Adding User Modelling to a Serious Game

The Methodology behind “My Dream Theatre”

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I dedicate this thesis to myself, for all the support I gave myself and because I would not have done this if it were not for me.

While we are at it, I would also like to thank the following people because without them I would have not been able to write the previous sentence: Mom and Dad.

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Resumo

Ao longo dos séculos, devido a alterações na sociedade e na economia, a educação tem evolvido, originando requisitos mais exigentes em termos de competências.

Na última década, gamificação e desenho centrado em incentivos têm sido temas bastante abordados em relação à indústria de jogos e de aplicações. Mais recentemente, estas técnicas começaram a ser aplicadas na medicina para ajudar no treino de procedimentos médicos, administração de medicação, avaliações psicológicas e aconselhamento.

No mesmo contexto, o projecto SIREN procura melhorar a capacidade de resolução de conflito das crianças, dando-lhes melhores ferramentas para lidar com situações de conflito. Isto é conseguido ao dar-lhes um ambiente seguro para aprenderem sobre conflito. O objectivo desta tese é o de melhorar um jogo do projecto SIREN, o “My Dream Theatre”, tornando-o num Sistema Tutor Inteligente. Isto é conseguido com recurso a técnicas de gamificação, para amplificar a motivação dos alunos, e geração procedural de conteúdo para criar uma experiência personalizada que se adapte ao aluno enquanto o jogo está a correr, com o objectivo de melhorar a aprendizagem.

A metodologia aplicada no “My Dream Theatre” de forma a torná-lo num Sistema Tutor Inteligente e os resultados e conclusões retirados durante este processo, são descritos neste documento.

Palavras-chave: Gamificação, Aprendizagem, geração procedural de conteúdo orientada pela experiência, experiência de utilizador, SIREN, jogos sérios
Abstract

Throughout the centuries education has evolved due to economical and cultural changes, leading to more complex requirements regarding societies needs.

In the last decade gamification and incentive-centered design have been hot topics regarding the game and application industry in general. More recently, they have began being applied in medicine such as medical training, proper usage of medication, psychology evaluation and counselling.

In the same context, the SIREN project aims to improve children’s conflict resolution capabilities in order to give them tools to better handle certain situations. This is done by giving them an open, friendly and safe environment to learn about conflict. The goal of this thesis is to improve a particular game of the SIREN project, “My Dream Theatre”, making it an Intelligent Tutoring System. This is done with gamification techniques and procedural content generation, in order to better adapt the game during runtime and deliver a better and more personalized learning experience.

The methodology applied to transform “My Dream Theatre” into an Intelligent Tutoring System and the conclusions and results drawn by this process are described in this document.

Keywords: Gamification, Learning, Experience Driven Procedural Content Generation, User Experience, SIREN, Serious Games
# Contents

Acknowledgments .................................................. vii
Resumo .............................................................. ix
Abstract ............................................................ xi
List of Tables ......................................................... xvii
List of Figures ......................................................... xix
Nomenclature ........................................................ 1
Glossary ............................................................... 1

1 Introduction .......................................................... 1
   1.1 Motivation ....................................................... 2
   1.2 Original Contributions ........................................ 3
   1.3 Thesis Outline ................................................ 3

2 State-of-the-art ..................................................... 5
   2.1 Gamification ..................................................... 5
      2.1.1 What is Gamification ....................................... 5
      2.1.2 Why should we Gamify .................................... 6
      2.1.3 Applying Gamification: Serious Games ...................... 6
      2.1.4 Formal Design Paradigm for Serious Games .............. 6
   2.2 Motivation Theories ............................................ 8
      2.2.1 Self-Determination Theory .................................. 8
      2.2.2 Incentive Theory ........................................... 9
      2.2.3 Expectancy Theory .......................................... 9
      2.2.4 Game Player Motivation ................................... 10
   2.3 Procedural Generation ......................................... 12
      2.3.1 Procedural Generation in Games ............................. 12
      2.3.2 Experience Driven Procedural Content Generation .......... 12
   2.4 Intelligent Tutoring Systems .................................. 13
      2.4.1 Purpose of an Intelligent Tutoring System ................ 14
      2.4.2 Structure of an Intelligent Tutoring System ............. 14
      2.4.3 Design and Development Methods .......................... 15
2.5 Conflict ........................................................................................................... 16
  2.5.1 Conflict Management and Conflict Resolution ....................................... 16
2.6 SIREN and My Dream Theatre ........................................................................ 17
  2.6.1 Teaching about Conflict Resolution in MDT ............................................. 18
  2.6.2 Playing My Dream Theatre ......................................................................... 19
  2.6.3 My Dream Theatre as an ITS .................................................................... 20

3 Related Work ........................................................................................................ 21
  3.1 Teaching Conflict In Games ............................................................................ 21
    3.1.1 Cool School: Where Peace Rules! ............................................................. 21
    3.1.2 Peace Maker ............................................................................................... 22
  3.2 Motivating the Player ....................................................................................... 23
    3.2.1 Minecraft .................................................................................................... 23
    3.2.2 Steam .......................................................................................................... 25
  3.3 Gamified Tools and Examples ......................................................................... 25
    3.3.1 Class Dojo .................................................................................................... 26
    3.3.2 Ribbon Hero ............................................................................................... 27
    3.3.3 Gamifying an Engineering Course .............................................................. 27
  3.4 Experience Driven Procedural Content Generation in Games ....................... 29
  3.5 SIREN Project ................................................................................................. 29
    3.5.1 Village Voices ............................................................................................. 29

4 A Methodology for Self-Adapting Serious Games ............................................. 33
  4.1 Defining the Skill Set ....................................................................................... 34
  4.2 Characterizing the Environment ...................................................................... 34
    4.2.1 Identifying Interactive Components ......................................................... 34
    4.2.2 Scenarios and Termination Conditions .................................................... 35
    4.2.3 Type of Environment ................................................................................ 35
  4.3 Player Model .................................................................................................... 36
    4.3.1 Actions on the Environment ..................................................................... 36
    4.3.2 Player Actions and Events ........................................................................ 36
  4.4 Motivating and Rewarding the Player ............................................................. 37
    4.4.1 Defining Rewards ....................................................................................... 37
    4.4.2 When to Reward .......................................................................................... 39
    4.4.3 How Skills are related to the Rewards ....................................................... 39
  4.5 Recurring Assessment Component .................................................................. 40
    4.5.1 Self-Contained and Two-Part evaluations ............................................... 40
    4.5.2 How are the Rewards related to the Recurring Assessment Component ...... 41
  4.6 Double Adaptive Layer .................................................................................. 41
    4.6.1 Advantages of a Two-Layer Architecture ................................................ 41
4.6.2 Suggestion Layer ......................................................... 42
4.6.3 Manipulation Layer ..................................................... 42
4.6.4 Layer Communication .................................................. 43

4.7 Applying the Methodology to “My Dream Theatre” ................. 43
4.7.1 The Skillset .............................................................. 44
4.7.2 The Interactive Components ......................................... 44
4.7.3 The Actions ............................................................. 44
4.7.4 The Scenarios .......................................................... 45
4.7.5 The Type of Environment ............................................ 45
4.7.6 The Player Model ...................................................... 45
4.7.7 The Rewards ........................................................... 46
4.7.8 The Adaptation ........................................................ 48

5 My Dream Theatre Architecture ............................................. 49
5.1 General Architecture ..................................................... 49
5.2 Adaptation Module ....................................................... 50
5.3 Double Layer Architecture ............................................. 50
5.3.1 Skill Suggestion Layer ............................................... 51
5.3.2 Game Adaptation Layer .............................................. 52
5.3.3 Badges ................................................................. 53
5.4 Solution Evaluation ....................................................... 54
5.4.1 Applying the Methodology .......................................... 54
5.4.2 User Testing .......................................................... 54
5.5 Conclusions and notes ................................................... 56

6 Conclusions ................................................................. 59
6.1 Future Work .............................................................. 60
6.1.1 Extended Period of Testing ........................................ 60
6.1.2 Task, Reward and Skill Ontologies ................................. 61
6.1.3 Adjusting Reward Difficulty ....................................... 61
6.1.4 Applying the Methodology to non-Serious Games ............ 61
List of Tables

5.1 Age distribution of “My Dream Theatre” testers .............................................. 57
5.2 Adaptation Game 1 Analysis ........................................................................... 57
5.3 Adaptation Game 2 Analysis ........................................................................... 58
# List of Figures

2.1 Self-Determination Theory ................................................. 8  
2.2 Expectancy Theory ......................................................... 10  
2.3 Richard Bartle's Player Taxonomy ....................................... 11  
2.4 John Radoff's Game Player Motivations ................................. 11  
2.5 ITS Structure ............................................................... 15  
2.6 ITS Development ............................................................ 16  
2.7 Dual Concern Model ......................................................... 17  
3.1 Cool School ................................................................. 22  
3.2 Peace Maker ................................................................. 23  
3.3 Minecraft Biome ............................................................. 24  
3.4 Minecraft Achievements .................................................. 24  
3.5 Team Fortress 2 ............................................................... 25  
3.6 Steam platform .............................................................. 26  
3.7 Class Dojo ...................................................................... 26  
3.8 Ribbon Hero ................................................................. 27  
3.9 MCP student types ......................................................... 28  
4.1 Suggestion Layer ............................................................ 42  
4.2 Manipulation Layer ......................................................... 42  
4.3 Layer communication ..................................................... 43  
5.1 Integration Architecture ................................................ 49  
5.2 Adaptation Integration ................................................... 50  
5.3 Suggestion System Architecture ...................................... 52
Chapter 1

Introduction

Conflicts seem to arise in almost every context and developmental stage of human life. Social conflict can be observed in the form of scuffles in school-yards, to bullying in the workplace or even in international warfare. Whether conflicts are inevitable or not is disputed, but there is a common agreement that there is a necessity to educate conflict resolution in the early stages of life.

The SIREN project\(^1\) is an international project that aims to create a new type of educational game, the conflict resolution game, which takes advantage of recent advances in serious games, social networks, computational intelligence and emotional modelling to create uniquely motivating and educating games that can help shape how children think about and handle conflict. The software developed by the project is able to automatically generate conflict scenarios that fit the teaching needs of particular groups of children with varying cultural backgrounds, maturity, and technical expertise, and the desired learning outcomes as specified by their teacher. By doing this, teachers, without specific technical training, can use the system in their classes and improve their students learning experience.

Currently the SIREN project is composed of two games: “Village Voices” and “My Dream Theatre”. While Village Voices is a game that promotes experiential learning, social constructivism and problem solving, “My Dream Theatre” was designed to prepare and teach skills to children related to conflict situations by making them act as a mediator instead of being the protagonist in the conflict situation.

In “My Dream Theatre”, the player takes the role of a theatre director that must manage a cast of several actors, each with their own personality perks, issues and acting skills. It is up to the director to assign each role of the play to an actor while keeping in mind that actors may become unhappy if they do not get the roles that they like. If an actor becomes disgruntled enough, a conflict situation will arise and actors may spread that conflict and/or leave the play. This will cause the performance to receive less points, in form of applause. In this serious game, it is expected that the player increases his or her vocabulary and meaning of many conflict related words such as, mediation, assertive, cooperative, etc. Also, it is expected that the game adapts to the needs of the player by providing conflict scenarios generated on the fly. These scenarios are not imposed but suggested and it is up to the teacher to decide if that scenario is indeed appropriate for the learning needs of the player.

\(^1\)http://sirenproject.eu/
This automatic generation of conflict scenarios is done by using techniques similar to the ones used procedural content generation that have been used on other games. These techniques were mostly developed by João Bertrand Cabral Campos et al. [2013b] in his thesis.

What was lacking on “My Dream Theatre”, prior to this thesis, was a structure that could assess the knowledge of the player and adapt the game so that it suits their learning needs. Also, player motivation was solely tied to game mechanics. This caused some players to not be motivated to learn because the game did not encourage them to explore different conflict resolution techniques. To better motivate the player, gamification techniques were applied to the existing game design.

In order to do this it was necessary to define an approach, a methodology if we may, to apply to “My Dream Theatre”. This methodology has to guarantee that the following characteristics: can be used on several games; keeps track of the players knowledge regarding several subjects; suggests a learning path and motivates the player.

This resulted in the definition of a Player Model, that accommodates the players experience, a Reward System that rewards the player when certain milestones are achieved, and a Knowledge evaluator that assesses the current knowledge of the player based on his actions and Rewards won. This was then implemented on “My Dream Theatre”, with the game engine Unity3D\(^2\) over the course of three months, followed by a one month evaluation of the system.

### 1.1 Motivation

With the constant changes in the economy status and society values, education methods are forced to evolve in order to better suit the teaching needs of the new generations.

Player motivation and Gamification are two closely tied subjects. As the gaming industry\(^3\) keeps growing, more and more people, from all ages, make contact with games on a daily basis. Such popularity makes people more receptive to game elements in non-game environments. Gamification uses game design techniques and game mechanics in non-game contexts to further engage users to learn and solve problems.

The SIREN project, which is composed of several serious games, aims to use these gamification techniques, coupled with procedural content generation, in order to deliver a personalized learning experience that is on par with the needs of the younger generations.

This thesis has two main motivations. The first one is the need improve the existing SIREN project game, “My Dream Theatre” by turning it into an Intelligent Tutoring System. Prior to this thesis, “My Dream Theatre” could not keep track of the players knowledge and adapt to it accordingly.

The second motivation is, since there is a lack of a methodology that guarantees the characteristics required by the SIREN Project - self-adapting games that evaluate the players knowledge and deliver a personalized learning experience - to propose said methodology.

In order to do this there was a research on motivational and gamification techniques, generation of

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\(^{2}\)http://unity3d.com/

procedural content, mainly experience driven ones, the development and components of an intelligent tutoring system and finally, conflict management styles and techniques.

All in all, this thesis aims to answer the following question:

*How can user modelling aid the process of adapting a serious game to the pedagogical needs of the user?*

### 1.2 Original Contributions

This thesis improved the game “My Dream Theatre” by applying gamification techniques and user modelling to make it into an Intelligent Tutoring System. This way, “My Dream Theatre” can now keep track of the players knowledge regarding conflict management and resolution strategies and adapt to it accordingly.

To achieve this, it was necessary to define a methodology that can be used on several games, keeps track of the players knowledge regarding different subjects, suggests a learning path and motivates the player.

The result of applying said methodology was the definition of a Player Model that accommodates the players experience, a Reward System that rewards the player when certain milestones are achieved and a Knowledge Evaluator that assesses the current knowledge of the player based on his actions and Rewards won.

