MoPPLiq: A Model For Pedagogical Adaptation of Serious Game Scenarios

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Abstract— In order to help teachers adapt the educational scenarios of Serious Games to their specific needs, we have built a model called MoPPLiq capable of formalizing the flow of activities in the game. This model integrates all the functionalities necessary to allow teachers to restructure the Serious Game scenario without altering the logic of the game’s storyline. In this paper, we describe the MoPPLiq model and discuss our evaluation of its expressivity by using model transformation.

Keywords— serious games, adaptation, storyboarding, modeling, authoring tools

I. INTRODUCTION

Serious Games (SGs) for educational purposes have become more numerous and more diverse over the past years. They now target all levels of education and cover a large variety of domains and subjects. However, their adoption by teachers remains marginal and much lower than one would expect. One of the typical problems that limits the adoption of SGs by teachers is their inappropriateness with the educational background [1].

The work presented in this paper tries to meet the general objective of designing tools to help teachers adapt the educational scenarios of SGs. More precisely, we present one aspect of our approach: the design of a model capable of representing and describing SG scenarios in a way that allows teachers to restructure them pedagogically.

First, we will detail “MoPPLiq”, our model that represents SG scenarios for the purpose of their adaptation. Then, before concluding, we will discuss the results of one of our evaluations concerning its expressivity. This evaluation is based on model transformation.

II. MODELING SERIOUS GAME SCENARIOS

Previous scientific work [1], and our own experience in SG design show that teachers want to be able to construct learning courses that meet their needs by organizing and sequencing the components of the SG scenario in a certain order. To meet their needs, we had to deconstruct the foundations of SG scenarios in order to model them in a meaningful way. By analyzing the existing models of SGs, but also models for TEL (Technology Enhanced Learning) systems and video games (especially design patterns), we identified three important features that we integrated into MoPPLiq, our SG scenario model.

In the following sub-sections, we present MoPPLiq through the prism of these three features.

A. Breaking Down Scenarios Into “Black Boxes”

Most of the models for TEL [2], [3] systems, video games [4] and SGs [5] break the scenarios down into a set of components defined by their goals. Some SGs are composed of a succession of components with the same game-play (e.g. Refraction1). In this case, it is very easy to model the scenario: we simply model one component and then vary its settings to represent all the other components of the SG. For the other SGs, which are made of components that have various game-plays (e.g. the quests and mini-games of Game for Science2), it wouldn’t be possible to design a generic model of the components’ inner mechanisms. Moreover, the components’ specific game play is not important when it comes to adapting the scenario. What really matters is its impact on the evolution of the scenario. In other words, we need to know the impact that each component has on the serious-player’s model and the game settings, especially if they have an impact on the other activities. This is why we decided to model the components of the SG scenarios as “black boxes” called “activities”. To describe the activities in MoPPLiq, we chose to characterize them by the educational and recreational goals they help achieve and that have an impact on the serious-player’s model and the SG’s scenario.

Figure 1. Level 6.2 of Refraction, modeled by an activity (rounded box) characterized by pedagogical goals (described in the information bubble).

For example, Refraction, a SG intended to help students learn to manipulate fractions (divisions, multiplications, additions), is divided into activities that meet educational and recreational goals. Level 6.2, for example, has the following educational goals: “Understanding that a fraction is a proportion”, “Adding fractions with different denominators”, etc. The MoPPLiq visual formalism describes level 6.2 as in Fig. 1.

1 http://play.centerforgamescience.com/refraction/site/
2 http://www.gameforscience.com/
The rounded boxes are activities. They are linked to each other, in order to depict the flow of the storyline. Each activity allows the serious-player to work on a set of goals. Some of these goals may also be prerequisites to start other activities.

B. Non-Linear Scenarios

TEL Systems, video games and SGs [4] often have non-linear scenarios, where the links between activities are conditioned by the serious-player’s actions. For instance, in Les ECSPER3 (that stands for “scientific and practical case studies for the fractures analysis” in French), the choices made by the serious-player in each activity sets the nature of the next activity.

For example, in one of the activities of this SG, the serious-player must infer whether the failure mode of a screw is brittle or ductile. If the answer is wrong, the next activity will be a support activity in which the learner will be given a short course on the subject so that he/she understands his/her mistake. If the answer is correct, the next activity will allow the learner to conduct further examinations of the screw, and the educational sub-goal “recognize a ductile failure mode” will be considered to have been “worked on” (the lack of sophisticated tracking system renders it impossible to know whether a sub-goal is actually reached or not and this is why we chose to use the term “worked on” instead of achieved).

Fig. 2 shows how MoPPLiq is able to graphically describe this kind of situation. The activity contains several “output states” that correspond to the serious-player’s choice and that are linked to different activities. The wrong answer (i.e. “Brittle”, the second output state) leads to the support activity and the right answer (i.e. “Ductile”, the first output state) leads to the next examination activity and it is linked to the educational goal that was worked on. This goal is also a prerequisite of the activity “Examination of the surface of the fracture”.

By allowing activities to have several output states with MoPPLiq, we are able to model non-linear scenarios that adapt to the serious-player’s choices and performances.

