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A Domain-Specific Modelling Language for Adventure Educational Games and Flow Theory

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***Abstract*— Designing educational games is a complex task and needs collaboration between game developers and an educator. Domain-Specific Modeling Language (DSML) offers an approach to simplify the design activities of educational games and support the involvement of both game developers and educators. This paper presents an extension of Serious Game Logic and Structure Modeling Language (GLiSMo), a DSML that designs the logical and structural views of educational adventure games. The gap in the original GLiSMo is that it did not allow an educational game to be designed according to any learning theories. Furthermore, the original GLiSMo does not cover all concepts in the adventure genre. The authors intend to extend the original GLiSMo by adding the concepts of Flow Theory and concepts of the adventure genre to make it more expressive. The extended DSML is called FA-GLiSMo. The authors evaluated the expressiveness of FA-GLiSMo using Framework for Qualitative Assessment of DSLs (FQAD). The result shows that the expressiveness of FA-GLiSMo is still 'incomplete' due to the lack of clarity of semantics for several domain concepts. Improvements were performed, and the finalized FA-GLiSMo now has fifteen (15) concepts of the Logic diagram, nineteen (19) concepts of the Structure diagram, and a new diagram called the Flow diagram containing five (5) concepts of the Flow Theory. The authors also demonstrate in this paper the concrete syntax of FA-GLiSMo using the Tales of Monkey Island game as a case study.**

***Keywords*— domain-specific modelling language; adventure educational game; flow theory.**

I. INTRODUCTION

A Domain-Specific Modelling Language (DSML) represents the behavior, structure, and requirements of a specific class of domains or problems [1]–[3]. One of the advantages of using a DSML is its ability to enable the reuse of models and to help developers in reducing programming efforts as well as development time [4]. A DSML assists the development of software applications by increasing the level of abstraction of models and enabling code generation functionality [5].

Games, specifically computer games, offer players a lot of interactive and engaging activities [6], [7]. According to Van Broeckhoven and De Troyer [8], computer games provide players with a specific set of tools, movements, and thoughts. Ulicsak [9] mentions that the player has an opportunity to explore, train, and learn in the virtual world of a computer game. All these benefits can be exploited to turn games into learning tools.

Developing exciting games for educational purposes is very challenging [10]. Educational games must be designed to be entertaining and informative. Therefore, a collaboration between game developers and educators is needed to develop successful educational games [11], [12]. DSML can be a tool bridging the involvement of both groups [13], [14]. If the development of educational games only involves educators, the outcome may be unattractive or dull, whereas, if only game developers are affected, the educational games might fail in applying the learning theory or key learning pedagogies [15].

DSML is a modeling language that is used for constructing software specific to a targeted platform to automate manual coding [16]. DSML represents essential requirements from program developers and domain experts. Program developers provide the technical aspects of software development, and domain experts provide full specifications of the problem domain [17].

A DSML is represented based on its purpose, concrete syntax, abstract syntax, semantic, and constraints [18]. The specific syntax of a language defines how expressions are created and their appearance. It is the concrete syntax that developers see when using a language. The concrete syntax can be textual or graphical. The abstract syntax of a language determines the set of all possible expressions that can be created [13]. The semantics of DSML is based on the abstract syntax, while constraints are rules to ensure that domain models are well constructed [19]. Usually, modeling languages are developed in the form of graphical than text. The graphical specification is preferred because graphical models are easier to understand and help individuals to understand a huge amount of information more quickly than large listings of text [5].

In this paper, we proposed a DSML that focuses on educational adventure games and the Flow Theory to ensure the learning process is embedded in the educational games [20]-[22]. The adventure genre is a famous genre for the educational game [23] that emphasizes the interaction between characters, game narratives, and solving puzzles, which might be useful to promote learning [24], [25].

Ju et al. [3] investigate the most suitable game genre for educational games, and they concluded that adventure is the best game genre for educational games. There are several important concepts in the educational adventure game [26]-[29] such as Players, Characters, Story, Narrative, Game Rules, Game World, Plot, Scenes, Theme, Objects, Goal, Feedback, Practice, Text, Graphics, and Sound, Animation, User Interface, Interaction, Exploration, Problem Solving, Reward, Guidance, and Learning Theory.

Many learning theories have been documented [30], [31]. For educational adventure games, Flow Theory is one of the most popular learning theories that has been adopted [32], [33]. Flow Theory has been proposed by Csikszentmihalyi [34]- [36], and it describes the state of complete absorption or engagement in an activity. Flow Theory explains the state of optimal experience [37]. Optimum experience happens when learners are engaged in their practice. The theory of flow concept is based on the connection between challenge and skills that will cause flow, boredom, anxiety, and apathy [33], [35], [38] as shown in Figure 1.

