



PONTIFICIA UNIVERSIDAD CATOLICA DE CHILE  
ESCUELA DE INGENIERIA

# **EXPLORING THE RELEVANCE OF VISUAL AESTHETICS ON EDUCATIONAL VIDEOGAMES**

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Thesis submitted to the Office of Research and Graduate Studies in  
partial fulfillment of the requirements for the Degree of Master of  
Science in Engineering

Advisor:

**MIGUEL NUSSBAUM**

Santiago de Chile, (October, 2012)

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To my family and friends, who accompanied me and supported me during this process. And to all the teachers who told me “*peut mieux faire*”.

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## **ABSTRACT**

When designing educational videogames we spend resources on graphics and aesthetics, although it is unclear how these affect players' interest or immersion. In order to approach this issue, we selected two different sorts of variables: animations and customization. We designed an experiment with a classroom videogame (focused on Math learning) to test the effect of these variables over immersion and learning; pre and post-tests were used to measure learning, while immersion and game experience were measured through a questionnaire. The results were analyzed through Ancova analysis and the Kruskal-Wallis method respectively. Our results in a two session experience showed that our variables had no effect over learning, although they had an impact over the children's emotional involvement.

Keywords: educational videogames; visual aesthetics; immersion; animations; customization

## **RESUMEN**

Al diseñar videojuegos educativos invertimos en gráficos y estética, aunque no es claro cómo estos afectan el interés de los jugadores o el efecto de inmersión. Para solucionar este problema, seleccionamos dos variables distintas: animaciones y personalización. Diseñamos un experimento con un videojuego en una sala de clases (enfocado al aprendizaje en matemáticas) para observar el efecto de estas variables sobre inmersión y aprendizaje; pruebas pre y post fueron usadas para medir aprendizaje, mientras que inmersión y experiencia de juego en general fueron medidos a través de un cuestionario. Los resultados fueron analizados a través de un análisis de la covarianza (Ancova) y el método de Kruskal-Wallis respectivamente. Nuestros resultados para una experiencia con dos sesiones prácticas mostraron que las variables escogidas no tuvieron un efecto significativo sobre el aprendizaje, aunque sí tuvieron un impacto sobre el involucramiento emocional de los niños.

**Palabras Claves:** videojuegos educativos, estética visual, inmersión, animaciones, personalización

## 1. INTRODUCTION

### 1.1 Motivation and Context

#### 1.1.1 Educational videogame design

Over the past few years, the idea of using video games as a medium for education has become increasingly popular. But creating a successful educational videogame is not an easy task, as it needs not only to be fun, but also needs to deliver an effective learning experience.

Several different proposals had been made on how to design these games (Amory, 2007, Annetta, 2010, Aleven et al, 2011), as well as on how to make the learning experience more effective, engaging, or enjoyable. (Rosas et al, 2003, Dickey, 2006, Cowley, 2008, Bond & Beale, 2009).

Ultimately, one of the keys on designing frameworks or models is to identify the core elements and patterns that define the complex structure of what makes a successful videogame (Cook, 2007); thus the need for understanding the role of these elements and how they interact with each other.

The work done by Barrios et al (2011) pondered over the role of fantasy (narrative) in educational games, proposing a structured methodology for the design of conceptual physics games that integrates the principles of intrinsic integration.

On the other hand, the work done by Echeverría et al (2012) focuses on the use and integration of new technology, by exploring the use of two different technological platforms for developing collaborative games in the classroom (augmented reality versus multiple mouse technology).

Another possible approach left to explore towards improving educational game designing comes from testing the role of aesthetics, and the value of investing on aesthetic improvements.

### **1.1.2 Aesthetics in videogames**

Aesthetics is generally considered one of the core elements of videogames (Hunicke et al, 2004, Schell, 2008). Unfortunately, it is also one of the most difficult to approach because of its abstract and subjective nature. The work of Niedenthal (2009) even focuses on exploring the meaning of the concept in the domain of game discussion, to reclaim perspective over the term.