Afterwards, this was implemented in “My Dream Theatre” with the Unity3D engine during February, March and April, and then it was tested with students over the course of May. This was the imposed schedule due to basic school calendar restrictions.

With what was observed and learned during the development and evaluation of “My Dream Theatre”, is then recorder and analysed on this document.

### 1.3 Thesis Outline

In the following chapters the research that was done and what was implemented will be presented on detail.

On chapter 2, we will start by explaining what is Gamification and why should it be used on section 2.1. Followed by motivational theories on section 2.2. Procedural generation content and techniques are analysed on section 2.3. The structure, development methods and purpose of Intelligent Tutoring Systems are described on section 2.4. A brief review of what are conflict management and conflict resolution techniques can be read on section 2.5. The SIREN project, its goals and “My Dream Theatre” are described in section 2.6.

Then on chapter 3, in section 3.1 we look into what was done regarding teaching conflict, how are players motivated by games is described on section 3.2, a sample of what are recent gamified tools and examples can be seen on section 3.3, and where has experience driven procedural content
generation has been used can be seen on section 3.4. Finally the other SIREN Project game, “Village Voices” is looked into more detail and compared to “My Dream Theatre” regarding educational goals and techniques on section 3.5.1.

The definition of the methodology can be seen on chapter 4 along with its application on “My Dream Theatre”.

On chapter 5, the current architecture of “My Dream Theatre” is presented, including what was done previously and what is contributed by this thesis, including the architecture and the defined badges. The results of the evaluation of the implemented system can be seen on chapter 5.4.

Finally, the conclusions and future work of this thesis are described on the chapter 6.
Chapter 2

State-of-the-art

In order to properly use gamification and procedural generation of content techniques in an educational context, research had to be done in the fields of Gamification, Motivation Theories, Procedural Generation of Content, Intelligent Tutoring Systems, conflict management and resolution techniques, and the work already done on the project in which “My Dream Theatre” by Campos et al. [2013a] is integrated, the SIREN Project. This research is presented in the following sections.

2.1 Gamification

In this chapter it will be explained what is Gamification and why is Gamification being used more and more these days since the term got coined in 2002 by Nick Pelling Zichermann and Cunningham [2011]. In this chapter we will also look into a practicable application of Gamification in the form of Serious Games.

2.1.1 What is Gamification

Video games are today one of the main forms of entertainment in Europe¹ and the rest of the world² and are being used as a medium to convey ideas and sell brands³. With the continuous growth of the gaming industry⁴ more and more people, from all ages, make contact with games on a daily basis. Such popularity makes people more receptive to game elements in non-game environments. Gamification uses game design techniques and game mechanics in non-game contexts to further engage users to learn and solve problems. A task can be Gamified in several ways but at it is core there is always a reward, as it was demonstrated by Hamari [2011]. This reward can be a badge, a trophy, a medal or something of monetary or personal value. Sometimes a task can be Gamified in such a way that there is a competition between the people that are trying to complete the task or there is a usage of meaningful choices or the introduction of the notion of a difficulty level. All of these serve to amplify the information

¹http://kotaku.com/5011072/study-video-games-mainstream-entertainment-in-europe
²http://www.esrb.org/about/video-game-industry-statistics.jsp
learning and retention of information by the player. Gamification techniques can, oddly, be applied to tasks inside a game that are cumbersome or hard to understand by the players. For example, a tutorial can be designed with the same principles that exist when gamifying a task.

2.1.2 Why should we Gamify

As stated in the previous section 2.1.1 there is a large part of the world population that has or had contact with games, in particular videogames, on a daily basis. Since the purpose of games is to entertain, it seems logical that if we turn a task into a game, that would be more pleasing to the person performing it. In order to know if we should Gamify a task, there should be some key points that must be addressed: Can we clearly identify the beginning and end of the task? Is there anything that can be improved by the player performing the gamified task? The people performing the task will be more motivated if the task is gamified?

In section 2.2 some motivation theories are addressed and related to Gamification. Regarding motivational theories there is always the issue that the intended is not being motivated\(^5\).

2.1.3 Applying Gamification: Serious Games

When we Gamify a task and turn it into a game we may not want that the player merely gets an extra motivation. There are cases in which the gamification serves to instruct and educate the player in matters that are hard or costly to teach, such as piloting an air plane. In such cases when the game has a primary purpose to educate, that game is defined as a serious game.

The notion of serious games has been around for a while. In 1970, Abt wrote that “serious games in the sense that these games have an explicit and carefully thought-out educational purpose and are not intended to be played primarily for amusement” Vogel [1970]. Since then Serious Games have been used in almost all areas, from education to aviation with varying degrees of success.

Although we can apply Gamification to a non-virtual task, by virtualizing the task we gain access to a controlled environment and to analysis tools that are impracticable or time-consuming to use in the real world. Examples regarding serious games can be consulted in the Related Work section 3, including one of the games of the SIREN Project, “Village Voices”.

2.1.4 Formal Design Paradigm for Serious Games

As it was stated by Gunter et al Gunter et al. [2006] in “A Case for a Formal Design Paradigm for Serious Games” there is a recent “mad rush to pour educational content into games or to use games in the classroom in an inappropriate manner and in an ad hoc manner in hopes that players are motivated to learn simply because the content is housed inside a game.” As such, they formalized a design paradigm for Serious Games based on the three principles identified by Robert Gagne in “The Conditions of Learning”, that are essential for instruction:

\(^5\)http://www.fastcodesign.com/1662656/sixty-two-reasons-why-gamification-is-played-out
• Provide instructions on the set of component tasks that build towards a final task;

• Ensure that each component task is mastered;

• Sequence component tasks to ensure optimal transfer to the final task.

According to Gagne’s theory, accomplishing these sequenced steps would assure that the student mastered the desired content and the learning objectives.

Coupled with Kellers ARCS Model ⁶ and game design elements, they proposed the following steps to help to ensure success and the feeling by players that the learning objectives are possible to achieve:

• 1. Create a situation that will gain the player’s attention via dramatic elements

• 2. Describe the upcoming choice in detail to ensure that the intent of a didactic choice is communicated

• 3. Know the state of the game at the outset of the didactic choice, and further, know the state of the instruction. Additionally, ensure that the placement of this choice is on par with other choices.

• 4. Determine how the didactic choice will be presented in the context of the game and determine the learning objectives that will be satisfied by this choice.

• 5. Extrapolate how the player will arrive at his choice and provide learner guidance during the course of the choice to assist in the acquisition of knowledge

• 6. Determine the consequences of each didactic choice and their impact on the instruction

• 7. Determine how to best assist the player in attribution of the outcomes of these didactic choices and how to assist the player in learning from mistakes

• 8. Describe how the choice affects assessment with regard to learning objectives and describe how this assessment will be communicated to the player

• 9. Describe the linkage of this choice to other choices that will reinforce the lesson and test the transfer of knowledge.

In conclusion they affirm that “As these learning principles are embedded during the design and construction of the games, better opportunities to teach content to students than most of what is being used to develop lesson activities in today’s classroom — classrooms being occupied by digital, game playing students – emerge.” Gunter et al. [2006].

The design and development of “My Dream Theatre” followed a similar approach and the methodology proposed in section 4 assumes that the game in question follows most of the previously stated steps.

⁶http://www.arcsmodel.com/
2.2 Motivation Theories

When Gamifying a task it is of utmost importance to make sure that the player is properly motivated so that the gamification achieves its purpose: to make a task more enjoyable to the one doing it. In this chapter three important theories regarding Motivation will be briefly reviewed: Incentive theory by Eysenck and Keane [2000a], Expectancy theory by Shepperd and Taylor [1999] and Ulrich [1976]; and Self-Determination theories by Ryan [2009]. Afterwards, Game Player Motivation will also be reviewed regarding what is thought to be believed that motivates a player to play a game.

2.2.1 Self-Determination Theory

The Self-Determination theory is a macro theory of human motivation and personality, concerning people’s inherent growth tendencies and their innate psychological needs. It was initially developed by Edward L. Deci and Richard M. Ryan, and has been elaborated and refined by scholars from other countries. Self-Determination Theory evolved from studies comparing the intrinsic and extrinsic motives, and from growing understanding of the dominant role intrinsic motivation played in an individuals behaviour.

Intrinsic motivation is the drive to seek out challenges and new possibilities that this theory associates with cognitive and social development. In contrast, Extrinsic motivation comes from external factors that may be an external demand or reward, the need to maintain self-worth, identification with preferred goals and external regulations that force a certain behaviour even though it is not enjoyed.

In this theory there are three innate needs that are identified and if they are satisfied they allow optimal function and growth: Competence, Relatedness and Autonomy.

As is depicted on Figure 2.1, Competence is the will to seek to control the outcome and experience mastery. Relatedness is the universal want to interact, be connected to, and experience empathy. Autonomy is the universal urge to be causal agents of one’s own life and act in harmony with one’s integrated self. As long as these three needs are satisfied, motivation should be within satisfactory levels.

![Figure 2.1: The Self-Determination Theory.](http://www.selfdeterminationtheory.org)
2.2.2 Incentive Theory

According to Incentive Theory, a person is more attracted toward behaviours that offer positive incentives than behaviours associated with negative incentives. Depending on the person, the notion of positive and negative varies and different behaviours can be observed for the same incentives, as stated by Douglas Bernstein [2005] and Eysenck and Keane [2000a].

Motivation can come from two sources, either from one-self or from others. When a reward of any kind is given after an action is performed, that reward is reinforcing the occurrence of that action. This is extrinsic motivation. Positive reinforcement aims to increase the frequency of a behaviour by introducing a positive stimulus, while a negative reinforcement removes an aversive stimulus.

Applying a proper reward can be hard since sometimes it may stimulate another behaviour than the one that was expected to be stimulated or it may not stimulate a behaviour at all.

2.2.3 Expectancy Theory

In 1964, Victor H. Vroom\(^8\) defined motivation as an individual process that governs choices among alternative forms of voluntary activities. Choices made by a person are influenced by how well the expected results of a given action or behaviour are going to match up to ones expectations. As such, Motivation can be described as the product between that person's Expectancy that a certain effort will lead to the intended performance, the Instrumentality of the performance to achieving his or her goals, and the desirability of this result for the individual, also known as Valence.

In more detail we can describe Expectancy as the persons belief that his efforts (E) will result in the attainment of performance (P) goals. This is closely related to self-confidence and past experience. Instrumentality can be described as the belief that if the performance goals (P) are attained, then he or she will get a reward. Finally, Valence is the value that the player places on the rewards based on his or hers needs, personal goals, values and sources of motivation.

As such, we can describe Motivation, like in figure 2.2, as the product between:

\[
\text{Motivation} = \text{Expectancy}(E) \times \text{Instrumentality}(I) \times \text{Valence}(V).
\]

This theory has been criticized several times by Porter and Lawler [1968] by being too simplistic and not being able to describe motivation properly when the there are several outcomes for achieving the goals. As such, Lawler suggested a new model of Expectancy theory based on four points: a person will usually have a preference among different outcomes; the person believes that their actions will let them achieve the outcome they desire; the desired outcome is generated by the persons behaviour; and finally, the actions performed by the person are performed taking into account the preferred outcome and expectation of that person.

\(^8\)http://id.loc.gov/authorities/names/n50013142.html
2.2.4 Game Player Motivation

In 1996 Bartle [2003] identified and described four approaches to playing Multi-User Dungeon Games. These approaches arise from the inter-relationship of two dimensions of playing style: action versus interaction; and world-oriented versus player-oriented; and from what he identified as the four things that players enjoyed most while playing Multi-User Dungeon Games: achievement within the game context, exploring the game, socialising with others and imposing oneself on others.

With this he characterised players in four types: Achievers; Explorers; Socialisers and Killers, as can be seen on Figure 2.3. He described Achievers as players that “regard points-gathering and rising in levels as their main goal, and all is ultimately subservient to this.” They only explore if it’s necessary, socialise in order to relax and gather information and only kill other players if they are in their way. Explorers are known for “try progressively esoteric actions in wild, out-of-the-way places, looking for interesting features (i.e. bugs) and figuring out how things work.”. Their joy comes from discovering new things and have little regard from interacting with other players in any way or achieving high scores. Players that like to empathise with people, sympathise, joke, entertain, listen or even merely observing people play are Socialisers. They will explore, achieve high scores and enter in skirmishes with other players in order to gain a better understanding about others and ultimately develop long-lasting relationships. Killers are known for imposing themselves on others. Exploring and getting high scores are usually means to achieve a particular form of socialising: killing other players. They are motivated by the rush to cause distress on others and achieving a kill in a new and ingenious way. Bartle [2003]

More recently Jon Radoff [2011] attempted to provide a new model of player motivations that has the simplicity of Bartle’s original template, yet is not restricted to Multi-User Dungeon Games or Massive Multiplayer Online Role Playing Games. In his formulation, he defines two axes that define the environment the player is in: the horizontal axis is the number of players involved in an element of gameplay. The further to the left the closer the game is to a single player game; to the right, the more players there are, the closer the game is to a Multiplayer Game. The vertical axis is the measurement used to communicate to the player how are they “winning” in the category of motivation. If we are closer to the top of the vertical axis things are more quantitative, such as leaderboards and point systems. If we are closer to the bottom there are more qualitative rewards such as emotions and stories. This is depicted on Figure 2.4.

According to these axes, the four quadrants are: Immersion, Achievement, Cooperation and Competition.

- Immersion is what relates to stories, role-playing, exploration, imagination, and a sense of connectedness to the world of the game.
• Achievement is the sense of progress, mastery of skills and knowledge.

• Cooperation is what defines player involvement in activities where they are helping each other, through creativity, shared adversity and overall group activities.

• Competition defines the player involvement where individuals compete over scarce resources, comparison, and win/loss situations.

As it can be seen, what motivates a player can also be defined by the previously described motivation techniques with the added characteristic that, by looking at what type of game the player is playing we can more clearly identify what motivates him or her in said game.

Now, since “My Dream Theatre” is a single-player game, according to Radoff’s research, we should
motivate the player by offering immersion and a sense of achievement instead of complex social interactions. This will reflect heavily on how we decided to motivate the player.

2.3 Procedural Generation

Procedural generation is the creation of media content automatically and usually on the fly, by using algorithms rather than creating it manually. With the advances on technology and consumer demand this type of technique is being more used in games today than in the past. In this chapter we will discuss Procedural Generation in Games and in particular Experience Driven Procedural Content Generation.