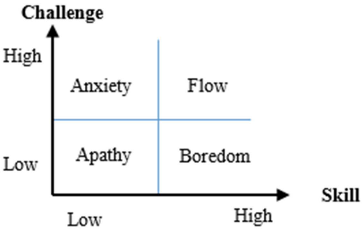

Fig. 1 Flow Theory Model

Flow happens when there is a balance between the skill of learners and the challenges in the provided learning task. Velikovsky [26] presented the model of the Flow State in Games that is derived from Csikszentmihalyi's concept of flow [26]. This model shows that the flow state occurs when the player's skills are high, and the level of challenge is also high. If the player's skill is high and the game challenge is low, the player will feel bored. While, if the player's skill is low and the game challenge is high, the player will feel anxious. The ideal way to engage the players is by providing appropriate challenges and opportunities to enhance their skills. Enhancing skills of learners typically require elements of guidance and practice, and this is where the adventure genre is strong since it includes the opportunity for players to explore the virtual game world and repeatable encounter tasks. Guidance is given possibly at the beginning and at the end of each attempt in performing the task.

II. Materials and Method

In this research, the proposed DSML is an extension of an existing DSML called Serious Game Logic and Structure Modeling Language (GLiSMo). GLiSMo is designed for the logic and the structure of an educational game [5], [39], [40]. The logic diagram describes the behavior of a serious game, and the diagram adopts the UML activity diagram. The structure diagram illustrates how a serious game is built, and the diagram adopts the UML class diagram. GLiSMo is developed for the adventure genre, but some concepts of the adventure genre are missing, such as Practice, Exploration, Guidance, and Problem Solving. These concepts are important as Guidance, Practice and Exploration will enable learners to improve their skills via repeatable tasks.

FA-GLiSMo is referred to GLiSMo's proposed extension for Flow Theory and educational adventure games. In the FA-GLiSMo logic diagram, there are ten existing concepts (States, Task, Action, Assessment, Stream, Event/ Message, Adaption, Fork Node and Join Node) and, seven new concepts (Exploration, Guidance, Decision Node, Merge Node, Interaction, Problem Solving, Practice). Nevertheless, the Adaption concept from the existing GliSMo was not included because this concept represents the adaptability of GLiSMo to integrate with any learning theory.

In the FA-GLiSMo structure diagram, there are ten existing concepts (Serious Game Root, Act, Scene, Object, Character, Inventory, Audio and Video Manager, Feedback Manager, Reward Manager, and GUI Manager) and nine new concepts (Plot, Story, Narrative, Theme, Game world, Game rules, Reward, Feedback, Player).

A new type of diagram called Flow diagram is introduced to incorporate the five concepts (Skill, Challenge, Flow, Feedback, and Goal) of Flow Theory in FA-GliSMo. There are five essential steps to develop DSML adapted from Deursen et al. [41] include preliminary study, DSML development, DSML evaluation, DSML modification, and lastly, the documentation process.

The first step in this research is a preliminary study. The author conducts a focus group workshop by inviting eight-game based-learning experts and dividing this group into two groups equally. The purpose of the focus group is to study the educational game domain. As a result, the focus group members suggested to the authors to focus on the adventure genre and Flow Theory.

The second step is the development of DSML. Several actions need to be executed in extending existing DSML for educational games. The actions include studying existing language, studying missing concepts to be added, specifying semantic for new concepts, appending abstract syntax, identifying and appending constraints, and lastly, appending concrete syntax.

The third step is evaluating the DSML using Framework for Qualitative Assessment of DSLs (FQAD) [42], [43]. FQAD provides a list of quality characteristics that can be used to validate a DSML. The author uses one of the quality characteristics, which is expressiveness and its six sub-characteristics, to evaluate FA-GLiSMo. Expressiveness is defined as the degree to which a problem-solving strategy can be mapped to a program. The six sub-characteristics of expressiveness are:

- Mind to program mapping: a problem-solving approach designed using FA-GLiSMo can be mapped into a program easily.
- Uniqueness: FA-GLiSMo provides only one right way to express all concepts in the language.
- Orthogonality: Each symbol in FA-GLiSMo is used to represent exactly one distinct concept in the domain.
- Correspondence to important domain concepts: FA-GLiSMo only includes domain concepts essential to the design of educational adventure games and Flow Theory.
- Conflicting elements: There is no conflict in the semantics and contrast between all domain concepts in FA-GLiSMo.
- Right abstraction level: FA-GLiSMo is at the right abstraction level for it to be useful to the intended users.

To evaluate the expressiveness of FA-GLiSMo, there are three main steps, as shown in Figure 2: 1) determine the importance level of the sub-characteristics, 2) determine the support level of the sub-characteristics and 3) determine the success level of sub-characteristics.