In an attempt to better understand the value of aesthetics on casual online games, the work of Andersen et al (2011) proposes testing the selective removal of aesthetic improvements (such as animation or music) and monitoring the repercussions over player interest through large scale testing. Their results showed that the presence of animations caused players to play more, while sound and music had little to no effect.

The purpose of this work is to explore further over the value of aesthetics and investment on aesthetic improvements, but in the realm of classroom educational videogames instead of casual online games.

This work also focuses on the impact of aesthetics over a different dimension of player interest: player immersion.

### **1.2.3 Player interest and immersive experiences**

Better graphics and music are features that serve as a selling point for videogames on the market, as well as a medium to attract the interest of players. But educational videogames can profit from such features in a different extent, as there are several areas

of interest intrinsically linked with aesthetics that may benefit from aesthetic improvement.

Dede (2009) mentions that immersive interfaces can enhance the learning experience, and emphasizes the need of further research over what can be achieved by using this medium.

Other researches also consider immersion as one of the main elements when designing successful games (Annetta, 2010, Fu et al, 2009).

But the work of Dede (2009) also states that the immersive experience draws on sensory factors (sensory immersion). At this point, it is important to consider that the aesthetic experience encompasses the sensorial experience. As Niedenthal (2009) reassures in his work, one of the three core meanings of game aesthetics is that it refers to the sensory phenomena that the player encounters in the game.

As such, investing over aesthetic content in a game (such as visual aspects) may have an impact over the immersive experience and, ultimately, over the learning experience.

## **1.2 Hypothesis**

The first hypothesis of this work is that investing on graphic improvement, such as animations or customization on the appearance of certain game elements, will have an impact over player interest, making education classroom videogames more immersive to children.

The second hypothesis is that these improvements will increase the learning effectiveness of the game. Further immersion will result on children more focused on the game activity, thus on the learning activity.

### **1.3 Objectives**

Consistently with the proposed hypothesis, the general objective of this thesis is to develop an educational classroom videogame with variable graphic content. The gameplay and mechanics will be based on an existing model developed on Rosas et al (2003) research of a game that teaches arithmetic and problem solving, but will follow the set of pedagogic rules and activity flow established on Alcoholado et al (2012) research.

The graphic variables will be inspired by Andersen et al (2011) research on the value of aesthetics in online casual games. Two graphic improvements, animations and customization, will be used as variables that can be easily enabled or disabled for testing purposes. Thus creating four versions of a same game, but with different aesthetic experiences.

To validate the hypothesis, the four versions of the game will be tested on a school environment. A large sample of third grade children will be divided into four groups, each testing a different version of the game. A post-test will be used to evaluate the children learning, and a questionnaire based on the EGameFlow scale from Fu et al research (2009) will be used to measure the players level of enjoyment and immersion perceived, as well as other relevant forms of player involvement.

### **1.4 Chapter Overview**

The current chapter serves as a brief introduction for this thesis, explaining the context, motivation, objectives and hypotheses. The following chapters refer to the methodology and procedure.

Chapter 2, which is based on a paper sent to the ISI journal Computers in Human Behavior, describes the methodology used for designing a learning activity aimed to test the impact of visual aesthetics over immersion and learning. It also explains the general procedure employed during this research. Section 2.1 provides a further description to the state of the art. Section 2.2 presents the Game design of MathMecha, an educational videogame developed for this research. Section 2.3 refers to experimental design. Section 2.4 presents the investigations results. Section 2.5 discusses the results obtained and the conclusions achieved.

Chapter 3 aims to provide additional information on certain topics no further detailed on chapter 2. Section 3.1 provides more insight on activity design. Section 3.2 presents further information concerning the game development. These include graphic content issues and considerations, as well as technical information about software development. Section 3.3 gives more information about fieldwork and the practical experience. Finally, section 3.4 discusses reached conclusions as well as future work.