2.3.1 Procedural Generation in Games

While software developers have applied procedural generation techniques for years\(^9\), only until the last decade did some products employed this approach extensively. Procedurally generated elements have appeared in earlier video games such as The Elder Scrolls II: Daggerfall, which takes place on a mostly procedurally generated world, to modern titles like Borderlands, The Elder Scrolls IV: Skyrim\(^10\) and Minecraft\(^11\). The latter having procedurally generated content at the very core of the game. Adding this type of content to games has two main advantages: avoiding repetition and adapting the game to the player. As in most games, in order to keep the player engaged a game should, while taking into account the scope of the game, offer as much new experiences as possible. If the player is already expecting something, the surprise factor is lost and the players expectations may lower. If the game can change just enough that the player is not bored, so the better. This is further enhanced if the generation of content can be adapted to type of player that is playing the game. This adaptation can be done by collecting the player’s opinion after he has played the game – Subjective Player Experience Modeling – or it can be done by analysing the player’s reaction during the game – Objective Player Experience Modeling – or it can be done by observing the player’s actions and reactions in the game – Gameplay-based Player Experience Modelling. These topics will be developed in the following subsection 2.3.2.

2.3.2 Experience Driven Procedural Content Generation

In Experience-Driven Procedural Content Generation, Georgios N. Yannakakis and Julian Togelius described Procedural content generation (PCG) as “(..) an increasingly important area of technology within modern human-computer interaction (HCI) design. Personalization of user experience via affective and cognitive modeling, coupled with real-time adjustment of the content according to user needs and preferences are important steps towards effective and meaningful PCG. (…)” Yannakakis and Togelius [2011] and Shaker et al. [2012].

Procedural content generation refers to the generation of content based on a pre-set of rules and collected data about the user. That content is then used to personalize the experience of the user. Per-

\(^9\)http://pcg.wikidot.com/
\(^10\)http://www.elderscrolls.com/skyrim/
\(^11\)https://minecraft.net/
sonalization of user experience is widely used on websites such as Amazon, in the form of suggestions of what you may want to buy or what others with similar tastes as you bought. It is also used in games such as Minecraft in order to generate coherent levels and biomes based and Whittaker [1970] Biome diagram.

Experience Driven Procedural Content Generation is of particular interest to “My Dream Theatre” Campos et al. [2013a] because each player will have different pedagogical needs and the game must be able to deliver them. This is done with Gameplay Experience Modelling GPEM Yannakakis and Togelius [2011] - by collecting data about the actions that the player does and what he has done in the past. For example, by evaluating the way that the player resolved conflicts and the badges that he earned previously, we may suggest a scenario that Promotes Yielding. It is then up to the player or to his tutor, to accept this scenario. Also, at the end of each Scenario, the tutor may rate the Scenario through a small quiz – Subjective Player Experience Modelling – in order to better filter results that are presented to players. The main assumption that drives GPEM is that player actions and real-time preferences are linked to player experience. Thus, by observing patterns of interaction and associating it context variables, it is possible to understand what the player is doing and what he might be learning. Subjective Player Experience Modelling considers only first person reports. Subjective player experience modelling can be based on either player’s free-response during play or on data collected through questionnaires, as demonstrated by Yannakakis and Togelius [2011].

Even though in “My Dream Theatre” we are not creating new content, we are adapting existing content to the user, based on the information stored on the Player Model. This information is the result storing the actions of the player on environment and then analysing said actions to adapt the game accordingly.

2.4 Intelligent Tutoring Systems

The concept of intelligent machines teaching students without the aid of a human teacher dates back as early as 1924, when Sidney Pressey of Ohio State University created a mechanical teaching machine that resembled closely to a typewriter with a window. This machine provided the learner with questions, allowed user input and provided immediate feedback by recording the score on a counter. With breakthroughs in Artificial Intelligence and the creation of the BASIC programming language in 1958, many schools and universities began developing Computer Assisted Instruction programs to aid student learning. This later evolved into what is know described as an Intelligent Tutoring System – ITS Lane [2006]. In this section we will look into the purpose of this type of system, its structure and what are the actual design and development methods.

In section 2.6.3 we will look into what had to be made in order to transform “My Dream Theatre” into an ITS.

12http://cis-alumni.org/TKurtz.html
2.4.1 Purpose of an Intelligent Tutoring System

Automation has had a notable impact in most industries since its inception in the manufacturing industry. Work posts that were deemed irreplaceable such as telephone operators have since been replaced largely by automated telephone switchboards and answering machines. In medicine, medical processes such as primary screening in electrocardiography or radiography are carried out at much greater speed and accuracy by automated systems. Automated teller machines have reduced the need for bank visits to obtain cash, perform payments and consult the balance. In general, automation has been responsible for the shift in the world economy from industrial jobs to service jobs in the 20th and 21st centuries. Automating a teaching process can be trickier since each student has different needs and requirements. As such, the definition of an Intelligent Tutoring System was born with research done by Lane [2006]. The purpose of an Intelligent Tutoring System is to enable a meaningful and effective learning manner by using a variety of computing technologies. Unlike other automation processes this one does not aim to fully replace teachers but does aim to take care of adapting what is taught to the student according to its own needs, stated Lane [2006].

2.4.2 Structure of an Intelligent Tutoring System

Following general consensus among researchers Sleeman and Brown [1982] the structure of an Intelligent Tutoring System is composed of the following: The Domain model; The Student model; The Tutoring model, and The User Interface model.

The Domain Model, developed by Anderson et al. [2004], is built on the cognitive architecture Adaptive Control of Thought-Rational – ACT-R – which tries to take into account all the possible steps required to solve a certain problem. Nkambou et al. [2010] stated that this model "contains the concepts, rules, and problem-solving strategies of the domain to be learned. It can fulfil several roles: as a source of expert knowledge, a standard for evaluating the student's performance or for detecting errors, etc.”.

The Student Model can be seen an overlay on the Domain Model. It is considered to be the core component of an ITS. It pays special attention to student's cognitive and affective states and their evolution as the learning process advances. As the student's proficiency in their problem solving increases, the system engages in a process called Model Tracing. Whenever the Student Model deviates from the Domain Model, the system identifies, or flags, that an error has occurred.

The Tutor Model accepts information from the domain and student models and makes choices about tutoring strategies and actions. This model should, whenever the learner requires, show what should be done next, relative to their current location in the model. In addition, the system should provide feedback to the student whenever he deviates from the Student Model. The tutor model must also calculate the odds that the student has learned certain skills and update his or her standing on the Student Model accordingly. This process is known as Knowledge tracing. Knowledge Tracing builds a profile of strengths and weaknesses relative to the Student Model regarding the actions that the student performed. This includes whenever the student requires for assistance.

13http://www.boston.com/bostonworks/galleries/30fast DECLINING OCCUPATIONS?pg=10
The User Interface model is responsible for clearly stating what is being taught and provide means to the student to explore and solve the problems presented.

Intelligent Tutoring Systems architectures reflects the emphasis that is given to the level of intelligence of the different models. A given system may generate new problems so that students can always have new problems to work on, but it might only have simple methods for teaching those problems. In contrast, another system that concentrates on multiple ways of teaching a particular topic might use a less sophisticated way of presenting the content that is being taught.

![ITS Structure](image)

Figure 2.5: ITS Structure.

2.4.3 Design and Development Methods

According to Anderson et al. [2004], the development of an ITS is similar to an instructional design process and consists of four iterative stages: needs assessment, cognitive task analysis, initial tutor implementation and evaluation, as is depicted on Figure 2.6.

The needs assessment stage involves a learner analysis, consultation with experts on the field and eventual users of the system. The goal of this first step is to specify learning goals and the overall direction of what is being taught. At this stage it is important to understand the learners’ needs and behaviours and the teachers requirements. While doing this one must take into account the probability that students can successfully solve problems, the time that it takes to the students to progress through the Student Model and, finally, the probability that the student will use the knowledge that he learned in the future. It is also important to conduct extensive testing in the interface regarding usability both in students and teachers, as demonstrated by Anderson et al. [2004].

The goal of the cognitive task analysis stage is to develop a valid computational model of the required problem solving knowledge. This implies interviewing domain experts, conducting “think aloud” protocol studies with domain experts, conducting “think aloud” studies with novices and observation of teaching and learning behaviour. This is done to clearly identify behaviours and ways of solving problems.

The initial tutor implementation involves setting up a problem solving environment in order to enable and support the learning process. This stage is followed by an evaluation of the system like any other software project.

The evaluation should include pilot studies to confirm basic usability and educational impact with
the target population of the system; formative evaluations of the system under development, including parametric studies that examine the effectiveness of system features and finally in order to check if everything is going as planned.

Figure 2.6: ITS Development Phases.

2.5 Conflict

Conflicts seem to arise in almost every context and developmental stage of human life. Social conflict can be observed in the form of scuffles in school-yards, to bullying in the workplace or even in international warfare. In this chapter we will look into conflict management and conflict resolution taking into account Thomas-Kilmann Conflict Mode Instrument, developed by Kilman and Thomas – TKI – and the Dual concern model of conflict resolution by Forsyth [2006]. We will also look into the work of the SIREN Project and its purpose.

2.5.1 Conflict Management and Conflict Resolution

Conflict Management and Conflict Resolution are the methods and processes involved in the resolution of conflict. This resolution may or may not be peaceful but will surely mitigate or even solve the conflict. Conflicts are inevitable and will occur as long as there is interaction with other people so, in order to improve the teenage and adult phases of life, it would be best to educate and give some sensibility to conflict resolution in the early stages of life. Conflict is usually deemed as something negative, however, conflict can also be positive if there is something to be learned from that conflict. Currently Conflict Resolution may be characterized by the Thomas-Kilmann Conflict Mode Instrument TKI and the Dual concern model of conflict resolution, spawned by Blake and Mouton [1978] studies, that identifies five conflict resolution styles: Avoidance, Yielding, Cooperation, Competitive and Conciliation. These conflict based styles are based on the assumption that people are either assertive, care for themselves, or cooperative, concern for others.

• Avoidance is characterized by low cooperativeness and low assertiveness. As the name states, avoidance occurs when the protagonist tries to avoid or postpone the conflict by ignoring it. The personal needs and the others’ needs are not important.

• Yielding is characterized by high cooperativeness and low assertiveness. In this approach, a protagonist sacrifices his or her own needs, in order to accommodate the other party’s goals. The protagonist concerns on satisfying only the others’ needs, thus being the contrary of competition.
Cooperation is characterized by high cooperativeness and high assertiveness. It is described by trying to achieve an agreeable solution for the problem between the conflicting parts, in order to satisfy the protagonist’s goals and the others’ goals. This approach tries to reach a win-win situation.

Competitive is characterized by low cooperativeness and high assertiveness. In this approach, protagonists try to maximize their own goals at expense of others, thus creating a win-lose situation.

Conciliation is characterized by medium cooperativeness and medium assertiveness. Its purpose is that both parties give up some part of their goals in order to establish an agreement. There are no winners or losers in this approach.

This is summarized in Figure 2.7.

2.6 SIREN and My Dream Theatre

The main goal of the SIREN project, headed by G. N. Yannakakis [2010], is to create an intelligent interactive software system, composed of several serious games, which should aid the teachers role in educating young people on how to resolve conflicts. Currently the SIREN project is composed of two games: “Village Voices” and “My Dream Theatre” developed by Campos et al. [2013a]. While “Village Voices” is a game that promotes experiential learning, social constructivism and problem solving, “My Dream Theatre” – MDT – was designed to prepare and teach skills to children related to conflict situations by making them act as a mediator instead of being the protagonist in the conflict situation. In “My Dream Theatre”, the player takes the role of a theatre director that must manage a cast of several actors, each with their own personality perks, issues and acting skills. It is up to the director to assign each role of the play to an actor while keeping in mind that actors may become unhappy if they do not
get the roles that they like. If an actor becomes disgruntled enough, a situation will arise and actors may
spread that conflict and/or leave the play. This will cause the performance to receive less points.

The objective of the game is to teach players about how conflict appears and how it can be handled
and solved. To achieve this goal, the game integrates conflict resolution skills into the actual gameplay.
This is done in two ways, firstly by allowing the player to attribute roles and generate conflict and,
secondly, by using the appropriate mediation strategy, taking into account the actors personality, to
solve the conflict. This way, it is expected that the player increases his or her vocabulary and meaning
of many conflict related words such as mediation, assertive, cooperative, etc.

Prior to the contributions of this thesis, the only adaptation that MDT had was regarding to the
knowledge that the player regarding game mechanics. With what was added the game now adapts to the
players’ knowledge of conflict and, consequentially, also to game mechanics. This is done by providing
a conflict scenario tailored to improve the players’ knowledge, based on the work of G. N. Yannakakis
[2010].

2.6.1 Teaching about Conflict Resolution in MDT

Teaching about conflict resolution encompasses solving a problem by having the involved people in the
dispute express their points of view, voice their interests, and find mutually acceptable solutions. As it
was stated in section 2.5.1 not everyone solves conflicts in a cooperative fashion. This creates a need
to devise a system that, in order to properly teach about Conflict resolution, must be answered properly.
This implies devising a program that not only teaches the principles of conflict resolution, the basics
of effective communication and listening, critical and creative thinking, and an emphasis on personal
responsibility and self-discipline but that also offers a point-of-view on the different ways of handling and
resolving conflict.

The proposed educational system implemented in “My Dream Theatre” has as primary goal to teach
the players’ about the required skills to effectively handle conflict situations and the fundamental con-
cepts of conflict resolution. This is done by giving them way to develop five skills which were identified
by Crawford and Bodine [1996]: Orientation (grasp concepts such as justice, tolerance, self-respect,
etc.), Perception (understand that people have different views of the same situation), Emotion (iden-
tify and control the emotions involved), Communication (acquire the right vocabulary and practice how
effectively convey a point of view or feelings), Creative thinking (find different possible solutions for a
situation) and Critical thinking (recognize and distinguish the positive and negative effects of each so-
lution). In order to develop these abilities, children must be taught several conflict related concepts.
One of the most important is how most people handle conflict situations. Thomas & Killmann Thomas
identified several behaviour patterns that describe how people react when faced with a conflict based
on two concepts: their assertiveness or the attempt to satisfy one’s own concerns; and cooperativeness
or the attempt to satisfy others’ concerns. Together they create a two-dimension space that represents
five conflict handling modes: competition, accommodation, avoidance, collaboration and compromise.
Other concepts such as conflict escalation, reframing, negotiation, mediation, conflict vocabulary and
the positive effects of conflict also need to be taught to children, and should, as much as possible, be included in the educational system.