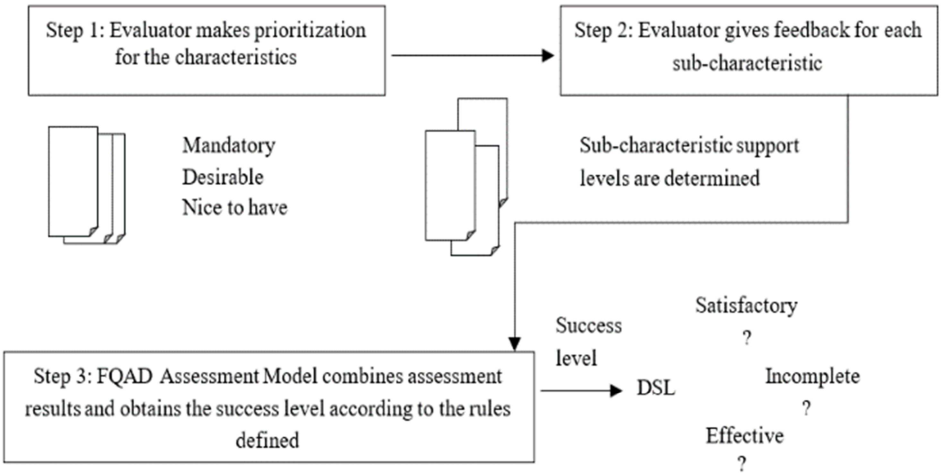
Step 1: Evaluator makes prioritization for the characteristics
Step 2: Evaluator gives feedback for each sub-characteristic
Mandatory
Desirable
Nice to have
Sub-characteristic support levels are determined
Success level
Satisfactory ?
Step 3: FQAD Assessment Model combines assessment results and obtains the success level according to the rules defined
DSL
Incomplete ?
Effective ?

Fig. 2 Assessment Steps in FQAD

The authors make prioritization (mandatory/desirable/nice to have) for the sub-characteristics to determine the importance degree. Then, the authors conduct interview sessions with seven-game developers to validate FA-GLiSMo and to gather feedback for the sub-characteristics. The feedbacks are in the form of support level (No support, Some support, Strong support, and Full support). Next, the authors determine the success level (Incomplete, Satisfactory, or Effective) of FA-GLiSMo effectiveness based on the importance degree, support level, and rules defined in FQAD. The rules are as follows:

- The expressiveness of FA-GLiSMo is considered incomplete when any sub-characteristics support level is rated lower than its importance degree.
- The expressiveness of FA-GLiSMo is considered satisfactory when all sub-characteristics support level is rated the same as its importance degree.
- The expressiveness of FA-GLiSMo is considered effective when all sub-characteristics support level is rated the same to its importance degree, and any sub-characteristics support level is rated higher than its importance degree.

The fourth step is the modification of DSML. FA-GLiSMo will be improvised based on the analysis of feedbacks obtained from the interview sessions. Some updates and changes will be made to improve FA-GLiSMo. Lastly, all the processes in this research are documented in conference papers, journals, and thesis.

III. Results and Discussion

This section explains the evaluation result of the expressiveness of extended GLiSMo and the demonstration of the final version of extended GLiSMo.

A. *Success Level of Expressiveness*

Table I shows the importance of degree for expressiveness sub-characteristic. All the importance level for the sub-characteristic are mandatory as the authors consider all the sub-characteristics critical to the usefulness of FA-GLiSMo. FA-GLiSMo will not be useful for designing educational games if it does not cover essential domain concepts, and game developers cannot map it to codes. Designers will also be confused when using FA-GLiSMo if the semantics and constraints of concepts conflict with each other, and many symbols can represent one concept.

TABLE I
Importance Degree of Expressiveness Sub-characteristic

Sub-characteristic	**Importance Level**
Correspondence to important domain concepts	Mandatory
Conflicting elements	Mandatory
Orthogonality	Mandatory
Uniqueness	Mandatory
Mind to program mapping	Mandatory
Right abstraction level	Mandatory

Next, the data collected in interview sessions with seven-game developers are analyzed to determine the support level for all sub-characteristics. For sub characteristics; correspondence to important domain concepts, the author wants to investigate whether all the concepts in FA-GLiSMo are relevant to an educational adventure game. All the concepts in FA-GLiSMo are rated full support except for the ones shown in Tables II, III, and IV.

Table II presents the result of logic concepts of FA-GLiSMo that do not correspond to important domain concepts. Developer [GD_6] rated not supported for 'practice' while developer [GD_4] rated optional for 'exploration.' Exploration is rated optional because some games have a linear plot.

TABLE II
LOGIC CONCEPTS OF FA-GLISMO DO NOT CORRESPOND TO IMPORTANT DOMAIN CONCEPTS

Status	Concepts	Game Developers
Not Supported	Practice	GD_6
Optional	Exploration	GD_4

Table III presents the result of the structure concepts of FA-GLiSMo that do not correspond to important domain concepts. Four concepts are rated optional because not all adventure games have inventories and characters. At the same time, Feedback Manager and Reward Manager are not necessary, but what is important are the concepts of reward and feedback.