## **2. EXPLORING THE RELEVANCE OF VISUAL AESTHETICS ON EDUCATIONAL VIDEOGAMES**

### **2.1 Introduction**

#### **2.1.1 Approaching the concept of Aesthetics in Videogames**

Videogames are the result of combining different resources, such as graphics, music and mechanics into a unique gaming experience. When attempting to group and identify the core elements that form a videogame, aesthetics is considered by Hunicke et al. one of the three essential components of the MDA framework (Mechanics, Dynamics and Aesthetics) (Hunicke, LeBlanc, & Zudek, 2004), a framework intended as a formal approach to understanding videogames.

In a similar manner, Schell defines his concept of “elemental tetrad” as the four main categories to classify game elements, where aesthetics is one of the main components of the tetrad (referred as the third quadrant), along with game mechanics, story and technology (Schell, 2008). Other studies that attempt to identify the characteristics that make a good game also suggest that aesthetic elements (such as customizability and user interface) are important or even crucial factors (Bond, & Beale, 2009).

Nevertheless, approaching the concept of aesthetics is not an easy matter. Niedenthal highlights the importance of understanding aesthetics in videogames beyond mere graphic aspects such as “eye candy”, and more on the lines of the traditional definition of aesthetics and aesthetic pleasures (Niedenthal, 2009). Because of the complexity of the concept, it is not an easy task to make an assessment on its value on the field of educational games.

Another approach is to consider other concepts that take aesthetic factors into account, such as immersion and flow.

### **2.1.2 Immersion and Flow: the role of aesthetics**

In their research, Jennett et al. mention the difficulty of measuring and defining the concept of immersion in computer games (Jennett, Cox, Cairns, Dhoparee, Epps, & Tijs, 2008). We are talking about immersion when a game is interesting enough to keep the player's attention, to the point where it can induce a lack of awareness of time and a loss of awareness of the real world.

On the other hand, Csikszentmihalyi presents the concept of Flow, which is described as the process of optimal experience, “the state in which individuals are so involved in an activity that nothing else seems to matter” (Csikszentmihalyi, 1990). There are several studies regarding immersion and flow in games, and their application in game design, such as Chen’s work (Chen, 2006).

Furthermore, in his article about a framework for SEG (Serious Educational Games) Annetta includes immersion (along with flow) as one of the six elements of educational games, also referred as the “I’s” for SEG design (Identity, Immersion, Interactivity, Increasing complexity, Informed teaching and Instructional) (Annetta, 2010). Both Annetta and Jennet et al. have stated that the concepts of immersion and flow overlap but are subtly different; the state of flow means an optimal level of involvement, and simple immersion would be a precursor state (Annetta, 2010, Jennett, Cox, Cairns, Dhoparee, Epps, & Tijs, 2008). Both states share some basic requirements, such as the need of adequate feedback and a sense of goal clarity. As it is, it could be possible to enhance gaming experience and player’s interest by investing in features that improve these overlapping factors.

At this point aesthetics plays an essential role, and the impact of aesthetic improvement could be measured through its effectiveness in improving player’s immersion. For

example, game feedback usually implies delivering a sensorial response that matches the player's actions, such as animations, sounds, music, etc. A better feedback means a more accurate sensorial response, thus helping to achieve higher immersion.

### **2.1.3. The value of graphic improvement**

According to Andersen et al., although it is highly mentioned how aesthetic elements play a critical role in the video game experience the exact value that aesthetic quality has on maintaining the players' interest is unknown (Andersen, Liu, Snider, Szeto & Popović, 2011). Their research involved performing large-scale experiments using online casual games, and testing the effects on player behavior over the presence or absence of the following aesthetic factors: animations, music/sound and modifying gameplay.

Our goal is to continue further the research on aesthetic improvement and its value in the field of educational videogames, which leaves us with the following research question: When it comes to visual aesthetics, what are the factors that affect immersion in a classroom educational videogame?

To answer this question, and following the example of Andersen et al. research (2011), we conducted an experiment focused on the observation of test subjects playing different versions of an educational videogame, where each version presents unique aesthetic experiences and different levels of graphic investment.