This is done in “My Dream Theatre” by putting the player into contact with the different conflict solving personalities and, in a certain way, force to understand their needs, while taking into consideration the game rules and how to achieve the best score possible. The game also adapts itself by offering tailored conflict scenarios to each player based on their progression on each of the five skills.

2.6.2 Playing My Dream Theatre

In “My Dream Theatre” the player assumes the role of a theatre director that has to direct rehearsals that lead into a play by managing the roles of each actor while making sure that they are not unhappy.

The game starts by presenting a cast of actors, each with its own way of resolving conflicts, conflict meter and preferred roles. The conflict resolving personalities can be one of the following: Collaborate, Dominate, Neglect and Appease. Each of these conflict resolving personalities are composed of two aspects Assertive or Non-Assertive and Cooperative or Non-Cooperative. The roles can be either The Hero, The Victim, The Villain or Figurant. The player is then presented with several roles, which may or may not be repeated. It is then up to him or her to sort those roles among the actors while keeping in mind that if an actor does not play one of his or hers preferred roles the conflict meter will get filled. If an actor ever reaches his or her conflict limit he will lash out and handle the conflict as he or she sees fit. It will always result in the actor leaving the set but sometimes they might also take someone else with them or spread conflict points which, in turn, may cause other actors to leave. After the roles are assigned and conflict points are calculated the player may attempt one of the following actions: do not interfere, talk with an actor, talk with two actors, talk with three actors. Each of these actions works best with a particular type of conflict resolving personalities and it is up to the player to figure out which are the most effective with different personalities. When the player decides which action to use he is then presented with the result of said action. If the action was well used, the involved actors will lose conflict points and gain a shield. This shield makes them more tolerant to conflict and represents their ability to solve conflicts on their own. If an actor received a role that he likes and has none or less conflict points than his shield, the actor receives acting points. After the results, each actor goes home. Meanwhile something occurs, like a playground scuffle or a disagreement and when the actors come back some will have gotten more conflict points. It is then up to the player to again sort the roles taking into account the preferences and conflict points that each actor has. There are three rehearsals until the play. After the play, the player is awarded with stars according to how well the actors performed. This is done by taking into account how many acting points each actor has.

The game was first designed and developed as a physical card game by João Cabral Campos et al. [2013b]. The main differences between the physical and virtual game is that in the physical game the player has to keep track of all the points and there is no adaptation. In the virtual version the Roles, Personalities and Events are all generated taking into account the players actions. Additionally, the player may or may not complete extra objectives, that are also generated taking into account the players’
experience, which award extra stars. These extra objectives also grant Badges which can be viewed by
the player and work as milestones for the system to keep track of the players’ progress.

2.6.3 My Dream Theatre as an ITS

As it was stated before in 2.4, an ITS is composed of four models: The Domain model; The Student
model; The Tutoring model, and The User Interface model. And its development is similar to an instruc-
tional design process which consists of four iterative stages: needs assessment, cognitive task analysis,
initial tutor implementation and evaluation.

While designing “My Dream Theatre” there was extensive care regarding the needs of students and
teachers, the theories behind conflict resolution and management and how the game could easily adapt
itself in order to provide a better and customized learning experience. This resulted in a rich Domain
Model which encompasses the five skills identified by Crawford and Bodine [1996]: Orientation, Per-
ception, Emotion and Communication; the five conflict handling modes: competition, accommodation,
avoidance, collaboration and compromise; and game environment which gives enough freedom to the
player, without pressure, to explore at his or hers own pace.

In addition to all of this, the interface of MDT suffered several iterations. In the beginning it had a
minimalist design, and it was expected that the players’ would be able to understand the actors mood by
facial expressions and body language. However since this proved unsuccessful, extra components were
added to the interface such as the score, an icon depicting the actors emotions, a conflict meter and
hover-tips in all of the elements. All of these improvements were done taking into account the opinions
of teachers and students alike, which are the target of this system. By game design the player is alerted,
with an unhappy actor, whenever he or she is not performing the correct actions. However, this does not
mean that what is being assessed is the players’ knowledge regarding conflict. Prior to the contributions
of this thesis, what was lacking for MDT to classify as an ITS was a more complete Student Model and
the Tutor Model. Which means, adding to the system the ability to self-adapt taking into account the
each players’ proficiency and knowledge of conflict resolution and conflict management.

In chapter 4 a development methodology that guarantees that the result of applying said methodology
will result in a game that monitors and adapts to the players’ knowledge, making the game an ITS, will be
described. And in chapter 5 the resulting architecture of “My Dream Theatre” and the results of applying
said methodology will be analysed.
Chapter 3

Related Work

The SIREN Project is very unique since there is no other project that puts together a serious game with the aim of teaching conflict resolution while adapting its content to the users needs. However, there are already some games that do these things individually. In this section we will address three games: “Cool School”\(^1\), “Peace Maker” by Burak et al. [2005] and “Minecraft”\(^2\). Each of these games will be analyzed regarding content generation, conflict resolution teaching and achievement system. Also, a gaming platform that will be analyzed, because of its influence on Achievement Systems in games, is Steam. In this section we will also look into successful gamification examples, including the gamification of the Masters course Produção de Conteúdos Multimédia of Instituto Superior Técnico Barata et al. [2013]. Regarding procedural content generation we will look into successful commercial games that use these type of techniques to enhance player experience.

3.1 Teaching Conflict In Games

As it was stated in a previous section 2.5, teaching and defining conflict resolution is a very broad subject. In this section we will present two other games, Cool School and Peacemaker, which handle conflict resolution, management and awareness in different ways.

3.1.1 Cool School: Where Peace Rules!

When we think about conflict in schools bullying immediately comes to mind. As such, it is a topic that has been heavily debated and analysed. It is no surprise that there exists a game that aims to teach children how to handle and prevent bullying. Regarding conflict resolution, “Cool School” is a serious game that aims to teach that. Set in a fantasy school, Figure 3.1 where all of the objects come to life, it depicts conflicts that children face every day. It has 52 different scenarios and player progress is monitored by the amount of letters that he or she has earned. “Cool School” is more oriented to prevent bullying than to handle other types of conflict since the player is prompted for the non-violent solution.

\(^1\)http://www.coolschoolgame.com/
\(^2\)https://minecraft.net/
and is rewarded for choosing correctly. At the beginning of each scene the player is presented with a non skippable cut-scene where the conflict is acted by the characters. At the end of the cut-scene the player is presented with a dialogue. The player must choose the best option to solve the conflict. If the player does the right choice he or she receives a virtual reward. There is also a brief cut-scene after the player does his or her choice showing the outcome of such a decision. This game does not adapt during playtime and it is up to the player to choose which scenarios does he or she wishes to face. As the time of writing there are no articles regarding “Cool School” about its efficiency in teaching the concepts it aims to teach. This game was written by F.J. Lennon, based on scenarios and outcomes researched by the University of Maryland's Dr. Melanie Killen.

![Figure 3.1: The Cool School Classroom.](image)

### 3.1.2 Peace Maker

As stated before, conflict happens in many situations and different contexts. A very actual, global-scaled conflict is the Israeli-Palestinian conflict. This conflict is a good example of a type of conflict that happens on a grand scale, is experienced by several people and has originated casualties. Even though it is a conflict that is experienced, either by direct contact or through other types of media, by a very large amount of people, no one has arrived at an optimal solution for the solution of this conflict. Peacemaker is a commercial serious game simulation of the Israeli-Palestinian conflict designed to promote “dialogue and understanding among Israelis, Palestinians and interested people around the world”. It is a good example of how games can be used to create awareness to a broader audience to a specific topic. The game puts the player in the role of either the Israeli President or the Palestinian President and lets him or her set the stage of conflict: calm, tense or violent. Afterwards the player is presented with the region in conflict and with the game interface as can be seen on Figure3.2. As the player progresses and conflict escalates or is eased, the player can watch videos and read in-game news regarding the conflict. It had as design principles the following:

- **Win condition** – Winning state is the two state solution;
- **Everyone wants peace** – The other side wants peace too;
• Some thing are uncontrollable – You lack complete control of your own side;
• One step at a time – Small concrete steps, not grandiose plans;
• Be realistic – Don’t let the perfect be the enemy of the possible.

Like “Cool School”, this game is a good example as how conflict can have different settings and be approached in several ways, some worse than others. One thing that sets it apart from modern serious games is the lack of an achievement system, relying solely on the motivation of the player to solve the conflict. However, if the player is indeed motivated, the game offers as much information as he or she wants.

Figure 3.2: The Peace Maker interface.

3.2 Motivating the Player

Motivating a player in a game has some unique particularities that are not observed in this area. In this section we will look into Minecraft, a successful game that uses an achievement system, and Steam, the currently most popular gaming platform, which uses an Achievement System and encourages game developers to include achievements inside their own games.

3.2.1 Minecraft

Minecraft is a survival-based game that is without doubt one of the games of the decade since it relied on a careful game design rather than state of the art graphics. One of its main features is an ever expanding, seemingly infinite landscape that is seamlessly generated taking into account the players actions and its location. What is interesting about Minecraft regarding “My Dream Theatre” is the biome generation that uses a Procedural Content Generation Technique. Not only does Minecraft collect data about the players’ actions but it also collects data regarding the environment that player is in. This way,
there will never be a sudden transition between a desert biome and a forest biome as can be seen on Figure 3.3. The transition is smooth in order to not break the players' experience. Another interesting aspect of Minecraft is the late introduction of an Achievement System. As can be seen on Figure 3.4, when the game was first released, players had to learn how to play and survive in the hostile world. They had to explore by themselves and figure out what had to be done. In a later update, Achievements were introduced. These achievements, shown in Figure 5, can be easily accessed by the player, cannot be shared via social networks and serve as a tutorial. This unarguably makes the game easier to newcomers, however it removes some of the discovery that previous players could enjoy when there wasn’t an Achievement System. Minecraft is not a serious game itself but it is a good example of how a game can give enough freedom to the player, without overwhelming him or her with choices and let him or her learn the game at their own pace. Furthermore, it shows that, although it is not necessary, an achievement system can be used to guide the player and record the progress in certain tasks without being invasive or annoying.

![Image](image1.png)

Figure 3.3: A water, forest and stone biome in Minecraft.

![Image](image2.png)

Figure 3.4: Some of the achievements in Minecraft.
### 3.2.2 Steam

Steam is a gaming platform that offers its users the ability to purchase a large variety of types of games in digital form and play them in almost any personal computer, as long as it is authorized. More recently Steam has also included chat in textual and voice form and also the ability to join other games that friends are playing, in the services that it offers. One major feature of Steam is its Achievement System. Introduced with “The Orange Box” in late 2007, achievements became available with the recent update to Steamworks, but Half-Life 2: Episode Two, Portal and Team Fortress 2 were the first games to include them. Since then, the achievement system has grown in popularity and Steam now offers a wide selection of games featuring the achievements system. Currently “Team Fortress” has 448 Achievements as can be seen on Figure 3.5. These achievements are presented to the player prior to him or her playing and are, non-intrusively to the gameplay experience, presented whenever the player earns them. Steam itself has an achievement system that promotes the use of the platform and social interaction as can be seen on Figure 3.6. What this shows is that achievements are widely accepted as norm in modern games and serve to add replay value, guidance and social acceptance among certain communities.

![Team Fortress 2 achievements](image)

**Figure 3.5:** Team Fortress 2 has 448 achievements

### 3.3 Gamified Tools and Examples

Games and game like components have been used to teach subjects for quite some time now. In this section we will present some modern Gamification tools and examples, specifically, Class Dojo and Ribbon Hero.
3.3.1 Class Dojo

Gamification is used to help teach skills and subjects sometimes in an indirect way by creating a game around a certain subject and other by intervening directly on how subjects are taught. Class Dojo is a teaching tool that seeks to help teachers by gamifying a class and improve certain behaviours in their classrooms. It does this by allowing the teacher to create classes, populate them with students, adding positive and negative behaviours and then rewarding the students when they perform said behaviours. This way it instantly reinforces good behaviour on students by providing fully customizable notifications such as “Well done Josh! +1 for teamwork!” This software also produces behaviour-tracking analysis and reports that can be shared. The interface presented to the teacher is depicted on Figure 3.7.

In constrast with “My Dream Theatre” there are very few automated actions on Class Dojo. It merely seeks to positively reinforce behaviours and leaves to the teacher to decide what to teach to each student, or to the class as a whole. However, since it is very generic, Class Dojo can be used to motivate the learning of any subject by gamifying the task.
3.3.2 Ribbon Hero

Ribbon Hero is a serious game developed by Microsoft Office Labs that has as main goal to teach the user about a feature of Microsoft Office. It attempts to do this by listing challenges in four sections: working with text, page design and layout, getting artistic, and quick points. Each challenge is composed of an example document which the user must edit by using a feature of Microsoft Office, that is being taught by the same challenge. Challenges have a score associated and are not sequential, they can be played in any order. By completing the task the user is awarded with half the possible score and then earn the remaining half by using the same feature later on.

This game is created to answer a common problem with Office users which is adapting to new versions of Office. Like Class Dojo, Ribbon Hero does not aim to adapt to the player, letting him or her choose their own learning path and positively rewarding the intended behaviours.

Figure 3.8: Ribbon Hero interface.

3.3.3 Gamifying an Engineering Course

As stated before, games have been used to motivate students in different academic levels. The masters course of Information Systems and Computer Engineering at Instituto Superior Técnico offers a 5-month long course called Multimedia Content Production - MCP - lectured by Barata et al. [2013].

This course was first lectured with a traditional evaluation composed of “five theoretical quizzes (25% of total grade), a multimedia presentation (20%), lab classes (15%), a final exam (35%), online participation on the course’s forums (5%) and class attendance (5% bonus grade)” with a final grade between 0 and 20.

Then the course was gamified and a new grading system was introduced. This evaluation was similar to the previous one and consisted of “quizzes (10%), a multimedia presentation (20%), lab classes (15%), a final exam (35%) and a set of collectible achievements (20%, plus a 5% grade bonus)”, stated Barata et al. [2013].

In total there are 75 achievements, with some of them being multi-level. Whenever a student earns an achievement or completes one of the evaluation components, he or she receives XP. That experience is translated into Levels and then, at the end of the course, translated into a grade from 0 to 20.
The gamification of this course followed a similar formula to the Points, Badges and Leaderboards that is commonly used. It uses 6 core game elements: XP, levels, leaderboards, challenges, badges and a skill tree. The leaderboard is the entry point to the gamified course and it allows users to “track their progress, explore their own and others’ achievement history, and to compare themselves with other classmates”. The XP and levels served the main purpose of transmitting direct feedback and progress.