TABLE III
STRUCTURE CONCEPTS OF FA-GLISMO DO NOT CORRESPOND TO IMPORTANT DOMAIN CONCEPTS

Status	Concepts	Game Developers
Optional	Reward Manager	GD_3
Optional	Feedback Manager	GD_3
Optional	Inventory	GD_6
Optional	Character	GD_6

Table IV presents the result of Flow Theory concepts of extended GLiSMo that do not correspond to important domain concepts. Developer [GD_4] states that 'skill' is a concept that cannot be explicitly designed into a game, and some tasks can be performed by not using any skills. However, the authors still think that 'skill' and its competence level are parameters that should be monitored and somewhat measured in order for the game to always be in the state of 'flow' (a balance between players' capability and the game difficulty level). A game designer can produce a logical design of the game to represent the change of game configuration to be in the state of 'flow' constantly. The Flow diagram can be used to present the different configurations of the game that are in the state of 'flow.' Game designers can also use the Flow diagram to show the various game configurations when it can be in the state of creating 'anxiety,' 'boredom' and 'apathy,' which the designers may want to avoid.

For the conflicting elements sub-characteristic, the authors want to investigate whether all the concepts in extended GLiSMo have conflicts in their semantics.

TABLE IV
FLOW THEORY CONCEPTS OF FA-GLISMO DO NOT CORRESPOND TO IMPORTANT DOMAIN CONCEPTS

Status	Concepts	Game Developers
Not Supported	Skill	GD_4

All the logic concepts of extended GLiSMo model do not have conflict except for the ones in Table V. 'Task' and 'Goal' are conflicting because developers [GD_1], [GD_4], [GD_5] and [GD_6] are of the opinion that completing a task is the goal. The authors, however, have the opinion that a task should be separated from the goal since a goal can be to obtain certain knowledge and this goal can be accomplished by completing more than one tasks.

TABLE V
LOGIC CONCEPTS OF FA-GLISMO THAT HAVE CONFLICT

Concepts	Game Developers
Task	GD_1,4,5,6
Goal	GD_1,4,5,6
Action	GD_6
Assessment	GD_6
Decision node	GD_6

Developer [GD_6] is also of the opinion that 'Task' and 'Action' should be combined and 'Action' to be used instead to represent both concepts. The original GLiSMo separates between 'Action' and 'Task' to separate the concept of performing an activity that is assessed, which is a 'Task' and performing activities not being assessed, which is an 'Action'. The authors follow the original GLiSMo. 'Assessment' and 'Decision node' are also considered to be the same by developers [GD_6]. Similar to 'Action' and 'Task', the original GLiSMo also separates the two because of the use of 'Decision node'. The 'Decision node' is not limited to only showing different branches of the game due to the result of an 'Assessment' but can also be used to represent different selection made by the players.

All the structure concepts of the FA-GLiSMo model do not have conflict except for the ones shown in Table VI.

TABLE VI
STRUCTURE CONCEPTS OF FA-GLISMO THAT HAVE CONFLICT

Concepts	Game Developers
Serious game root	GD_7
Act	GD_1,2
Text, graphic and sound	GD_1,2
Game rule	GD_1
Scene	GD_1
Character	GD_2
Game world	GD_1,3
Theme	GD_1,5
Feedback manager	GD_3,6
Reward manager	GD_3,4,5,6
GUI Manager	GD_1,2,6
Video and audio manager	GD_1,2,6
Animation	GD_2,6
Narrative	GD_2,3,4

The game developers involved in the assessment felt that there are conflicts between concepts of the original GLiSMo, which are 'Act,' 'Text, graphic and sound,' 'Feedback

Manager,' 'Audio and Video Manager,' 'GUI Manager,' Reward Manager,' 'Act,' 'Scene' and 'Character. They believe that 'Text, graphic and sound,' 'Audio and Video Manager,' and 'GUI Manager' are representing the same concept thus should be all represented by only one element in the abstract syntax.

'Reward Manager' and 'Feedback Manager' are conflicting when the authors introduced the concepts of 'Feedback' and 'Reward.' The 'Feedback Manager' and 'Reward Manager' are concepts representing the game component that collect records of all rewards and feedbacks obtained by the players to present statistics.

Developer [GD_2] thinks that 'Act' is the role played by the 'Character' but this is a misunderstanding as according to the original GLiSMo, 'Act' means different segments, missions or levels of a game. Developer [GD_1] also confused the 'Act' with 'Game rules.' 'Game rules' means a set of procedures of how a game should be played.

Developer [GD_1] also of the opinion that 'Theme,' 'Scene,' and 'Game world' is of the same concept. 'Scene' is a concept FA-GLiSMo takes from the original GLiSMo, meaning different geographical locations in the game. The authors added 'Game world' to represent the aggregation of all the scenes in the game. 'Theme' is a concept less related to the geographical locations in the game but more of a general description of the background story of the game.