However, it is important to consider that our conditions are not the same as Andersen et al. research (2011). For example, the differences between casual games and “serious” games (like videogames in a classroom), especially when it comes to environmental conditions. Casual online players are free to participate or not on the gaming experience, and their main objective is having fun. On the other hand, we will

understand an educational videogame in a classroom as an imposed activity, where the player's main objective is still having fun, but the activity's real goal is the learning experience.

Furthermore, the original research evaluated the importance of aesthetic quality through the presence or absence of three variables: animation, music/sound effects and optional rewards. In our case, it is uncertain whether we can actually achieve immersion (and how can we measure it) in a classroom environment with the proposed activity, or which variables could in fact hinder or prevent an immersive experience. Nevertheless, we can rely on certain assumptions.

In this study, we refrain from testing the effects of music and sounds, because they can be considered as disturbing elements in a classroom full of students playing at once (if no headphones are provided). We also leave aside optional rewards as a possible variable, limiting the experience to a single activity and learning objective.

We focus instead on the importance of the visual aspects of the game aesthetics through different levels of graphic improvement. We understand the concept of "graphic improvement" as elements that effectively improve the visual quality of the gaming experience.

There are many possible approaches to improve the visual aesthetic quality of a videogame; we propose the testing of two different graphic improvements as experimental variables: Animation and Customization. Investing on animated content in a videogame is generally effective in improving the overall aesthetic quality, and had positive results on the original research when it comes to maintain the players' interest (Andersen, Liu, Snider, Szeto & Popović, 2011). On the other hand, customization allows players to modify certain graphic aspects according to their liking, thus providing a more custom fit aesthetic experience.

Finally, to carry out this experimental activity support from academic institutions such as schools is needed; so large-scale testing the magnitude of Andersen's research (Andersen, Liu, Snider, Szeto & Popović, 2011) is unlikely to be possible. However, one of the advantages of doing the activity in the classroom is that we can introduce other types of surveys, like questionnaires and pre- and post- tests, which can be used to measure immersion and learning. Thus answering whether we are able to achieve immersion in a classroom environment.

The structure of this chapter is the following: Section 2.2 presents an educational activity designed to teach and reinforce arithmetic and problem solving, including details on the game design of MathMecha, a videogame specially developed for this purpose. MathMecha also supports the enabling or disabling of features such as animations and character customization, so we can measure the effects of their presence or absence over immersion. Section 2.3 presents a detailed description of the experiments carried out and the measuring instruments used. The tests results are presented on Section 2.4 and further discussed on Section 2.5, along with possible future work.

## **2.2. Activity Design**

### **2.2.1 Game Design**

#### **2.2.1.1 General description**

To answer our research question, we designed an educational videogame called MathMecha focused on math teaching and problem solving. MathMecha also includes a feature that allows enabling or disabling other graphic features such as animations and customization. The concept and core mechanics of this game were based on the previous work done by Rosas et al. (Rosas, Nussbaum, Cumssille, & et al., 2003), for

educational Gameboy games. We particularly chose a simple game, so the impact of graphic improvement could be better perceived.

Once the children start the MathMecha game, there is a brief slide show introduction explaining the game story: a giant monster is attacking a city and the children need to assemble a giant robot to defeat it. The only way to achieve this is by solving a series of mathematical equations. For every right answer, a new piece of the robot is assembled. On the contrary, for every mistake, an already assembled piece “falls” from the robot. The penalty is necessary to prevent the children on succeeding in the game only by guessing the right answers. The next equation only appears after the present one is answered correctly.

