

# A Design Pattern Library for Mutual Understanding and Cooperation in Serious Game Design

Bertrand Marne (Bertrand.Marne@lip6.fr), John Wisdom (John.Wisdom@upmc.fr), Benjamin Huynh-Kim-Bang (Benjamin.Huynh-Kim-Bang@lip6.fr), Jean-Marc Labat (Jean-Marc.Labat@lip6.fr)

**Cite us as:** Marne, B., Wisdom, J., Huynh Kim Bang, B., Labat, J.-M.: A Design Pattern Library for Mutual Understanding and Cooperation in Serious Game Design. Proceedings of the 11th International Conference on Intelligent Tutoring Systems (ITS 2012). p. 135-140. Springer Berlin / Heidelberg (2012).

**Abstract.** With serious games (SG) design it is difficult to offset fun and learning, especially when commercial partners, with different goals and methods, are involved. To produce an effective combination of fun and learning, we present our Design Pattern Library to address this issue. This library is aimed to help teachers fully take part in serious game design and to encourage mutual understanding between the different stakeholders enhancing cooperation.

**Keywords:** serious games, methodology, design patterns, game design, instructional design, cooperation, pedagogy

## 1. Introduction

Serious game design usually comes down to how to help teachers understand the needs and methods of game-designers<sup>1</sup>; and vice versa; furthermore, how to facilitate mutual understanding between these stakeholders and others involved in the design process.

To address these problems, one goal of our research team is to provide some design tools to facilitate collaboration, cooperation, and mutual understanding between the teachers, the designers and other stakeholders, not yet involved in the process of game creation.

We chose to build a Design Pattern Library integrating our conceptual framework based on six facets [1, 2] to allow everybody concerned to speak the same language, to be on the same conceptual wave length, and to allow some insight into the design process. We shall first discuss the previous work on Design Patterns and present our library. Next, we shall present our fieldwork applying the library to it.

## 2. Previous Work and Methodology

The state of the art on how to design serious games does not contain many references to Design Patterns. However, whether related work on ITS and video games, or guides to good practices or repositories of rules and principles, we find in the literature many elements that have formed the basis for our work. We studied DPs in education and e-learning, e.g. in Intelligent Tutoring Systems [3] or analyzing usage in learning systems [4]. But they do not take into account the game-

---

1 We can broadly group the stakeholders into two categories, the pedagogical experts and the game experts (by pedagogical experts or teachers we mean knowledge engineers, teachers, educators, and domain specialists. By game experts we mean game designers, level designers, game producers, sound and graphics designer, and so on)

playing dimension needed to design an SG.

The work specifically oriented towards serious games or at least video games seemed best suited to facilitate SG design. We therefore sought some aspects that might encompass the concept of Design Patterns as defined by Alexander [5] and described by Meszaros [6].

One of the first aspects is their organization. The list of eleven DPs for Educational Games, constructed from interviews with students (gamers) by Plass and Homer [7] lacks overall coherence. It seemed to us both difficult to use in fieldwork and to add to. The collaborative DP library, developed on the web by Barwood and Falstein [8], is another example. More than 400 patterns are (tag) referenced. But this very number would require much organization to facilitate the search for patterns and especially their use as a reference system for the various experts.

Gee [9] (a list of principles organized according to design problems), Aldrich [10] (a sophisticated encyclopaedic DP library), and Schell [11] (questions for game designers organized according to workflow) provide an interesting structural framework for both their DP libraries or design methods. But we mostly retain the work of Kiili [12], and Björk & Holopainen [13] which is closest to Alexander's [5]. Indeed, their library has an overall coherence that is both simple to understand and functional. Their DPs refer to one another to create a Pattern Language. Moreover, Björk & Holopainen [13] insist that their Design Patterns are not intended to define what is good or to give guidelines, but to catalogue known references to build a vocabulary to enable participants to discuss design.

The latter DPs were similar to what we were looking for in DPs for serious games. Unfortunately, unlike those of Kiili [12], Plass and Homer [7], and even in a way Aldrich [10] and Schell [11], the work of Björk and Holopainen [13] is not at all oriented towards the serious (pedagogical) aspect of games. Their DPs can indeed be used for designing the fun aspect of an SG, but very few of them can contribute to combining both fun and education as we would like in an SG.

We have nevertheless retained some of them. Those retained as such are followed by the words "(GD)" in the list of our Design Patterns (Section The Content of Our Design Pattern Library). Other patterns were adapted, such as "*Serious Boss*", an adaptation of "*Boss Monster (GD)*".

On the other hand, the work of Kiili [12] focuses on the design of serious games and therefore on their serious dimension. But unlike Björk and Holopainen [13] (200 DPs from interviews with 7 game designers), and also Gee [9] (who examined many successful games involved in learning), and Schell [11] (who provides 100 "lenses" for analyzing the design of serious games from his experience as a game designer and producer of many games), etc., Kiili [12] built his library from his experience designing only one single game (*AnimalClass*). In fact, the library is still rather poor (8 DPs classified in 6 categories). However, their relevance is great and we decided to adopt some of them in our library. They are followed by "(K)" (See section The Content of Our Design Pattern Library). We compiled all our collected data covering different design experience, knowledge, and methods using the Design Patterns provided by Meszaros [6].