All the concepts of the Flow Theory model do not have conflicts except, as shown in Table 7. The game developers highlighted the relationship between 'Skill' and 'Challenge,' and 'Flow,' 'Optimal experience,' and 'Enjoyment.' Developer [GD_6] suggested 'Flow,' 'Optimal experience,' and 'Enjoyment' to be combined.

TABLE VII
FLOW THEORY CONCEPTS OF EXTENDED GLISMO THAT HAVE CONFLICT

Concepts	Game Developers
Skill	GD_2,4,6
Challenge	GD_3
Flow	GD_6,7
Optimal experience	GD_6,7
Enjoyment	GD_6

For orthogonality sub-characteristic, the authors want to investigate whether the proposed notation is representing one concept. All the game developers have a similar opinion where all notations display the right concepts, and the different concepts need to be checked and modified.

For uniqueness sub-characteristic, the authors want to investigate whether a game design can only be drawn using the same way. All the game developers have a similar opinion. The proposed symbols are unique and easy to draw since the notations include the name of concepts.

For the mind to program mapping sub-characteristic, the author wants to investigate whether FA-GLiSMo can be used to design any adventure games. During the interview sessions, the authors asked interviewees to draw diagrams of Tales of Monkey Island based on the game walkthrough, and all the game developers successfully performed this task. Lastly, for the right abstraction level sub-characteristic, the authors investigated whether all the concepts are at the right level of abstraction for them to design educational adventure games. From their experience in designing Tales of Monkey Island using FA-GLiSMo, all the game developers have the opinion that the proposed language is at the right level.

The feedback obtained from the interviews are transcribed and encoded into NVivo for further analysis to determine the support level. Table 8 shows the support level of each sub-characteristics.

TABLE VIII
SUPPORT LEVEL OF EXPRESSIVENESS SUB-CHARACTERISTIC

Sub-characteristics	**Extended GLiSMo Models**		
	Logic	**Structure**	**Flow Theory**
Correspondence to important domain concepts	Some support	Some support	Some support
Conflicting elements	Some support	Some support	Some support
Orthogonality	Full support	Full support	Full support
Uniqueness	Strong support	Strong support	Strong support
Mind to program mapping	Strong support	Strong support	Strong support
Right abstraction level	Full support	Full support	Full support

TABLE IX
SUCCESS LEVEL OF EXPRESSIVENESS SUB-CHARACTERISTIC

Sub-characteristics	**Extended GLiSMo Models**		
	Logic	**Structure**	**Logic**
Correspondence to important domain concepts	Incomplete	Correspondence to important domain concepts	Incomplete
Conflicting elements	Incomplete	Conflicting elements	Incomplete
Orthogonality	Effective	Orthogonality	Effective
Uniqueness	Satisfactory	Uniqueness	Satisfactory
Mind to program mapping	Satisfactory	Mind to program mapping	Satisfactory
Right abstraction level	Effective	Right abstraction level	Effective

The analysis performed using NVivo shows that most of the feedbacks highlighted concerns regarding correspondence to important domain concepts and conflicting elements. Out of all the concepts supported by FA-GLiSMo, only seven (18%) of the concepts not receiving full support. 61% of elements in FA-GLiSMo are being mentioned as conflicting. Therefore, the authors concluded that the support level for correspondence to important domain concepts and conflicting elements to be 'some support.' Orthogonality and right abstraction level have full support. Uniqueness and mind to program mapping have strong support.

Lastly, the success level of each sub-characteristics and the expressiveness characteristics are determined based on rules defined in FQAD. Since correspondence to important domain concepts and conflicting elements have supported level lower than their importance degrees, the expressiveness success level for FA-GLiSMo is incomplete. Table 9 shows the success level of all expressiveness sub-characteristics.

Taking the results of validating FA-GLiSMo, the authors modified abstract syntax and semantics of FA-GLiSMo based on the feedbacks given by interviewees during the validation. Since the 'Goal' and 'Task' concepts have conflict, the authors decided to eliminate 'Goal' and modify the semantic of 'Task.' The authors also make some modifications to the abstract syntax and semantics of the FA-GLiSMo structure diagram. 'Text, graphic and sound,' 'Audio and Video Manager,' 'Animation,' and 'GUI Manager' elements in the abstract syntax are removed, and a new element called 'Audio and Visual Manager' is added to represent all these concepts. The semantics of the feedback manager, reward manager, narrative, game world, and theme has been modified. 'Reward' and 'Feedback' are new concepts added to the abstract syntax.

For Flow Theory concepts, the author makes some modifications to the semantic of 'Flow.' The concepts of 'Control,' 'Concentration,' 'Immersion,' 'Motivation,' 'Optimal experience,' and 'Enjoyment' are removed from the abstract syntax, and these concepts are explained in the semantic for 'Flow.'