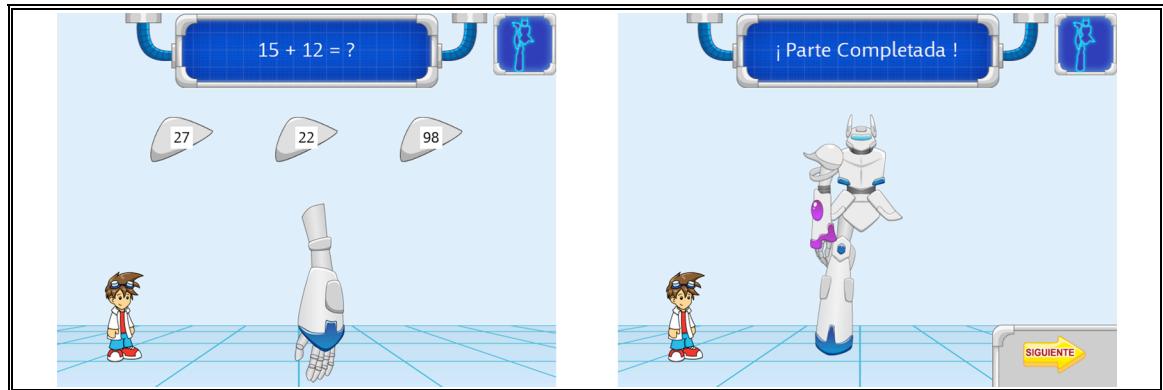


Figure 1.Screenshots from the game MathMecha.

On Figure 1, the left picture features a robot arm being assembled, while the one on the right corresponds to a transition screen between parts. The children’s avatar on the lower left of the screen reacts according to the player’s answer if animations are enabled, either with a celebration or an explosion in case of failure.

The children progress in the game by assembling six major areas of the robot (Figure 1): the head, the torso, the right arm and leg, and the left arm and leg. Each major area corresponds to a different level, and thus a different difficulty according to a level progression defined by pedagogical rules established by Alcoholado et al. (Alcoholado, Nussbaum, Tagle, Gomez, Denardin, Susaeta, et al., 2011). Once the robot is completed, the children are rewarded with a last sequence of slides, featuring their robot defeating the monster.

MathMecha was also designed to support two specific graphic improvements: Animations and Customization. These two variables could be easily enabled or disabled, thus resulting in different versions of the same game. The details concerning animation and customization and their implementation in the game are described in the following section.

Table 1: Description of animations in the game when this feature is enabled

Character/Avatar animations	<ul style="list-style-type: none"> <li>- Character celebration (when answering correctly)</li> <li>- Character failure (when a mistake is made)</li> </ul>
Robot Animations	<ul style="list-style-type: none"> <li>- Parts moving to assemble</li> <li>- Celebration when a major area is completed</li> </ul>
Feedback Animations	<ul style="list-style-type: none"> <li>- Explosion (failure)</li> <li>- Glitter and shine (success)</li> </ul>

We understand enabling animations in this case as the presence of animated content that adds to the gaming experience. For example, when a robot arm is completely assembled, it will move and flex for a short period of time. This could be taken as a reward for completing a part. Animations are a very useful tool to provide feedback to users actions, but we do not want players to become completely lost when the animated

content is disabled. The game was designed keeping that in mind so there is always some sort of feedback even if there are no ostentatious animations. For example, when the player answers a question correctly his avatar executes a short celebration if the animated content is enabled, while only a green check symbol appears if animations are not available.

### **2.2.1.3 Customization**

The term customization in the videogame context means to allow users to modify some aspects of the game according to their personal preferences. These changes generally apply to gameplay or visual assets. When it comes to gameplay, changes usually differ greatly from game to game. On the other hand, visual modifications generally extend to character or environment appearance. When a user has access to such a feature and can impose his aesthetic preferences to the overall game style it can be considered a graphical improvement in the gaming experience.

The game MathMecha features graphic customization by allowing users to choose between the parts of two different robot models to assemble, each with its own design (presented on Figure 2).