C. Adaptable Activities

Advanced SGs, TEL systems and video games often adapt their behavior to the serious-player’s model [4], [6]. To illustrate this behavior, let us take the example of Game for Science again, a Massively Multiplayer Role-Playing SG. In this SG, there is a quest called “Water you waiting for?” that teaches the various techniques to reduce the pollution of a river. Its first activity is a lab analysis exercise that has two operating modes. The first mode is the “beginner-mode” that offers a tutorial to the serious-player. The second mode is the “expert-mode”: without any help, the serious-player must perform a correct lab analysis. Depending on the serious-player’s model (i.e. having performed a lab analysis before, or not), the activity doesn’t have the same behavior. To express these different modes and their connection to the serious-players’ model (i.e. the goals they worked on in previous activities) with our model MoPPLiq, we use several input states for each activity as you can see on Fig. 3.

The sub-goal “Having done the lab analysis tutorial” is linked to the “expert” input state as a prerequisite. It is also linked to the “beginner” output state as a worked educational objective. In this example, a novice learner that starts the activity with the “beginner” input state, exits with the “beginner” output state and his serious-player model is updated with the goal “Having done the lab analysis tutorial”.

http://campus-douai.gemtech.fr/course/view.php?id=934

Figure 2. Example of a non-linear scenario. The brown tips marked 1 and 2 are the output states that represent the players’ choices and lead to different activities.

Figure 3. Part of the scenario of the quest “Water you waiting for?” (from Game for Science).
D. Maintain Logic of the Storyline

To provide teachers with a visual representation of the scenario flow graphs (e.g. Fig. 1, 2, 3, 4) and a set of tools to modify them, we implemented the MoPPLiq authoring tool. This authoring tool also features a model checking system to help the teachers maintain the logic in the storyline during its modification: when an educational prerequisite goal cannot be matched in the scenario, creating a pedagogical inconsistency, our authoring tool raises an alert so that the teacher can rearrange or add activities accordingly. If the modifications brought to the scenario create inconsistencies in the storyline, our authoring tool offers the possibility of adding “buffer activities”.

Let us explain this concept with a basic example: suppose a teacher has structured a scenario with an activity that has the prerequisite “the serious player must carry a hammer” because it will be used. However, in the scenario the teacher has designed, none of the previous activities allow the serious-player to obtain a hammer. To solve this inconsistency, the authoring tool automatically offers to insert a buffer activity that allows the serious-player to get the hammer before the activity that requires it (Fig. 4). To avoid disrupting the educational choices made by the teacher, these buffer activities have no educational purposes or prerequisite conditions.

![Figure 4. Example of buffer activity insertion in our authoring tool](image)

To ensure that MoPPLiq is adapted to most SGs, we conducted several tests, described in the next section.

III. TESTING THE EXPRESSIVITY OF OUR MODEL

Our first idea to test the expressivity of MoPPLiq, was to model a large variety of SGs with our tool. But, as it is impossible to test all types of LGs, we chose another method covering a broader spectrum of game types: trying to import data directly for SG authoring tools into our own tool. The goal was to measure what part of the models implemented into these authoring tools we are able to express with MoPPLiq’s formalism. We chose to use two very different authoring tools to test a wide range of concepts with our model: we tried to import files from Legadee [5] and eAdventure [7].

A. Import from Legadee

We were very successful importing Legadee’s files. Indeed, its underlying model is not far from ours and we were able to express most of the elements defined in the Legadee model with MoPPLiq. There is only one feature that we were not able to express with MoPPLiq: the fact that the activities are nested in bigger groups of activities. Because this feature can be useful to help teachers, we are considering the relevance of integrating it into our model.

B. Import from eAdventure

Importing eAdventure files was a lot more challenging because its underlying model is very different from MoPPLiq’s. The main difficulty was to identify the links between activities because they are referenced in several types of elements such as objects, conversations, cut-scenes, etc. Nevertheless, we succeeded in expressing most of eAdventure’s elements with our model. The only element that we didn’t manage to transpose into MoPPLiq is the centralized system that handles events and that is capable of stopping an activity and starting another one. We are currently working on extending our model to support these types of events in a discontinuous sequence of activities.

IV. CONCLUSION

Teachers express the need to adapt SGs to their specific teaching context by modifying the pedagogical scenarios. To meet this need, we propose a model, called MoPPLiq that represents SG scenarios and provides the information necessary to allow teachers to restructure them. It offers three main features to model the SG scenario. First, the scenario is cut up into a sequence of activities defined by the pedagogical and recreational goals they help achieve. Second, the actions of the serious-player are formalized as output states of the activities (linked to “worked on” sub-goals). Third, the connectors that depend on the serious-player's model are formalized through the input states of the activities (linked to prerequisite goals). This model has been implemented into an authoring tool that helps teachers to restructure the scenarios and offers a model checking system to detect and correct any inconsistencies in the storyline. This tool allowed us to test the expressivity of MoPPLiq by transforming other models belonging to two SG authoring tools into the MoPPLiq formalism. This evaluation indicates that MoPPLiq is able to express most of the elements of these models and leads the way to further improvements.

REFERENCES