This is particularly interesting because it is an academic level course that is being gamified and because the gamification was successful in improving grades and student motivation.

From a total of 52 students only 2 students failed the course. Of the 50 that had a positive evaluation, six of those reached level 20 thus getting the highest grade possible, and of the remaining students none of them had less than 14.

As stated in their paper, “gamification led the students to participate more and be more active learners. Throughout the semester, a total of 2235 posts were made by students, for an average of 139 per week while classes lasted. This contrasts with a much lower figure for the un-gamified version, where only 211 posts overall were made by students.”. Even though most of these posts were done to earn certain achievements, this led students to work more often on tasks and exercise the skills taught on the course.

By carefully analysing in which way the students played the PCM game, the authors were able to identify the following profiles: The Achiever, the Late Awakener, the Consistent Student and the Disheartened Student.

The Achievers were the students that enjoyed playing the game and went beyond the minimal requirements whenever possible. These made 21% of the total amount of students.

The Late Awakeners were students that neglected the course achievements at first but later started participating when they saw that they had bad standings on the leaderboard. Late Awakeners represented 15% of the total amount of students.

The Consistent Student types spent a consistent and not very high effort with the tasks proposed, only doing what was required and not going out of their way to accomplish extra achievements and tasks. These compromised the majority of population, representing 40%.

The Disheartened Students represent 21% of the total amount of students. These students started off as Achievers but later reverted to Consistent Students.

As shown on their paper, 3.9 shows the distribution of student types by grade.

This work is particularly important because it not only shows that it is possible to gamify subject at a higher level of education but also because it was successful in teaching content and motivating students, two goals that are shared with “My Dream Theatre”.

![](Figure 3.9: MCP student types.)
3.4 Experience Driven Procedural Content Generation in Games

As it was stated previously 2.3.2 as information about users gets more readily available and processing power increases opportunities for more diverse custom content appear in all areas. One of the areas where Experience Driven Procedural Content Generation has been used with good success is the game industry. Many years ago when computer games were starting to appear, memory constraints prevented developers from using a lot of pre-made content. As a result, content such as maps would be produced on the fly using algorithms. Since games aim to keep the player engaged for as much time as possible, Content Generation provides a way to create new events inside a virtual world. Three recent games, Borderlands, Minecraft and Skyrim have used Content Generation to great success by using it as a core to the game.

Borderlands uses Procedural Content Generation to create a system that managed to create 3.166.880 unique weapons. Skyrim uses a PCG system to create quests and adapts the difficulty of the dungeon based on the players’ level.

3.5 SIREN Project

The Social games for conflIct Resolution based on natural iNteraction - SIREN - Project, lead by G. N. Yannakakis [2010], aims to create an intelligent interactive software system, composed of several games, to support teachers in the education of children, mainly on how to resolve conflicts. This system offers role-playing serious games where conflict scenarios are presented. It is then up to the children playing to perform different actions in order to solve the presented conflict situations. The goal of the SIREN project is to provide a safe, reliable and fun environment that allows children to learn about specific concepts regarding conflict and conflict resolution. Currently, this is done by two games: “My Dream Theatre” and “Village Voices”. “My Dream Theatre” will be looked into more detail in its appropriate section while “Village Voices” will be looked into briefly in the next sub-section.

3.5.1 Village Voices

In the “Village Voices” multiplayer game the children has to learn how to manage relationships, status and wealth for the good of the community. During this process conflicts that may arise. This game aims to convey concepts such as mutual gain and collaboration while supporting the core learning objectives underlined in the SIREN Project. The “Village Voices” game relies on the presence of a learning facilitator, such as a techar, that guides the player informally and sporadically. The pedagogical approach of this game is experiential learning and social constructivism. This is done by allowing the player to experiment another perspective by changing its role. This way, conflict scenarios can be more meaningful to each one of the players. This game is heavily based on common conflict themes that were found during user research, such as friendship or property dispute.
Concept

On the surface, “Village Voices” is about survival and prosperity in the village, but on closer inspection is about friendship and collaboration. These four points are the basis of self-generating conflict scenarios between the players. Each player has a specific class with its own goals. At the beginning of the game these goals can be achieved by not collaborating. As the game progresses, the player is forced to either ask for the help of other players or steal from them thus creating conflict since not all players are cooperative and have different sets of morals. Different actions will bolster or harm the players reputation.

Game Objectives and Learning Objectives

In keeping with the core concepts of mutual gain and collaboration, the overall objectives of the game shared by all players are to: keep the village healthy and flourishing, in terms of development, growth, and attracting new inhabitants; to minimise negative aspects associated with life in the village, including dropping quality of life, and number of inhabitants who move out. “Village Voices” supports many of the core SIREN learning dimensions: Perceptual, Emotional, Communication, Creative-thinking and Critical Thinking. Perceptual is fostered by creating game conditions in which conflicts arise frequently. This way the students can learn how to see an issue from different perspectives. The Emotional aspect is developed since the players have to interact with each other they will learn how to recognise the distortion effect that strong emotions have on an issue. By requiring that players communicate with each other, the game is developing their Communication skills. Furthermore, switching roles forces the player to adopt and communicate different strategies. By changing roles the player is also improving his or hers Creative-thinking by coming up with a variety of conflict resolution options. Finally, Critical thinking is fostered by offering choices to the player, presenting objectives and developing the overall complexity of said objectives.

Gameplay and Mechanics

This game is set on a three dimensional village where the inhabitants of the village pride themselves on being industrious and productive. The player takes the role of an artisan that has to create and deliver products. The creation of products is done by collecting a certain amount of materials. These materials can only be picked up by a certain type of artisan. This way, in order for the player to create more elaborated products he has to collaborate with different artisans. If the player chooses not to collaborate he may steal from others. Whenever a conflict situation arises the player is prompted to describe his or hers feelings regarding that situation. This way, as long as the player answers truthfully, the game is able to trace a profile of the player regarding conflict resolution.

Game Adaptation

At the time of writing this document, there are no publications regarding adaptation to the player in Village Voices. It is known, inside the SIREN project, however that “Village Voices” is based on recorded
play sessions with users. Instead of adapting the content of the game, the Agents that populate the world of “Village Voices”, emulate the behaviour of real players in previous gaming sessions. This adds some credibility to the characters while promoting specific scenarios.

This approach was not done in “My Dream Theatre” since the Actors do not interact with each other, besides spreading conflict, and “My Dream Theatre” is not a multi-player game.
Chapter 4

A Methodology for Self-Adapting Serious Games

In order to make the necessary adaptations for “My Dream Theatre” to become an Intelligent Tutoring System, a methodology had to be defined before making changes in the game.

Since the SIREN project includes games that can teach children about conflict, and more may appear on the future, there was a need to formally define a general approach when designing the adaptation system, in order to guarantee that the game has the following properties: (1) it must successfully teach one or more subjects; (2) the game adapts itself according to the knowledge of the player; (3) the game rewards the player whenever he or she reaches certain milestones; (4) what is learned on one game is transported to other games.

Based on the research done on motivation, gamification techniques, and ITS development a methodology that guarantees that these four goals are respected is proposed in the following section. This methodology defines a set of steps to gamify a task: define a Skill Set that the player must be proficient with; characterize the Environment regarding its constraints, such as which components can be interacted with and what are the termination conditions; characterize the Player by having a Model that represents him or her accurately in the game; determine which preconditions must be met before the player is evaluated; how and when is the player rewarded; and finally how is all of this connected and how does it adapt itself to the players’ needs.

This methodology assumes that the objectives and game mechanics that are applied after or in conjunction with it are in compliance to the formal design paradigm described in section 2.1.4.

In this section we will go through all of the steps that must be performed in order for the game to have the properties that were previously described. The steps are the following: definition of a Skill Set; Environment characterization; identification of Interactive Components on the Environment; the Scenarios and respective Termination Conditions of an Environment; the type of Environment; the Player Model and the Actions that can be performed; the Rewards and the Recurring Assessment Component that deals with the Adaptation of the game.
4.1 Defining the Skill Set

The first step that must be taken is to determine which Skills are meant to be taught to the Player, and evaluated by the system, thus defining the Skill Set. However, before determining the Skill Set we must determine what is a Skill in the scope of the proposed model. A Skill can be almost anything as simple as “digging holes” to something more abstract as “Empathy - Understanding other peoples emotions”. A Skill should be identified by a sequence that is unique in the set of Skills. However, the identifier alone does not give us anything besides a context. In order for the Skill to be evaluated by the system it has to be able to be quantified.

Also, in order to determine the relevance of each Skill, it should have a function that returns the weight of the Skill based on player knowledge or Environment characteristics. To determine the weight of the Skill, this function can take into account the Rewards that the player has earned, the development of each other Skill, the current state of the game, etc. This way it is possible to order and filter Skills by relevance, taking into account the current knowledge of the player.

By increasing or decreasing the value that is associated to the identifier we are actively quantifying the player’s proficiency in such skill and with the weight function it is also possible to know how relevant the Skill is to the player. After determining which skills do we want the player to learn we should have something similar to this Skill Set, A = \{Id1, Val1, WeightFunc1\}, \{Id2, Val2, WeightFunc2\}, ..., \{IdN, ValN, WeightFuncN\}. A more specific example could be the following Skill Set A = \{“Dig holes”, 1, DigHolesEvaluator\}, \{“Pick up Rocks”, 3, PickUpRocksEvaluator\} that tells us that the “Pick up Rocks” Skill is more developed than the “Dig holes” Skill.

4.2 Characterizing the Environment

After the Skill Set is determined, the Environment can be defined. This Environment can be one that already exists or it can be fabricated in order to suit our needs, which are the teaching of the Skill Set that was previously defined. The Environment should at least be characterized by the following: components that can be interacted by the user; Scenarios that happen on the environment; the termination condition of each the Scenarios and the type of Environment to which the Model is going to be applied.

4.2.1 Identifying Interactive Components

If we want the player to learn something in the Environment that we chose or fabricated, we must allow him or her to interact and explore the Environment. This is done by determining all of the Elements of an Environment and deciding which of them are Interactive Components. When identifying Interactive Components in the Environment the following should be kept in mind:

- The player must be able to interact with the component during a play session;
- It is possible to know if the component has been interacted with;
- Not all elements of the Environment have to be interacted with;
• The element may or may not be related to a Skill;

• A set of elements can be a single interactive component;

For example, a Large Rock is an Element that and an Interactive Component. A Small Rock is an Element but not an Interactive Component. However, several Small Rocks make an Interactive Component. As it will be explained further in the chapter 4.3.1, the Interactive Components do not have to be directly related to a Skill but the Actions performed on them must.

4.2.2 Scenarios and Termination Conditions

On a single Environment several Scenarios may exist. A Scenario is composed of a set of well defined Interactive Components and Termination Conditions. The Termination Conditions of a Scenario are a set of rules that define when should the Scenario be terminated. A Scenario can have several of these and the Player should always be able to accomplish at least one of them. The Termination Conditions may be shared between Scenarios. The Termination Conditions of an Scenario should be used if they occur naturally (i.e. a car crosses the finishing line) in order to respect familiarity. If the Environment itself does not have a closing objective or some sort of milestone that indicates to the player that the scenario is over, then the Termination Conditions should be fabricated. For example, if the Environment is a city park where the Player can ride his or hers Bike freely, there could be a Time Limit for the ride or an area where the player goes to when he wants to finish the Scenario. By defining different Scenarios it is possible to expose the Player to some Interactive Components while disabling others thus allowing a richer learning experience.

4.2.3 Type of Environment

As stated before, what is evaluated, and is related to the Skill Set, are the Actions that are performed on the Interactive Components of an Environment. However it is important to correctly appraise and define the type of Environment since the way that the player interacts with the Components can be limited by the specificity of the Environment. An Environment can be characterized according to the following: type of input required, whether it is synchronous or asynchronous, the time constraints and repeatability.

Regarding Player Input, it may Require No Input if the Environment may change even without input from the player (i.e. a city full of people) or it may Require Input if the Environment may only change if there is player input (i.e build a chair);

The Environment is Asynchronous if events happen asynchronously on the environment. (i.e. a game of football) and Synchronous if the events happen at specific moments in time (i.e. a game of chess)

If there is no expiration date for the lifetime of the Environment (i.e. the universe) the Environment has No Time Constraints. If the Environment is terminated after a period of time. (i.e. a car race) it has Time Constraints.
When the Environment cannot be repeated with the exact same constraints as before (i.e. while learning to drive a car, the car crashes) it is Not Repeatable. If it can be reproduced any number of times with the same constraints (i.e. a tennis game between two players’) it is Repeatable.

4.3 Player Model

As stated before there is a Skill Set composed of Skills that are meant to be learned by the Player, an Environment that has one or more Scenarios which are in turn composed of Interactive Components. Those Interactive Components are then acted upon by the Player with Actions. Thus it is necessary to define the Actions that can be performed and learning Skills that are to be evaluated. The Player Model is the structure that keeps track of all the Actions performed by the player, the state of the Environment during the play sessions and the progress of the Player regarding the Skills that are being assessed.

4.3.1 Actions on the Environment

Actions can be performed by anyone in the Environment but only the actions performed by the Player should be assessed. Thus, there should be two separate categories of actions: Player Actions and Non-Player Actions. Non-Player actions should affect the state of the Environment in some way that the Player needs to react or acknowledge them. Player Actions, even though they might not always affect the state of the Environment, must be able to be assessed to determine if they have been correctly used or not. As it will be described on the following section, in order to know assess the knowledge of the player on a given Skill, it is necessary to validate his or hers actions.

4.3.2 Player Actions and Events

When the Player interacts with an Interactive Component he is either using correctly or incorrectly a Player Action. However, sometimes it may not be possible to certain that the player is learning just by doing a certain action at a certain point of the game, it may be necessary to perform additional actions or trigger a determined Event. Events are meant to give more freedom when defining milestones and may be composed of several player actions, consequences of certain actions, or certain characteristics of the component that was interacted with.

For example, for the Scenario S1 in Environment E1 there are three Interactive Components: “Large Rock”, “Small Rock” and “Small Blue Rock”; the following Skills “Pick up rocks without hurting your back.” and “Distinguish between coloured objects” are to be learned by the Player and the only Player Action that exists is “Pick Up Rock”.