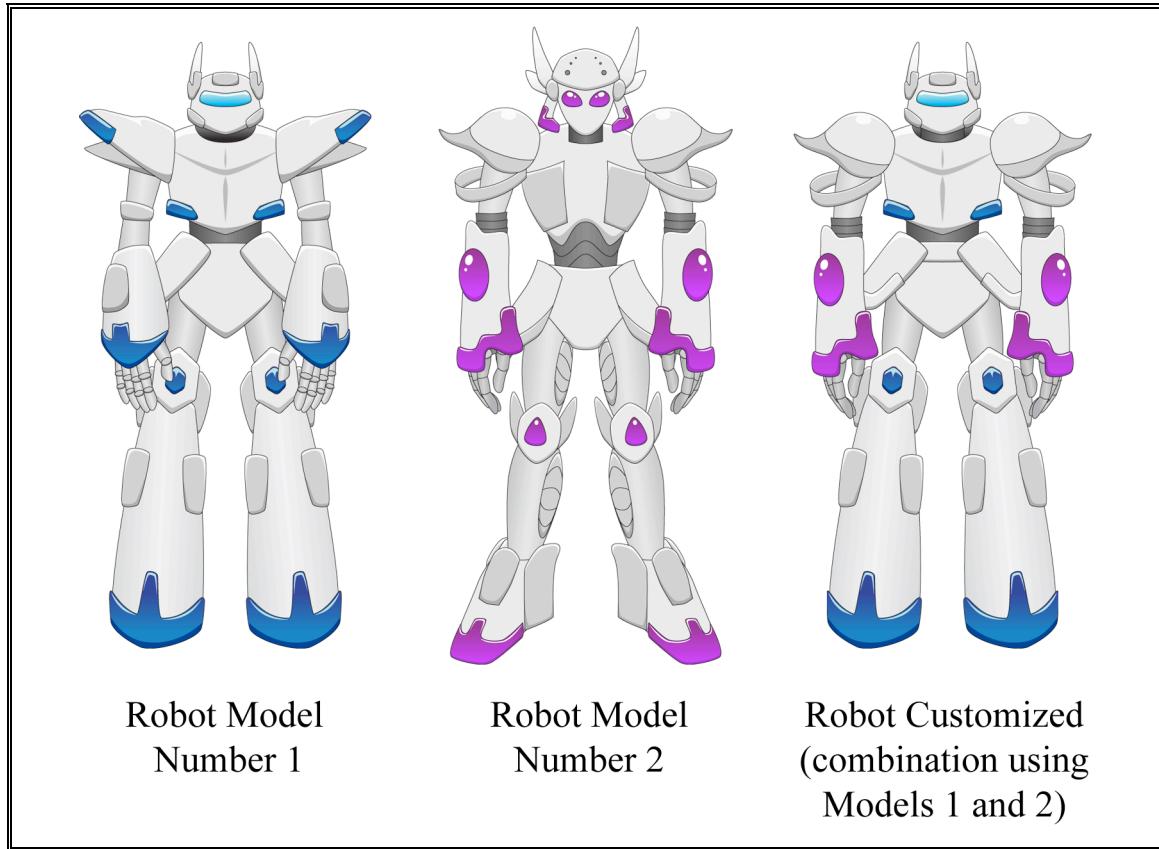


Figure 2: Robot models available to assemble in the game MathMecha

Figure 2 displays the two robot models available to assemble in the game and a possible combination of both. The head, arms, legs and body are interchangeable, allowing up to 64 possible outcomes.

This customization does not affect gameplay in any way, as the rules remain the same regardless of the robot model. The animated content (if there is any) also remains roughly the same. Each robot part is assembled in the same way (moving pieces coming together) and has its own small animation when completed. All these animations are about the same duration and complexity.

When customization is available, students can also choose their avatars gender at the beginning of the game (Figure 3). Again, besides personal preference, this choice does

not affect gameplay in any way. The avatars share the same animations and are only slightly altered to fit each gender.