B. Demonstration of FA-GLiSMo

An adventure game, which is Tales of Monkey Island, was used to demonstrate the FA-GliSMo. Tales of Monkey Island is about a pirate, Guybrush Threepwood and his wife, Elaine Marley, attempting to defeat the undead pirate, LeChuck. The prologue of this game is used in this paper to demonstrate the logic and structure diagrams. Figure 3 shows the structure diagram.

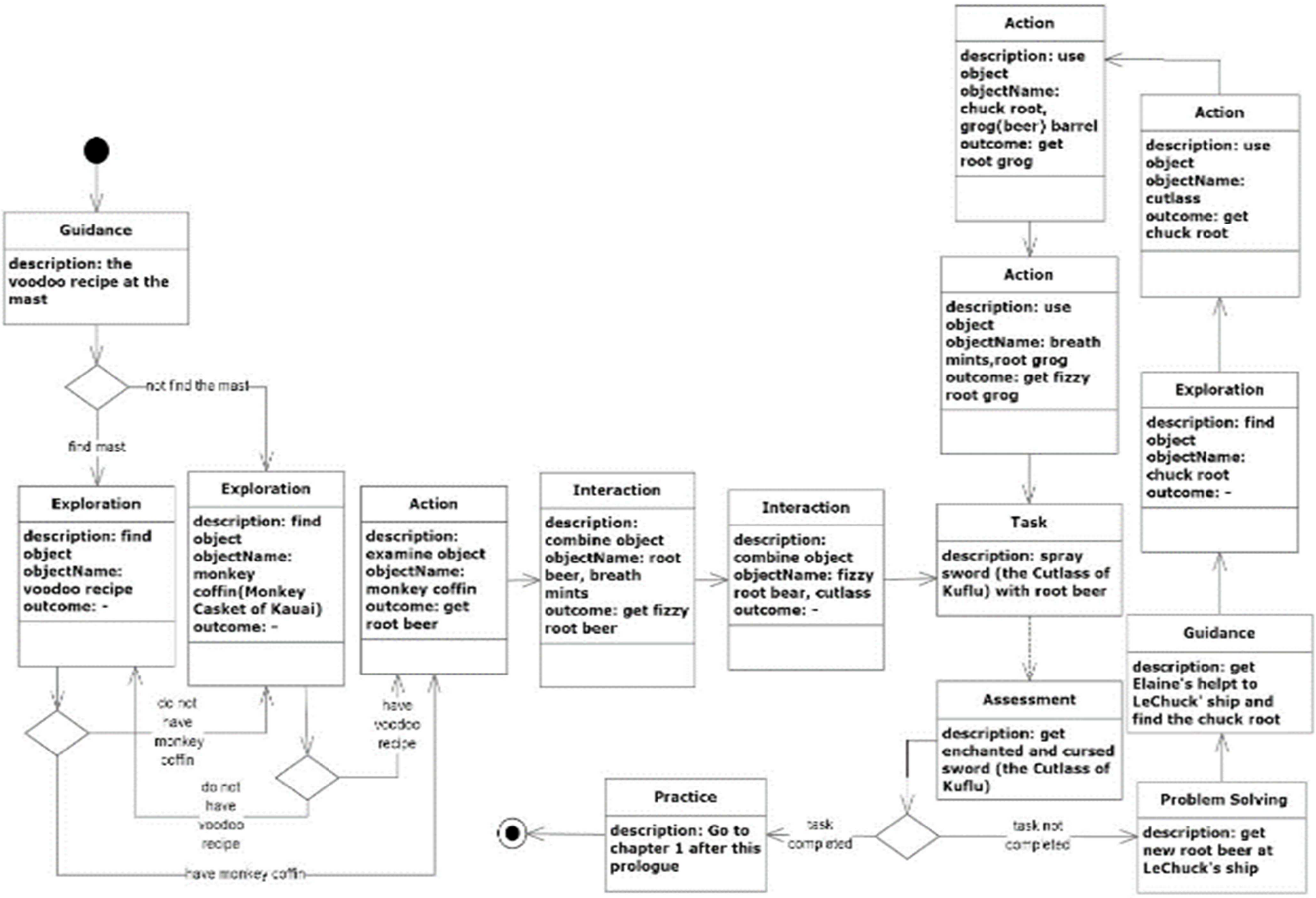
Guidance
description: the voodoo recipe at the mast
not find the mast
find mast
Exploration
description: find object
objectName: voodoo recipe
outcome: -
Exploration
description: find object
objectName: monkey coffin(Monkey Casket of Kauai)
outcome: -
Action
description: examine object
objectName: monkey coffin
outcome: get root beer
Interaction
description: combine object
objectName: root beer, breath mints
outcome: get fizzy root beer
Interaction
description: combine object
objectName: fizzy root bear, cutlass
outcome: -
do not have monkey coffin
do not have voodoo recipe
have voodoo recipe
have monkey coffin
Action
description: use object
objectName: chuck root, grog(beer) barrel
outcome: get root grog
Action
description: use object
objectName: cutlass
outcome: get chuck root
Action
description: use object
objectName: breath mints,root grog
outcome: get fizzy root grog
Exploration
description: find object
objectName: chuck root
outcome: -
Task
description: spray sword (the Cutlass of Kuflu) with root beer
Guidance
description: get Elaine's helpt to LeChuck' ship and find the chuck root
Assessment
description: get enchanted and cursed sword (the Cutlass of Kuflu)
Practice
description: Go to chapter 1 after this prologue
task completed
task not completed
Problem Solving
description: get new root beer at LeChuck's ship