If the Player uses “Pick Up Rock” on a Large Rock he will hurt his back, however if he uses “Pick Up Rock on a Small Rock” the Skill “Pick up rocks without hurting your back.” is increased. Both the correct and incorrect use of the Player Action should be logged in the system. However, we may want to check if the player only “Pick Up Rock” on blue colored rocks. Thus we may define the following Event “Use the Skill Pick Up Rock only on Small Blue Rocks”.

36
4.4 Motivating and Rewarding the Player

As it was stated before in the section 2.2 there are many factors that determine what motivates a person to do something. In 1996, Gambrel et al. [1996] performed research that demonstrated that motivation influences students' involvement in a given task and academic achievement. This implies that if a student, or in our particular case, a player, has a goal, he or she will attempt to achieve said goal.

In traditional teaching, after being evaluated, a student is rewarded with a grade. This grade is then used by his or hers peers to assess the proficiency on the given subject. This naturally gives a goal to the student: get the highest grade possible. However, in games, most of the time, rewards tend to be bound to the game itself and, even though they might help the player to progress in the game, they have little meaning in the real world. There are also rewards that are solely meant to show-off to other players', such as the achievement system of Steam 3.2.2.

A serious game can have several different education goals and multiple rewards. In this system each Scenario has its own goals in the form of Termination Conditions. This does not mean that by reaching a Goal the Player has learned something. It is necessary to create Intermediate Goals in order to keep player interest high and relate the Skills that we are trying to teach to the Player and the Tasks that he performs.

If we take into account the Expectancy Theory Eysenck and Keane [2000b] explained on section 2.2, we can describe player motivation with the following: Player Motivation (PM) = Expectancy(E) x Instrumentality(I) x Valence(V). Expectancy is the player's belief that his efforts (E) will result in the attainment of performance (P) goals. This is closely related to self-confidence and past experience. Instrumentality is the belief that if the performance goals (P) are attained, then he or she will get a reward. Finally, Valence is the value that the player places on the rewards based on his or hers needs, personal goals, values and sources of motivation.

With careful Game Design it is possible to keep the players' Expectancy in realistic values, Instrumentality can be guaranteed as long as the game rewards the player whenever he accomplishes something meaningful and Valence can be manipulated by offering carefully crafted Rewards that appeal to the Players. This also goes on par with the revised model that LawlerPorter and Lawler [1968] suggested.

These Rewards have yet another meaning to the system, they offer an easy and immediate way to asses the Players proficiency on each Skill.

In order to keep the player engaged in the game and to monitor his or her progress there needs to be a system that keeps track of that progress. This is done by rewarding the player at certain milestones.

4.4.1 Defining Rewards

When defining the Rewards that are given to a player, there should be a special care to not define these randomly or on a whim. The Rewards should attend to the games' pedagogical needs.

As such, when designing which Rewards the player can earn, each one them has to be allocated to a different dimension. In addition, in order for the badges to respect both the pedagogical needs,
game design and effectiveness, they must be subjected to the Kellers ARCS model\(^1\) subcategories: Perceptual arousal; Inquiry arousal; Variability; Goal orientation; Motive matching; Familiarity; Learning requirements; Success opportunities; Personal control; Natural consequences; Positive consequences and Equity.

Applying Kellers model to games is not new. In 1998, Dempsey and Johnson proposed applying the ARCS model to select and analyse which games are most effectively used in the classroom. As such, a similar model can be applied while designing the Badges. By asking the following questions to ourselves regarding the Rewards, and answering them in a positive manner, we are assuring that they are meaningful to the game and to the players’ learning experience.

- Perceptual arousal - What can we do to capture their interest on this Badge?
- Inquiry arousal - How can we stimulate an attitude of inquiry about this Badge?
- Variability - How can we maintain their attention while trying to earn this Badge?
- Goal orientation - How can we best meet the learners needs? (Do we know their needs?)
- Motive matching - How and when can we provide the learners with appropriate choices, responsibilities and influences while trying to earn this Badge?
- Familiarity - How can we tie this Badge to the learners experiences?
- Learning requirements - How can we assist in building a positive expectation for success?
- Success opportunities - How will the earning of this Badge support or enhance the students beliefs in their competence?
- Personal control - How will the learners clearly know that the earning of the Badge is based upon their efforts and abilities?
- Natural consequences - How can we provide meaningful opportunities for learners to use their newly-acquired knowledge/skill?
- Positive consequences - What will provide reinforcement to the learners successes?
- Equity - How can we assist the students in anchoring a positive feeling about earning a Badge?

While designing Rewards we should also keep in mind the following: does this Reward have any influence on the players’ learning experience and will it alter the game in any way? If all of this is respected then the Rewards will surely be tied to the game and the goals of the game.

\(^1\)http://www.arcsmodel.com/
4.4.2 When to Reward

In “The Role Of Expectancy In Delayed Reinforcement”, by Mahrer [1956], demonstrated that if a person experiences a certain type of reward as consequence of a specific action, he or she is most likely to have a high degree of Expectancy regarding being rewarded under similar circumstances.

In modern games, as it was stated on section 3.2.2, there is an ample variety of achievements, badges and overall rewards. Most of these rewards follow a similar framework to the one suggested by Hamari [2011], but there is no written rule of when should a player be rewarded in a game. However, in a serious game that wants to teach something, there are some aspects that we can keep in mind while defining when should the player be rewarded.

The player should be rewarded only if there is a high enough degree of certainty that the player has learned something. This degree of certainty can be pre-determined by conducting user tests and agreeing on what is the most correct value or following the opinion of an expert on the subject. When this happens the player is eligible to be rewarded, the question that poses is, when should the player be rewarded?

This is a question not easily answered since, because of internal and external factors, it is not guaranteed that the player will understand what did he just do that justified a reward.

When deciding when to reward the player, the following should be taken into consideration:

- How long does a play session last?
- Is the reward fostering a positive reinforcement?
- Is the reward going to motivate the player?

After the Rewards are defined, the amount of times that a task needs to be performed should be defined by an expert on the area and then adjusted after play-testing is done. However, other factors may influence this decision. As it will be observed on section 5.3.3, the Badges created for “My Dream Theatre” were defined taking into account the limited time that players’ had to interact with the game. Also, the purpose of these tests was to evaluate the adaptation mechanism, thus the amount of times that a player had to perform a task in order to gain a Badge was relatively low.

4.4.3 How Skills are related to the Rewards

Relating Skills with Rewards is relatively easy. A Task is associated to a certain Skill and can be composed by any number of Player Actions and/or Events. These Events are certain conditions that are related to Player Actions but are only met if, for example, an NPC performs a Non-Player Action.

As such, we can define that a Task T is described by the following \( \{ S_1, \{ A_1, A_2, Ev_1 \} \} \), where S1 is a Skill and A1, A2 are the Player Actions that have to be performed by the Player, Ev1 is the event that must happen in order for him or her to complete the Task.

Now, if we define R as the following Reward, \( \{ T, 5, G_1 \} \), where T is the Task previously defined, 5 is the amount of times that the task must be performed in order for R to be earned and G1 is the Game.
where the player can complete this task, we are saying that “If player completes Task T in Game G1 at least five times, then he is proficient on Skill S1 and should be rewarded with R”.

This way, by looking at the Rewards that the player has earned it is possible to determine which are the Skills that are least or more developed by the Player. If the Skills are transversal to the games, in each game we can know what are the proficiencies that the player already has and adapt the game accordingly.

4.5 Recurring Assessment Component

In order for the system to adapt to the Player, his or hers knowledge must be evaluated. Since the Player Model constantly keeps track of the progress of every Skill and the Scenarios have well-defined Termination Conditions, it is possible to evaluate the players’ progress from the beginning of the Scenario until it ends. This evaluation is done by the Recurring Assessment Component – RAC.

This Recurring Assessment Component is composed of Tasks. As we have seen before, these Tasks are directly related to Skills. Tasks can be abstract such as “Make sure everyone is happy”, which may involve the use of several Player Actions to accomplish, or it can be more straightforward with something like “Cheer up Anna.” which involves using the “Cheer Up” Player Action on the NPC “Anna”. Also, as stated before, for consistency, all Player Actions that are required to be used to accomplish a Task should be related to the same Skill Set as the Skill Set of the Task. This component constantly evaluates the players' knowledge and rewards him or her if the conditions defined on the Rewards are met.

In this section we will explain the two identified types of assessment, how are Rewards won by the player and how does the game adapt itself.

4.5.1 Self-Contained and Two-Part evaluations

For the purpose of this system, the evaluation can be of two types, Self-Contained or composed of Two Parts, and assesses the progress of each Skill and rewards the player properly.

A Self-Contained evaluation means that the Player Actions performed by the Player during the Scenarios are enough to assess his or her knowledge on the Skills that are being developed. However, this implies that the evaluation can be repeated several times and that the player never “flunks”. This Self-Contained evaluation can be, for example, composed of several Tasks, that are accomplished by performing Player Actions, that the player must complete. These Tasks can be fundamental for the game to progress or can be merely side-objectives to the game itself.

A Two-Part evaluation is used when the actions of the player on the Environment are not enough to assess the knowledge of the player on certain Skills. Thus it is necessary to complement it with another evaluation. This evaluation can be a final score or a more traditional component like a test. The result of this test should then be translated into Rewards so that the system can still keep track of the knowledge of the Player even though it did not evaluate his or hers Actions.
4.5.2 How are the Rewards related to the Recurring Assessment Component

As it was said before in 4.4.3, Rewards are related to Tasks that are in turn related to Skills. When the player completes Tasks he advances his or hers progress in a certain Skill thus gaining Rewards.

By looking at the earned Rewards, the RAC can determine which and how much the Skills are developed and suggest appropriate Tasks that are related to said Skills. In turn this will adapt the game so that these new Tasks can be accomplished. This process is done by double layer system that is explained in the following section 4.6.

4.6 Double Adaptive Layer

In order for the game to truly adapt to the player’s needs, it does not only need to identify those needs but also to create situations in which the player is able to progress its Skill Set.

This is done by using a two-layer architecture in which one layer - Suggestion Layer - focuses on determining the player’s knowledge and the second - Manipulation Layer - on manipulating game conditions and providing Tasks. The Suggestion layer is described on this thesis and encompasses the Skill Set, Environment, Player Actions, Tasks and Rewards. The Manipulation layer is the work of João CabralCampos et al. [2013b] and it will be described in the following sections. Both layers are connected by the Skill Set which the Player is being taught.

4.6.1 Advantages of a Two-Layer Architecture

By using a two level architecture, the player’s knowledge about the Skill Set is separated from the game system itself, meaning that the Player Model can be used throughout several games that educate for the same topic, i.e. “My Dream Theatre” and “Village Voices”. This means that both layers can adapt at different paces: while the first layer can contain information and adapt to the needs of a Player regarding the Skill Set, the second layer can adapt the game rules taking into account the player’s Skill Set and his or hers proficiency with the game. For example, a Player can be very proficient with the Empathy Skill because he learned it on Game A but he doesn’t know how to play Game B which also teaches the Empathy Skill. This gives a very big advantage to the system: it can easily be scaled over several Games that focus on the same topic. In order for this to happen, each Game must implement the Reward system previously described so that there is a uniform evaluation. By doing this the Suggestion layer can collect all the Badges that the player has earned throughout the games and asses the proper level for each Skill. Each Game must also implement its own Manipulation layer so that it can consume the information that the Suggestion layer transmits. By having each game sharing the same Suggestion layer, information regarding the Skill Set of the player can be used by the system in order to make more accurate and adequate decisions over which competences should be to developed, thus enriching the education of the child.
4.6.2 Suggestion Layer

The main purpose of the Suggestion Layer is to determine the knowledge of the player. This is done by analysing Player Input and updating the Player Model. Then, with the information of the Player Model, the layer checks with a Reward Database to determine if the player has won any Rewards. By knowing which Rewards the player has won, the System can determine which Skill is the one that should be taught to the player, thus fulfilling the pedagogical needs. This process can be observed in Figure 4.1.

![Figure 4.1: Suggestion Layer.](image)

4.6.3 Manipulation Layer

The main purpose of the Manipulation Layer is to adapt the game content taking into account the information received from the Suggestion Layer. This adaptation must provide a Scenario that allows the Player to have contact with the Skill that is currently being developed. This adaptation can occur in several phases while the player is interacting with the system. If the Player has not yet chosen a Scenario to play, the Manipulation Layer should provide an adequate Scenario, however if the player is already completing a Scenario and the learning requirements change, the Manipulation Layer should adapt the Scenario accordingly so that the new learning requirements can be fulfilled.

This process can be observed in Figure 4.2.

![Figure 4.2: Manipulation Layer.](image)
4.6.4 Layer Communication

Layer communication is done by assessing which are the player’s needs in terms of Skills in the Suggestion Layer and sending those needs to the Manipulation layer. As it was described before, these needs are determined with the Recurring Assessment Component, by looking at the Rewards that the player has learned, by assessing the Weight of each Skill, via the weight function, the Skills that has most weight is identified and signalled to the Manipulation layer. The Manipulation layer then adapts the game so that the Player can effectively complete Tasks that are related to the Skill with most weight. As the Player completes Tasks he earns Rewards thus altering the progression of each Skill and changing the weights of each Skill.

The way that layers communicate can be observed in Figure 4.3.

![Figure 4.3: Layer communication.](image)

4.7 Applying the Methodology to “My Dream Theatre”

Since the rules of “My Dream Theatre” have already been describe in section 2.6.2 and the methodology has been described in this chapter, we can now apply the methodology to the game.

To recap, we need to:

- Define the Skill Set;
- Identify the Interactive Components on the Environment;
- What Actions can be performed;
- Which Scenarios exist and their respective Termination Conditions;
- What is the type of Environment;
- Which information does the Player Model contain;
- What and how many Rewards exist;
• How will we adapt the game based on the information gathered.

Each of these points will be addressed on their respective sub-sections.

4.7.1 The Skillset

The skillset was already defined on the project scope and is composed of the five skills identified by Crawford & Bondine Crawford and Bodine [1996]: Orientation, Perception, Emotion and Communication. Since the game aims to give a “hands-on” approach on all of the skills, the same weight function will be used on all of the skills. This function will return a weight based on the amount of Rewards that the player has earned on each Skill. This way, the Skill that is suggested to improve is always the least developed Skill.

As such, we can characterize the Skill set as the following:

\[
\text{Skill Set } S: \{ \{ \text{Orientation}, 0, \text{LeastDeveloped} \}, \{ \text{Perception}, 0, \text{LeastDeveloped} \}, \{ \text{Emotion}, 0, \text{LeastDeveloped} \}, \{ \text{Communication}, 0, \text{LeastDeveloped} \} \}
\]

4.7.2 The Interactive Components

There is only one type of Interactive Component on “My Dream Theatre”, the Actor. This was done per game design and it makes perfect sense taking into account that the game aims to teach the player conflict resolution skills and that can be done by helping other solve their own conflicts.

