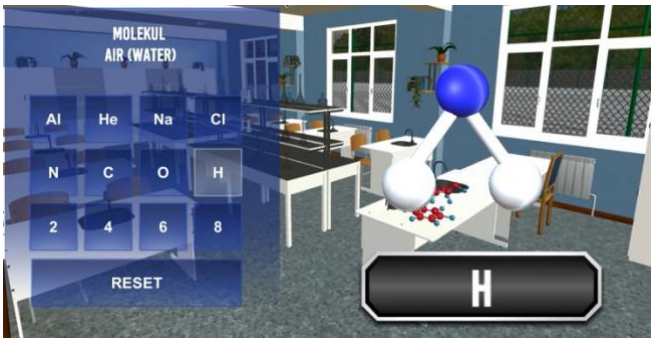

Fig 7. Implementation Configure Typology in the Chemical Labs Game

Game Kitchen Labs uses a 3D visual display to increase the attractiveness of players. The choose-typology applied in this game is combined with storytelling in the form of commands to players to choose certain cooking utensils. Figure 8 shows the implementation of choose-typology in this game.


Fig 8. Implementation of Choose Typology in Game Kitchen Labs

This game also adopts solve-typology in the form of button combinations and actions for seamless learning experience. For example, for the cooking training scenario, the player is asked to cook a steak by carrying out the correct cooking process, starting from finding ingredients, turning on the stove, and making sure to cook according to the type of doneness of the meat. Figure 9 shows the implementation of solve-typology in this game.


Fig 9. Implementation of Solve Typology in Game Kitchen Labs

Measuring the level of player interest in these two games was carried out using a User Experience Questionnaire (UEQ) survey of 26 question points [33][34]. A survey was conducted on students in the Applied Science Faculty. The Chemical Labs game was tested on 38 respondents with a composition of 27% female respondents and 73% male respondents, while the Kitchen Labs game was tested on 32 respondents with a composition of 34.4% female respondents and 65.6% male respondents. The average age range of the respondents was between 18-20 years old and the majority had played digital games on PC or mobile platforms.

The surveys yield high attractiveness scores for all games between the range of 1-3 for the UEQ scale. Table 3 shows the recapitulation of the results of the conducted UEQ survey.

TABEL III. UEQ SURVEY RECAPITULATION

UEQ Scales	Chemical Labs	Kitchen Labs
Attractiveness	1,632	1,542
Perspicuity	1,316	1,271
Efficiency	1,112	1,227
Dependability	1,283	1,112
Stimulation	1,493	1,367
Novelty	0,822	0,914

The survey result shows that developing educational game scenarios based on usage and variations of game typology can increase players' interest in playing educational games. Besides that, a combination of storytelling, visuals, and a variety of mechanics is also needed to produce an educational game with an interesting mechanic approaching the pattern of entertainment game mechanics.

V. CONCLUSION

The Educational Game Scenario Model is a game scenario development model that adopts imperative game goal typologies, which are mapped using the Three Act Structure model. The author claims that this model has contributed to knowledge and has a strong foundation for producing interesting educational game scenarios. This model is also expected to open opportunities for further research, such as finding the most effective typology for an educational game or the best typologies combination for educational game scenarios.

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