Focused on our goal of helping experts to collaborate on serious game design, we used an empirical method to build our Design Pattern Library. To discover new patterns, we also examined different sources and studied their content. For instance, we have made an in-depth analysis of six Serious Games mixing fun and education (*StarBank*, *Blossom Flowers*, *Hairz' Island*, *Ludiville* produced by

KTM-Advance and *Donjons & Radon* produced by Ad-Invaders<sup>2</sup>).

## 1 Our DP Collaborative Library

The library consists of 42 Design Patterns classified within our conceptual framework: *The Six Facets of Serious Game Design* [1, 2]<sup>3</sup>. We shall present the entire library in a list where it is organized with the Facets (Section The Content of Our Design Pattern Library). But first, we shall present one example to illustrate how DPs can best be used: “*Reified Knowledge*” (Facet #4: *Problems and Progression*). Please note that Design Patterns are typically written in *italics*.

### 2.1. Pattern: *Reified Knowledge*<sup>4</sup>

Context: The particular game the team is designing involves a variety of competence and knowledge issues.

Problem: How can one help users become more aware of their acquired knowledge?

Forces: Several problems arise. How can we make the player aware of the progress he has made for each skill or activity without taking him out of the Flow? How can we use this type of information to enhance his/her motivation and enjoyment of the game?

Solution: Represent items of knowledge or competencies (skills) with virtual objects to be collected. If the player has acquired the requisite skill or piece of knowledge, he/she will be given an object symbolizing this or that knowledge acquisition.

For instance, in *America's Army 3*, medals can be won when special deeds are accomplished. For example, a user wins a “*distinguished auto-rifleman*” medal when he/she has won 50 games as a rifleman in combat. Medals, however, do not further player progress in the game; and are more a way of reifying the playing style by rendering it concrete. The user can see his/her acquisitions either in knowledge or skills embodied in medals awarded. Every medal is placed in a showcase, and thus is exhibited as a means of recapitulating what has been acquired.

Example: In *Ludiville* (a KTM-Advance game for a bank), knowledge about home loans is reified by beautiful trading cards (as in a game called *Magic the Gathering*). Once having learnt a new piece of knowledge, players obtain the related card, which they can use later in the game to meet new challenges

Related Patterns: *Object Collection*: also used to motivate players who like to collect things.

### 2.2. The Content of Our Design Pattern Library

– [Facet #1] Pedagogical Objectives: *Categorizing Skills, Price Gameplay vs. Educational Goals*

– [Facet #2] Domain simulation: *Simulate Specific Cases, Build a Model for Misconceptions*,

<sup>2</sup> <http://www.ktm-advance.com> and <http://www.ad-invaders.com>

<sup>3</sup> <http://seriousgames.lip6.fr/site/spip.php?page=facets>

<sup>4</sup> <http://seriousgames.lip6.fr/site/?Reified-Knowledge>

### *Elements that Cannot be Simulated, An Early Simulator, Do not Simulate Everything*

- **[Facet #3]** Interactions with the simulation: *Museum, Social Pedagogical Interaction, Serious Boss, Protege Effect (K), Advanced Indicators, Validate External Competencies, Questions – Answers, New Perspectives, Pedagogical Gameplay, Microworld Interaction, Time for Play /Time for Thought, Quick Feedbacks, Teachable Agent (K), In Situ Interaction, Pavlovian Interaction, Debriefing*
- **[Facet #4]** Problems and Progression: *Measurement achievements, Surprise, Smooth Learning Curve (GD), Fun Reward, Game Mastery, Freedom of Pace, Reified Knowledge*
- **[Facet #5]** Decorum: *Object Collection, Local Competition, Loquacious People, Graduation Ceremony, Fun Context, Wonderful World, Narrative Structures (GD), Serious Varied Gameplay, Informative Loading Screens, Hollywoodian Introduction, Comical World*
- **[Facet #6]** Conditions of use: *Two Learners Side by Side*

Our Collaborative Design Pattern Library for serious games is also available with full details on the web<sup>5</sup>.

## 3. Fieldwork and Discussion

We had the opportunity to test the Design Patterns on several occasions. First they were presented to 20 students of a video game school (ENJMIN<sup>6</sup>): future game designers, programmers, and project managers. We explained the concept of Design Pattern and each DP was shown to them. Next the students could ask questions to clarify the meaning. Finally, they answered a questionnaire on each of these Design Patterns.

Secondly, Design Patterns have been tested by two teachers who wish to make serious games. One is a university English teacher to help French students apply for a graduate course in the USA. The other is a Junior High biology and geology teacher designing a game about the body's immune system. We will present the results and conclusions of these tests.