4.7.3 The Actions

Player Actions on MDT were defined by game design and are the following:

• Attribute a Role to an actor;
• Use Mediation Action - Talk to an Actor;
• Use Mediation Action - Talk to Two actors;
• Use Mediation Action - Talk to Three actors;
• Use Mediation Action - Do not intervene.

Non-Player Actions of Actors on MDT were also defined by game design and are the following:

• Is happy with Role;
• Is not happy with Role;
• Gain Conflict;
• Lose Conflict;
• Spread Conflict;
• Gain Shield;

• Leave rehearsal.

4.7.4 The Scenarios

There are two types of scenarios in “My Dream Theatre” and they were already defined by game design. Both of them are rehearsals for the Play but one of them only happens if there have been no rehearsals done yet.

The first Scenario is the first to appear and is characterized by the introduction of the Actors and Roles. The termination condition of this Scenario is when the player used a Mediation Action, after Roles have been assigned, and the rehearsal is over.

The second Scenario happens after the first one is done. This Scenario is similar to the first one but in addition, before the Actors enter the rehearsal there is an event that increases the Conflict level of some Actors. This scenario always appears after the first one and its termination condition is when the player used a Mediation Action, after Roles have been assigned, and the rehearsal is over.

4.7.5 The Type of Environment

Regarding Player Input, MDT is classified as Require Input since the game does not progress unless the player performs an Action.

The Environment is Synchronous because events happen in specific points of the game: External Event in the beginning of the Rehearsal, followed by the generation of Roles, attribution of said roles and subsequent Mediation Action.

The Environment has No Time Constraints since the game is not timed and does not change unless the player interacts with it.

The Environment is Repeatable since the same Scenarios can be repeated over and over again regarding Actors and generated Roles.

4.7.6 The Player Model

The Player Model must contain the following:

• Current Actors: the roles they like, conflict level and number of shields;

• Generated Roles: which were the generated Roles so far.

• Actions performed: on whom did the player use a certain Mediation Action, how did the player attribute the Roles;

• Badges: which Badges exist and what Badges did the player won;

• Skills: what is the level of development of each Skill.
With this information it is possible to know exactly what actions did the player perform and how did they affect the game. In addition, the adaptation system can look into this information and manipulate the external events and generated roles to increase the probability of certain behaviours to emerge.

4.7.7 The Rewards

The Rewards in “My Dream Theatre” appear as Badges. These Badges are related to each of the Skills previously defined.

“Perceptual” badges encourage the students to see an issue from different perspectives. “Emotional” badges aim to make the students should learn how to recognise the distortion effect that strong emotions have on an issue. “Communication” badges purpose is to help the students develop skills in expressing one or more parties’ perspectives or feelings on an issue, particularly when these perspectives are different from one another. “Creative-Thinking” badges help the students develop the ability to come up with a variety of conflict resolution options. “Critical-Thinking” badges purpose is to encourage students to learn objective criteria for choosing between options and have experience with developing them.

Based on the Actions defined previously, and on the recommendations of the methodology, this originated 11 badges: “Complete all Mediation Objectives”, “Give Shields to all players”, “No Flipouts”, “Effectively use Talk to One Actor”, “Effectively use Talk to Two Actors”, “Effectively use Talk to Group”, “Actor Flipped-out with his favoured Role”, “Flipout from External Event”, “No one gained Experience”, “Each type of Actor got an Undesired Role”, “Let an actor spread conflict points”.

The “Complete all Mediation Objectives” requires the player to complete all four Mediation objectives. These Mediation objectives require the player to use Mediation actions, i.e. “Talk to One Actor”. The objective of this Badge is to encourage the player to try all of the Mediation actions. This Badge can be defined as the following “Complete all Mediation Objectives”: \{T1, 1, “My Dream Theatre”\} and T1:\{“Creative-Thinking”, \{“Use Mediation Action - Talk to an Actor”, “Use Mediation Action - Talk to two Actors”, “Use Mediation Action - Talk to three Actors”\}\}.

The “Give Shields to all players” requires the player to give Shield points to all of the actors. This Badge requires a deep understanding of the rules of the game since in order for the Actors to gain Shields they have got to have conflict points first. Its purpose is to motivate the player to explore the Shield mechanic. This Reward is related to Player Actions but does not depend from a certain action. It depends instead on an Event, which is “All Actors won at least one Shield”. As such this Badge is defined by the following “Give Shields to all players”: \{T2, 1, “My Dream Theatre”\} where T2:\{“Creative-Thinking”, \{“All players won at least one Shield”\}\}.

The “No Flipouts” badge require the player to reach the final play without any Actor having a flipout. This Badge is associated to the “Critical-Thinking” skill and its purpose is to motivate the player to keep all of the Actors happy. This Reward is related to Player Actions but does not depend from a certain action. It depends instead on an Event, which is “All actors remained on stage until the play”. This Badge is defined by the following “No Flipouts”: \{T3, 1, “My Dream Theatre”\} where T3:\{“Critical-Thinking”, \{“All actors remained on stage until the play”\}\}.
The “Effectively use Talk to One Actor”, “Effectively use Talk to Two Actors”, “Effectively use Talk to Group” are badges that are associated to the “Critical Thinking” skill. The purpose of these badges is to make the player understand that if the Mediation Actions are used on certain types of Actors there are better outcomes. Now, these Badges do depend directly on a Player Action but there is no way to specify how is a Player Action used effectively. As such, these Badges are dependent on an Event which is “Use X effectively”, where X is the identifier of the Mediation Action. Also, in order to guarantee that the player did understand how to use correctly the action, he or she must use it effectively 10 times.

The “Actor Flipped-out with his favoured Role” badge is related to the “Emotional” skill and its purpose is to show to the player that actors can flipout even if they got what they wanted. This situation can happen when another actor spreads conflict. This Badge is also related to an Event instead of directly to Player Actions, “Flipout with favoured role assigned”. It can be described as “Actor Flipped-out with his favoured Role”:

{\text{T6, 1, “My Dream Theatre”}}

where T6:{\text{“Emotional”, (“Flipout with favoured role assigned”)}}.

The “Flipout from External Event” badge is related to the “Emotional” skill and its purpose is to show to the player that conflict situations can originate from anywhere even when everything appears to be fine. As the previous Badge, this Badge relies on an event, “Flipout from External Event”. This Badge is defined by the following “Flipout from External Event”:

{\text{T7, 1, “My Dream Theatre”}}

where T7:{\text{“Emotional”, (“Flipout because of External Event”)}}.

The “No one gained Experience” badge is related to the “Emotional” skill. Its purpose is to encourage the player to observe the reaction of actors when they do not get what they want. This situation is inevitable because of game adaptation and the situation itself: if Actors always get what they want they will gain experience. This Badge is related to the Event “No Actors gained experience until the end” and can be defined as the following “No one gained Experience”:

{\text{T8, 1, “My Dream Theatre”}}

where T8:{\text{“Emotional”, (“No Actors gained experience until the end”)}}.

The badge “Each type of Actor got an Undesired Role” is related to the “Perceptual” skill and its purpose is to make the player observe the reaction of actors when they do not get what they wanted. This implies that the way that the Player attributes Roles is stored. As such it depends on an Event which is “For each type of Actor, it receives an undesired role”. It is defined by the following “Each type of Actor got an Undesired Role”:

{\text{T9, 1, “My Dream Theatre”}}

where T9:{\text{“Perceptual”, (“For each type of Actor, it receives an undesired role”)}}.

Finally, the “Let an actor spread conflict points” is also related to the “Perceptual” skill and, like the previous badge, its purpose is to make the player see the effect of conflict spread on other actors. This happens when an actor flipsout, as such it depends on the Event “Actor flipped out”. It is defined by the following “Let an actor spread conflict points”:

{\text{T10, 1, “My Dream Theatre”}}

where T10:{\text{“Perceptual”, (“Actor flipped out”)}}.

This makes the following Badge count per Skill: “Creative-Thinking” has 2 Badges; “Critical-Thinking” has 4 Badges; “Emotional” has 3 Badges; “Perceptual” has 2 badges; and “Communication” has 0 badges.

The game does not have any “Communication” badges, as the player cannot express its feelings in
any way. Just by playing the game, the player should be able to understand the different perspectives of conflict and the impact, even though there is no way of measuring that through game actions.

### 4.7.8 The Adaptation

Adapting “My Dream Theatre” is relatively straightforward. Based on the Badges that the player has won, the Suggestion Layer suggests the least developed Skill. By using the interface, the student, or teacher can accept that Skill or choose another one. Based on that Skill, the Manipulation Layer checks which Badges of that Skill have not been completed yet, and based on the Tasks that must be completed for each Badge, generates Actors, External Events and Roles that facilitate the completion of the Tasks. These Tasks are presented to the player in textual form throughout the game.

In the next section, the Architecture of “My Dream Theatre” will be described, the results of user testing will be presented and conclusions regarding this methodology will be drawn.
Chapter 5

My Dream Theatre Architecture

“My Dream Theatre” was developed mainly by Henrique Campos, João Cabral and Serious Games Interactive with the game engine Unity3D over the course of 2 years. In this section, the architecture of “My Dream Theatre” regarding the adaptation component will be described and the results of user testing will be analysed, as well as our own experience while using the proposed methodology.

5.1 General Architecture

The architecture for “My Dream Theatre” can be broken down in the following modules: Theatre Player, that takes care of the interaction between the player and the game; Theatre Game Manager which interfaces with the game actors, and handles their states, the roles, the external events, and players actions; the Actor that has each characters information and handles the animations; the Adaptation module which is responsible for procedurally generating content and adapting the game to the player; and the Autonomous Agent System that handles the Intelligent Agents if deemed necessary.

The way that modules are connected can be observed in Figure 5.1.

![Integration Architecture](image-url)

Figure 5.1: Integration Architecture.
5.2 Adaptation Module

As it was stated before, in order for “My Dream Theatre” to be an ITS it must have a Tutor and Student Model. Enter the Adaptation Module. This module is responsible for changing the behaviour of the game according to the learning needs of the user. In the process of developing this adaptation module, we came across two essential features required to achieve the intended goal: the module has to understand and measure the knowledge of the player using it in order to know what are his/her educational needs; and, after knowing the educational goals for the user, the system should guarantee that its usage would allow those goals to be learnt. This is done by promoting certain actions of the user or by creating relevant educational situations.

As can be seen on Figure 5.2, the Adaptation modules retrieves information from the game system by being updated whenever there are Roles attributed or External Events happen. It also receives any Events that the Theatre Watcher may fire.

Since the adaptation module has two main responsibilities, evaluate the player and adapt the game, a double layer adaptation module was developed in order to guarantee these goals.

![Figure 5.2: Adaptation Integration.](image)

5.3 Double Layer Architecture

To implement both desired features, a two-level architecture was implemented, as seen in Figure 4.3. In this architecture each level focuses on one of the features described. The top layer, the Skill Suggestion Layer, of the architecture is responsible for identifying what does the user knows about Conflict and also for suggesting what should be the learning priority of the player. The bottom layer, the Game Adaptation Layer, is responsible for manipulating the game elements in order to guarantee that the scenarios that the player experiences can provide a proper environment to learn the educational topics that are required.

By using this type of architecture, the players’ knowledge about an educational topic is separated from the game system itself, meaning that the player’s user model can be used in several games.

Also, since different topics may require other ways to teach a subject and, consequentially, different games. Thus, it was necessary to devise a system that could be used on any game that could be part of
the SIREN Project. This way, to signify what the player has learned and to allow an efficient and flexible way for the two layers to communicate, an objective system was devised.

This system defines a series of tasks that the player has to complete in order to obtain a better score or progress in the game. To complete these tasks, the player has to go through a certain situation or perform a specific action which is considered as having educational value or promoting the learning of a specific concept, regarding the topic that is being taught. The completion of an objective also provides badges to the player, like the ones found in modern games. This achievement system keeps track of what tasks the player has successfully completed, which rewards has he earned and also which educational skills the player has gained throughout their game history. Other games may wish to reward the player with something other than Badges. The system is prepared, in some extent, for such an eventuality. Although, due to interface restrictions the current version of SIREN allows for a limited amount of rewards.

In “My Dream Theatre”, when the players comply with objectives a certain amount of times, they earn badges, symbolizing that they have already learned or understood a certain concept. As badges are earned, the players progress on the skills being taught also advances and different objectives are presented, related to the least developed skill, promoting the education of every concept that the game has to teach.

Both levels of the architecture implement the three following processes:

- Observe and interpret user Input;
- Update by adjusting internal models that evolve on the basis of that input;
- Adapt the game by using the up-to-date models to determine the system’s adaptive behaviour.

By guaranteeing these three processes, both layers, in unison, make “My Dream Theatre” an Intelligent Tutoring System.

5.3.1 Skill Suggestion Layer

The Skill Suggestion Layer of the implemented system is responsible for understanding what is the player’s knowledge regarding the educational topics being taught. It is also responsible for signalling and requiring an adaptation of the tasks required of the player in order to promote the learning of concepts that the user is most lacking. In sum, it is the Student Model and part of the Tutor Model.

The three processes Input, Update and Adaptation, that were referenced in the previous section are respected as following: the Input is done by keeping track of what the player already knows. This input process is solely interested in knowing if the player was able to obtain a new badge through its interactions with the game; the The Adaptation is done by maintaining a user model for each player that interacts with the game. This user model is sub-divided in categories of skills that the player should learn by interacting with the game, representing the knowledge that the child has on each educational topic. Each badge implemented is linked to one of these category of skills, and, as the player gains new
achievements, the user model is updated accordingly; Finally, the Adaptation process is done to determine what is the main learning need of the player based on the badges that have been already obtained. That information is passed on to the game system, which determines, based on its list of implemented objectives/tasks, what the player has to perform in order to promote the required educational content. It is then through the completion of these tasks that the player will gain new badges, and therefore learn the new educational content.

The Skill Suggestion Layer is composed of the following components: the System Watcher; the Player Model; the Player Manager and the Reward System.