Fig. 3 Example of the ExtendedGLiSMo Structure Model

All games start with a Serious Game Root, and the game has story, character, and act. An act is similar to the concept of levels, and in this case study, it is the prologue. The prologue's plot is about how Guybrush Threepwood saves his wife and relates the plot as a novel. The plot in the story is about Guybrush enchanting a sword known as The Cursed Cutlass of Kuflu. The scene or location where the act happens is at The Rock of Gelato. The three characters in the prologue are Guybrush, Elaine, and LeChuck, and Guybrush has an inventory that will keep objects that he found. Enchanting the Cursed Cutlass of Kuflu requires the objects: vodoo recipe, monkey coffin, root beer, chuck roots, cutlass, and breath mints.

Figure 4 shows a logic diagram for the prologue act. The black circle represents the initial-state, the act's starting point. The arrow represents a current, the act's flow. First, the players will receive guidance in the form of hints. The diamond represents a decision where the player either explores the virtual world to find the voodoo recipe or the monkey coffin. Once finding the voodoo recipe and the rootbeer in the monkey coffin, the player can interact with both items and the breath mint in Guybrush's inventory. The result of the interaction between breath mint and rootbeer is a fizzy rootbeer. Then the player can complete the task by spraying the fizzy root beer on the sword. However, the task completion is determined by an assessment. A dotted arrow represents messages and events to the assessment. If the task completed, the player will end the act, and the encircled black circle represents the final state. Failing to complete the task will require the player to enchant the sword differently.