The ENJMIN students are video game experts, and so did not learn much about making video games from our Design Patterns. Indeed, at that time, our library contained mostly DPs describing game design. However, they were not yet versed in the area of serious games, and were indeed interested in having new Design Patterns based on the educational aspects of game design.

On the other hand, the two teachers were interested in those Design Patterns that were originally meant for game designers.

The first project, called *Graduate Admission*, was our first attempt to design a game with the help of the DP Library. We started by exploring the game design possibilities using the DP *Game-Based Learning Blend*. Several other DPs were used while the design process, such as: *Narrative*

<sup>5</sup> <http://seriousgames.lip6.fr/DesignPatterns>

<sup>6</sup> ENJMIN “*Ecole Nationale du Jeu et des Medias Interactifs Numériques*” is a video game school at Angoulême, France.

*structure (GD), Time for Play /Time for Thought, Debriefing, Reified Knowledge*, etc. The DPs allowed the teacher to structure his project and to go deeper into the cultural and especially game design issues involved. For instance, without these tools, he would probably not have thought about the use of symbolic objects as metaphors for knowledge acquisition.

The second game project design focused on finding a suitable game type for teaching the immune system. The teacher chose to begin by exploring the DP Library for inspiration. The DP *Time for Play /Time for Thought* seemed very interesting both because it was adapted to the challenges posed by the teaching of immunology: the difficulty for the student to be able to keep in mind the matching mechanisms between body defenses and microbes while they are applying these in their activities (exercises). Moreover, he found the meta-cognitive aspect of this Design Pattern very stimulating. It finally allowed him to choose the right type of game play: Tower Defense. This type of game allows players first to prepare their strategies, then check, in an action phase, if the strategy is valid; and finally, they can move on to a reflective phase where they can adjust or modify their initial strategy and so on.

For both those teachers, the Design Pattern Library allowed them to find gameplay solutions for pedagogical problems.

As a conclusion, these first two opportunities to apply DPs to SG design has shown that they could indeed give one group of experts (the educational team) a language that would help them understand the aims, means, and methods of another group (game designers). Vice versa, we need to complete the DP Library with patterns focused more on pedagogy to allow the video game specialists to understand the skills and competences of the teachers in greater depth.

## 4. Conclusion and Future Avenues of Research

The Design Pattern Library fits well into our Six Facets Conceptual Framework and should in the long run enhance the game design process especially for those project members who are not specialized in video games or pedagogical ones. However, it appears necessary to improve and to complete this library by focusing more on the latter field as the number of DPs here needs to be increased and completed in greater depth. To achieve this aim, we have created a collaborative web site<sup>7</sup> where future members of our community can make suggestions and propose novel DPs of their own. Moreover they can vote and comment on Design Patterns, or translate them into another language.

## 5. References

1. Marne, B., Huynh-Kim-Bang, B., Labat, J.-M.: Articuler motivation et apprentissage grâce aux facettes du jeu sérieux. Actes de la conférence EIAH 2011. p. 69-80. Université de Mons, Mons, Belgique (2011).
2. Capdevila Ibáñez, B., Marne, B., Labat, J.M.: Conceptual and Technical Frameworks for Serious Games. Proceedings of the 5th European Conference on Games Based Learning. p. 81-87. Academic Publishing Limited, Reading, UK (2011).

<sup>7</sup> <http://seriousgames.lip6.fr/DesignPatterns>

3. Devedzic, V., Harrer, A.: Software Patterns in ITS Architectures. *Int. J. Artif. Intell. Ed.* 15, 63-94 (2005).
4. Delozanne, E., Le Calvez, F., Merceron, A., Labat, J.: A Structured Set of Design Patterns for Learner's Assessment. *Journal of Interactive Learning Research.* 18, 309-333 (2007).
5. Alexander, C., Ishikawa, S., Silverstein, M.: *A pattern language.* Oxford University Press US (1977).
6. Meszaros, G., Doble, J.: A pattern language for pattern writing. *Pattern Languages of Program Design-3.* p. 529–574. Addison-Wesley Longman Publishing Co., Inc., Boston, MA, USA (1997).
7. Plass, J.L., Homer, B.D.: Educational Game Design Pattern Candidates. *Journal of Research in Science Teaching.* 44, 133–153 (2009).
8. Barwood, H., Falstein, N.: The 400 Project, [http://www.theinspiracy.com/400\\_project.htm](http://www.theinspiracy.com/400_project.htm).
9. Gee, J.P.: *Good video games + good learning: collected essays on video games, learning, and literacy.* Peter Lang, New York, NY, USA (2007).
10. Aldrich, C.: *The complete guide to simulations and serious games: how the most valuable content will be created in the age beyond Gutenberg to Google.* John Wiley and Sons, San Francisco, CA, USA (2009).
11. Schell, J.: *The Art of Game Design: A book of lenses.* Morgan Kaufmann (2008).
12. Kiili, K.: Foundation for problem-based gaming. *British Journal of Educational Technology.* 38, 394-404 (2007).
13. Björk, S., Holopainen, J.: *Patterns in game design.* Cengage Learning (2005).