The System Watcher receives all sort of input from the player and stores it in the Player Model. In the Player Model are stored the number of sessions that the player played, how many flipouts there were, the shields that were earned, the total conflict tolerance and the overall information about the Actors. The external events and actions that the player performed are also stored. In sum, it has all the data that is required to characterize the player. The Player Manager, with the information from the Player Model, checks which badges were completed and which Skills are least developed. Finally, the Reward System has all of the Badges and allows the Player Manager to query which Badges exist and were completed. Each Badge has information about which Skill it has associated, what are the objectives and how many times do they have to be completed to earn it, the progress of the Badge and its description.

The components of this layer and the way they communicate can be observed in Figure 5.3.

5.3.2 Game Adaptation Layer

The Game Adaptation Layer was implemented by João Cabral and is what guarantees that every player is able to complete the objectives presented, by manipulating and adapting the game’s elements, challenges and difficulty.

The three processes Input, Update and Adaptation, are respected as following: The Input simply retrieves information about the decisions and actions that the player made while interacting with the game. These are stored in order to later be analysed; The Update is done by an internal user model, which is updated using the statistics and other information gathered in order to understand how players perceive each in-game situation and what are their reactions to them; Finally, the Adaptations is done by manipulating the game’s elements: Roles, External Events, Actors, including personalities and conflict
tolerance. This way it is possible to create situations that allow the current objectives to be completed. This is done by analysing the current game state, and searching the entire spectrum of possible events to find the ones that most promote the tasks required of the player. However, since each child has a different understanding of the game and of the situations that occur, the user model is applied to predict what will be their reaction to each event, and therefore guarantee that the educational objective is perceived, understood and can be completed by every child.

After the game starts, and the educational objectives are chosen, the Game Adaptation Layer then has the task of guaranteeing that the player is able to complete the objectives that are presented. This adaptation is done by manipulating the events that occur, external events and rehearsal roles that the player has to assign each round, which would normally be randomly chosen by the game system. This way, the player is “forced” to go through certain situations and his/her actions are “guided” according to the educational objectives presented.

This level of the adaptation system is highly dependent on the actual game system and design, as it must adapt according to the game specific objectives, and also create a user model that predicts what the player will do based on statistical or other data extracted from the player's interaction with the game system. This prediction may even be hard-coded in the system if it is deemed necessary. In “My Dream Theatre” the relevant information about the player is how does he decide to assign the available roles to actors and the mediation actions used to solve conflict situations. Each round, the Adaptive process checks the current game state and objectives and iterates through every possible game states, such as the combination of events and rehearsal roles, and checks what actions the player is likely to perform according to the user model. By comparing the most probable outcomes and the educational objectives asked of the player, the system manipulates and chooses the event and rehearsal roles that allow the player to complete the objectives. This way the player is being guided into the intended educational situations. As the player acts upon the game environment by assigning roles and solving conflict situations, the Game Adaptation Layer keeps adapting the game.

The current interface of “My Dream Theatre” allows the teacher to either generate conflict situations with the suggested Skill or choose another Skill altogether. This was done to give freedom to the teacher: if he or she does not agree with what the system is suggesting or wants to enforce a certain skill, the suggestion system can be disregarded.

5.3.3 Badges

The Badges previously defined on Section 4.7.7 were implemented taking advantage of Unity3D’s framework. This was done by defining each Badge as its own separate entity and then loading it based on the information of a specifications file. This way it was possible to add new Badges without recompiling the project.
5.4 Solution Evaluation

In this section we will proceed to evaluate what was implemented taking into account two things: what we learned by using the methodology and did the adaptation system had any influence in the players’ experience.

5.4.1 Applying the Methodology

Applying the Methodology to “My Dream Theatre” was very straightforward since the game was already designed and tested. The Skill Set, Environment, Player and NPC Actions were well defined and as such the time that we spent more was the definition of Badges. The Badges themselves were not hard to define because there had been extensive testing before and the game already naturally tries to teach the subjects without the adaptation system.

What did went wrong, and that can be seen on the next section, was the estimation of how many times did the students needed to perform certain tasks to earn the Badges. As such, it is highly recommended that, when designing the Rewards, particularly when defining which Tasks are needed to be completed in order to reward the player, it is taken into account the average expected duration of a game session and how many sessions are there going to be. If this is not done properly one of two thing can happen: players never earn Badges, thus making it impossible to discern if they learned anything without the aid of external tests; players are Rewarded without actually learning anything. This can also be discerned with external testing.

Even though the methodology was not applied to the game from the beginning of the game design, the results were satisfactory and the methodology was quickly implemented on “My Dream Theatre”.

5.4.2 User Testing

Evaluation of “My Dream Theatre” regarding user testing occurred during the month of May. During this month, all of the components of “My Dream Theatre” were tested, including the Adaptation component.

Testing was done on weekly sessions with participants from a pool of students with ages between 10 and 13. The distribution of the ages can be observed on Table 5.1. Of the 67 students that participated on the testing, 33 (49.25%) of them were females. Among the 67 students, 14 (20.90%) students were picked randomly to constitute the control group. This group did not play the game and its purpose was to determine if there were any external factors regarding conflict management and resolution concepts, i.e. a television show educates about conflict management and resolution.

All of the testing sessions were supervised by “My Dream Theatre” developers and GAIPS grant holders, Henrique Campos and João Cabral. Some tests were also attended by João Tiple, co-developer of the adaptation component. Post testing debriefing to assess the knowledge of the students, regarding conflict resolution skills and management, was done with questionnaires elaborated by Joana Campos, also a GAIPS grant holder and “My Dream Theatre” developer.
The testing sessions had a duration of one hour due to them being done during school hours and, although the game is not a multi-player game, in order for all of the students involved in the testing to play it, two players at once played the game in the same computer. During these sessions the students played a tutorial game, at least two scripted games and, in some cases, two adaptation games. Not every group played games with the adaptation component due to time constraints and some hardware failures. This resulted in 53 games played with the adaptation component.

This should be a satisfactory number of games, however no group played more than two games with the adaptation component, meaning that some Badges were impossible to achieve. This is a major flaw in Badge design since we should have reviewed the pre-requisites of each badge as soon as it was apparent that students would not be able to play more than two games with adaptation.

Since this thesis is about the adaptation component of “My Dream Theatre” and not on the efficiency of the game in teaching conflict resolution, we will focus on the logs obtained from the testing sessions and how did the adaptation component influence the players’ choices and gameplay.

While analysing the logs there were 4 situations that we were looking for: how many micro-objectives (MOs) did the player complete, how many badges did the player won, were any of the badges won related to the micro-objectives and if the actions of the player were influenced in any way by the MOs, for example, if the player used a certain mediation action because it was present on the micro-objectives, even if it was not the best action to be done. In each game the group was presented with a maximum of 3 micro-objectives from different learning dimensions.

The results for the first game can be observed on Table 5.2. There was an average of 2.08 micro-objectives completed per group, 68.57% of the groups managed to earn a badge on this first game and all of these badges were related to the micro-objectives. Only 8.57% of the players did actions that were contrary to the optimal play in order to earn a Badge or complete a micro-objective. Looking in depth to the logs we can observe that all of the Badges won were either the “No Flipouts” or “Give Shields to all players”. It was not expected that the players’ could earn Badges that required a certain amount of micro-objective to be completed but it was also not expected that the players’ would be able to earn either of these badges on the first game. However this is viewed as a positive result because players were introduced to the badge system on their very first experience with the adaptation component.

The results for the second game can be observed on Table 5.3. There was an average of 1.27 micro-objectives completed per group, 16.67% of the groups managed to earn a badge on this first game and all of these badges were related to the micro-objectives. Of all the groups in this session, only one, accounting for 8.57% of the groups, did actions that were contrary to the optimal play in order to earn a Badge or complete a micro-objective. One group that did not complete any micro-objectives or earn any badges in the first game did not complete or earn them again in the second. One group that had completed all of the micro-objectives and earned a badge on the first game did not complete micro-objectives or earn badges on the second game. As it was expected, objectives regarding badges that were earned, were not repeated in the second game for those that had earn said badges on the previous game.

These tests already give us some information regarding how do the players’ play the game and
how they respond to the presented micro-objectives and difficulty of the badges. However, two game sessions is not enough to make meaningful conclusions.

5.5 Conclusions and notes

The work with “My Dream Theatre” allowed for a greater understanding regarding user modelling and game adaptation to different types of user. Unfortunately, the short period of testing was not enough to conclude if the players’ did benefit from a personalized experience or if the micro-objectives altered the way they played the game in a significant way. This evaluation would benefit immensely from an extended period of testing that would include tests with the adaptation component and without it in order to determine if the students way of playing was definitely affected or not by the adaptation component.

This will be hard to accomplish with the same pool of players since this has to be done in a school environment and this requires permissions and available time from the students. More so, some of these students might no longer be in the same school.

However, since the methodology is defined and was successfully applied to “My Dream Theatre”, it is entirely possible to apply it to another game and conduct the testing with a different pool of users.
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Table 5.1: Age distribution of “My Dream Theatre” testers

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<th># Badges Earned</th>
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Table 5.2: Adaptation Game 1 Analysis
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<th># Badges Earned</th>
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Table 5.3: Adaptation Game 2 Analysis
Chapter 6

Conclusions

All of the research that was done on Gamification, User Modelling and Intelligent Tutoring Systems, allowed us to elaborate and put into practice a methodology that, if properly used by game designers, guarantees that the result of applying said methodology will be able to teach to the player a certain Skill Set and adapt correspondingly to the players’ successes and failures. Additionally, since the methodology is generic, it is possible to continue testing the validity of a personalized learning experience, via serious games that adapt to players’, even if the “My Dream Theatre” project does not go through, with another game.

The work that was done with “My Dream Theatre” showed that it is possible for a serious game to adapt to the person that is playing it, even if those tests did not produce a complex adaptation. The gamification techniques that were applied on “My Dream Theatre” not only allowed us to add extra incentives to the game, but they also created a stable core that keeps track of each players’ progress. With this information the game can then adapt correspondingly, thus making “My Dream Theatre” an Intelligent Tutoring System.

The research that was done in gamification techniques and existing gamifications, coupled with the research done in motivation theories, resulted in the creation of Badges that are well connected with the game and properly identify situations that we want the player to pay attention.

Without the work done by previous authors in the fields of Intelligent Tutoring Systems and Procedural Content Generation, it would have not been possible to create the Double Adaptive Layer structure that is the basis of the adaptation system of “My Dream Theatre”. This system not only stores information about the player but also suggests which is the best learning path to a certain him or her.

Following the implementation of said system, the one month testing period, with children from ages 10 to 13, provided us with enough data to realize that, even though the children enjoyed the game, learned some vocabulary regarding conflict, and received a personalized learning path due to the adaptation system, it was not possible to determine if a personalized learning experience is better or worse than a traditional one.
6.1 Future Work

Although “My Dream Theatre” was tested and implemented successfully, there are some points that can be improved or receive more attention.

The first point is that even though the adaptation system was tested to determine if it worked as expected, no tests were conducted to check if a personalized learning experience is actually better than a regular uniform learning experience.

Secondly, “My Dream Theatre” Badges and tasks were done taking into account the limited interface space, project objectives and requirements, and the badges and learning objectives of “Village Voices”. However, the game is ill prepared for future games. It will be a very labouring task to adapt “My Dream Theatre” to work with other games. For example, if a new game introduces a new badge that represents a skill that is also taught on “My Dream Theatre”, it will be necessary to alter the source code of “My Dream Theatre”.

Finally, the badges and tasks difficulty were determined by taking into account the limited time to test the game. If the testing period would have been longer, perhaps some badges would have been very easy.

Additionally, even though the proposed methodology is intended to teach real life skills it can also be used to teach game mechanics, thus creating a self-adapting tutorial for gamers.

6.1.1 Extended Period of Testing

The period of testing for “My Dream Theatre” had the duration of one month. This was not enough to validate the efficiency of a personalized learning experience. It is suggested that there is a longer period of testing were it can clearly be observed if there is any, or none, difference between a personalized learning experience and a regular uniform learning experience.

Since the proposed methodology was elaborated in a fairly generic way, this testing can either be done with “My Dream Theatre” or another game that follows the methodology.

Ideally, the testing would have a similar duration and evaluation to the one used by the authors of “So fun it hurts - gamifying an engineering course”. In this evaluation, the progress of each player should be analysed regarding the badges they earned, which skills are most developed individually and globally by the test group and the rate at the badges and tasks are accomplished. In parallel, another group should play the game without the adaptation component.

The pool of players should be divided in a group that plays the game with adaptation and other without adaptation. This should grant enough information over a significant amount of time to compare the results obtained from both groups and determine if a personalized learning experience is indeed useful.
6.1.2 Task, Reward and Skill Ontologies

The concept of the Semantic Network Model was formed in the early sixties as a form to represent semantically structured knowledge. Its purpose is to drive the evolution of the current Web by enabling users to find, share, and combine information more easily. This is done by attributing meaning to actions and components and then sharing that meaning between different platforms.

If we consider that the SIREN Project is composed of several games that aim to teach conflict resolution, it is only natural to consider that what is learned in one game, should be transported by the player, but also be recorded by the system. If there is an ontology of Tasks, Rewards and Skills, it is possible, by using the same principles of the Semantic Web, to tell the system that Task X in game A is the same as task Y on game B.

If this is done, then a player could play a game for the first time but already adapted to what he or she learned on a different game altogether. In addition, it would be easier to add new games to the SIREN project since almost everything would be standardized.

6.1.3 Adjusting Reward Difficulty

As stated before, the difficulty of the badges and tasks of “My Dream Theatre” was determined taking into account the limited time to test the game. If the testing period would have been longer, the degree of difficulty to earn some badges would have been very different.

In the proposed methodology it is also stated that the difficulty of the badges should be defined after there is some user testing or experts are consulted in the matter.

An alternative is to define the difficulty of the badges in a laxer fashion and then adjust their difficulty as the players’ play the game. This would require that the actions performed by all of the players’ are stored and cross-checked to determine if the difficulty of a badge should be increased or lowered. For example, if players’ are constantly failing a badge then the difficulty of that badge should be lowered. Or if a badge is being completed ahead of scheduled by many players, then its difficulty should be increased.

6.1.4 Applying the Methodology to non-Serious Games

The proposed methodology was designed taking into account that there is a need to teach a certain Skill Set with a game. However, it can also be used to teach game mechanics inside a game. For example, when designing a tutorial, a game designer can use the proposed methodology. Since the Environment and Player Actions are already defined, the game designer only has to determine which Skills does he want the player to learn in the tutorial, which Tasks should he perform and what Rewards does the player earn when he completes said tasks. This way, perhaps the player could do a tutorial that only teaches him or her what he has not grasped yet.
Bibliography