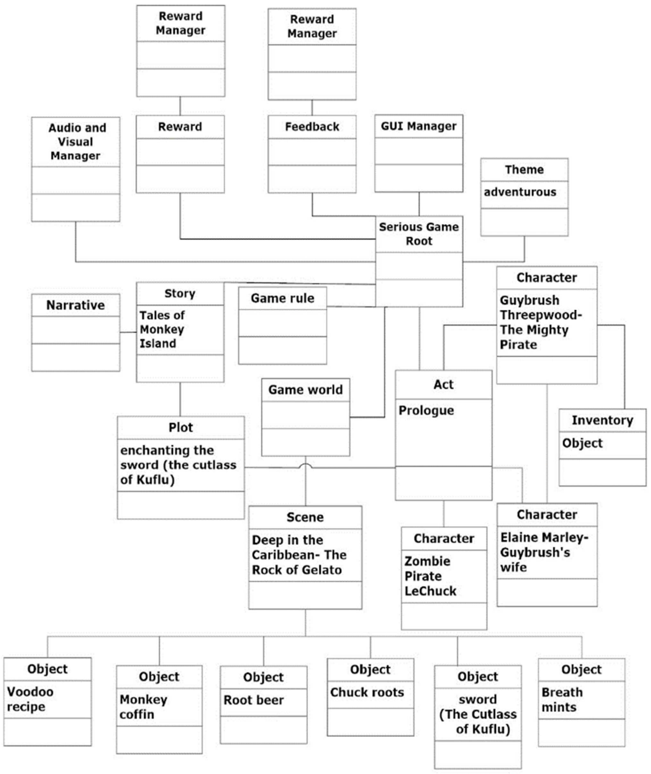

Fig. 4 Example of the Extended GLiSMo Logic Model

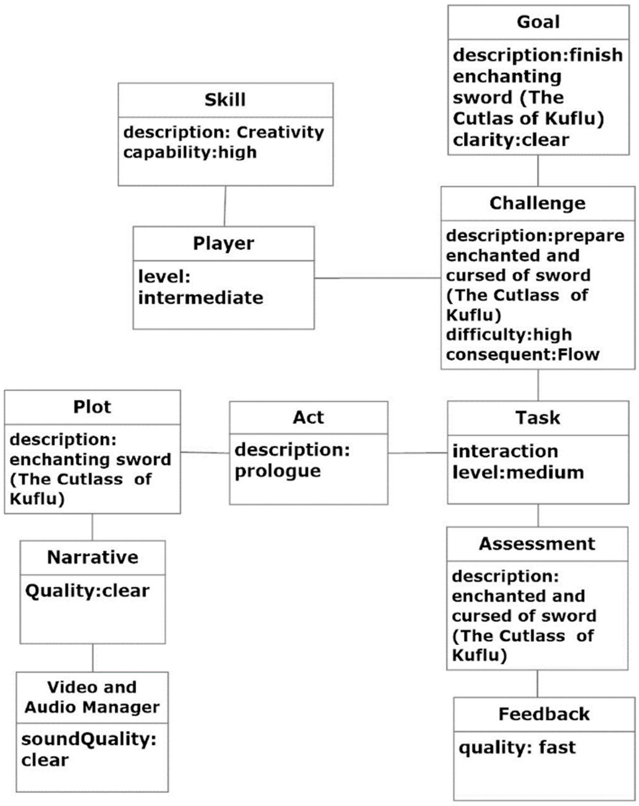

Fig. 5 Example of the Extended GLiSMo Flow Model for creating flow

Figure 5 demonstrates a flow diagram using Tales of Monkey Island Act One. For the player to experience flow, the player's skill should be intermediate and must have high creativity skills. The challenge should provide a high difficulty level for the game to be challenging. Accomplishing the task, the goal of this act should be clear and be provided at the appropriate time. The interaction level in the act should also be medium, and feedback after attempting the task should be given at the right time. The game narrative and video and audio manager should be compelling for the game to be engaging. The flow diagram can be used for the designer to show configurations that will lead to 'flow' and the configurations to avoid that will lead to 'boredom,' 'apathy' and 'anxiety.'

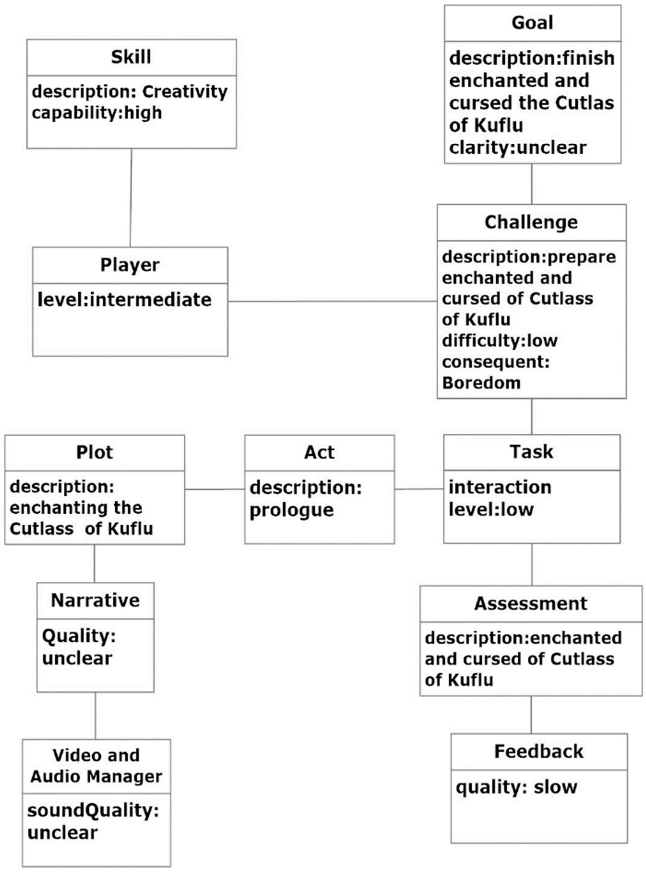

Fig. 6 Example of the Extended GLiSMo Flow Model for boredom

Figure 6 demonstrates a flow diagram for boredom using Tales of Monkey Island Act One. The players will get bore when his or her creativity is high but the level of difficulty of the game is low and the goal provided is unclear, interaction level when a player is performing a task is low, the feedback quality is slow, narrative quality is ambiguous.

IV. Conclusion

This paper proposed the FA-GLiSMo language by extending the original GLiSMo with important concepts of the adventure genre and Flow Theory. FA-GLiSMo consists of three types of diagrams: Structure, Logical, and Flow diagrams. The FA-GLiSMo now covers 19 concepts in the Structural diagram, 15 concepts in the Logical diagram, and five concepts in the Flow diagram. With the increase in several supporting concepts, the expressiveness of FA-GLiSMo will increase. The authors evaluated the expressiveness of FA-GLiSMo using FQAD. The initial result shows that FA-GLiSMo expressiveness is incomplete due to the conflicting elements and correspondence to important domain concepts that only receive the level 'some support.' After analysis, the authors concluded that the semantics of certain concepts need clarity, and the authors made the improvements. The improved FA-GLiSMo is used for demonstration by designing the Tales of Monkey Island game. A modeling tool for FA-GLiSMo was recently developed. The way forward for this research is to extend the language further to cover more learning pedagogies and another game genre. The tool could also be improved to generate underlying code according to a specific game engine automatically.

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