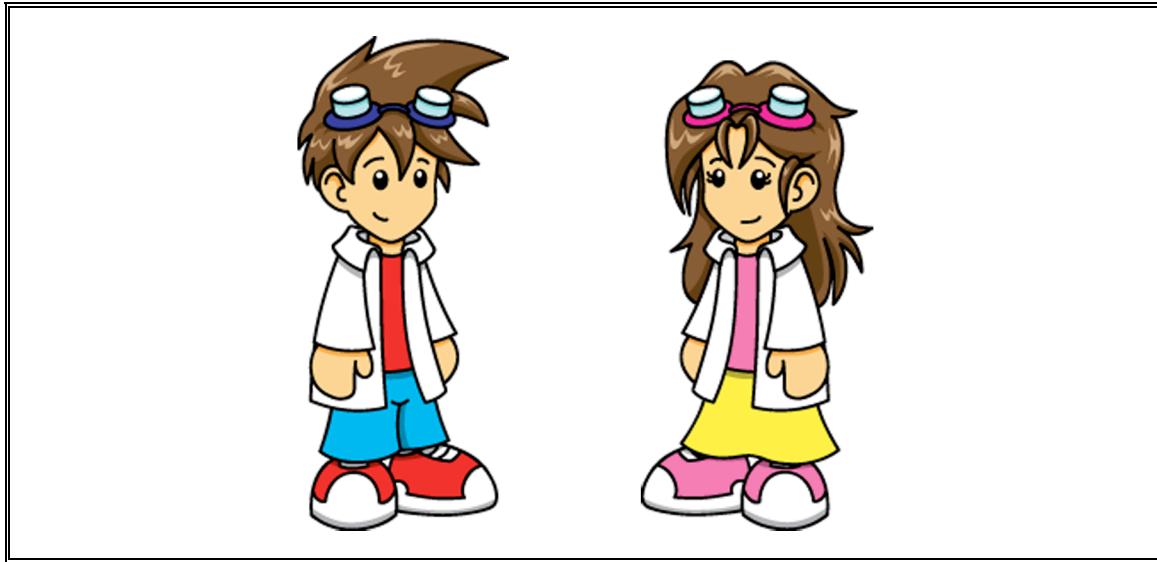


Figure 3: Character Avatars

### 2.2.2. Pedagogic Designs

Following the model established by Alcoholado et al. (Alcoholado, Nussbaum, Tagle, Gomez, Denardin, Susaeta, et al., 2011) each equation presented to the students during the game corresponds to a specific pedagogic rule; this rule maintains until a success criteria is met, increasing the pedagogic difficulty following the Chilean curriculum for arithmetic (Mineduc, 2011) for grades 1 to 3. The total number of rules used in this application is 45; 32 for addition and subtraction levels, 9 for multiplication and 4 for division.

## 2.3 Experimental Design

To provide answers to our research question (what are the factors that affect immersion in a classroom educational videogame?) the software described in the previous section was used in a state subsidized lower socio-economic class elementary school in Santiago (Chile) in three different third grade classes, with a total of 72 children (38 boys and 34 girls), in order to study and compare the children's behavior and results according to the two defined variables (thus defining four different groups), as shown on table 2.

The school had two computer labs with about 24 computers each. These computers are mostly used for teaching purposes, such as English interactive lessons; students can have supervised access to the computers when the lab is free.

Table 2: Study groups, according to the defined variables: Animation and Customization.

Study Groups	Variables	
	Animation	Customization
1	Not supported	Not supported
2	Supported	Not supported
3	Not supported	Supported
4	Supported	Supported

Each group was subjected to four sessions, each lasting approximately 30 minutes according to time restrictions imposed by the school. A pre- and post- test was carried out during the first and last session respectively, while the other two were practical sessions using the software. The results of the pre-test were used to determine the initial game level difficulty of each children according to their knowledge.

Although our initial intent was to sort out the students in equally sized groups with about 30 people, several problems occurred during the experience (such as students' absence to sessions or administrative issues). The details concerning the groups and their final size are shown on table 3.

Table 3: Study groups and their respective sizes

	Group 1 (Control group)	Group 2 (Animation only)	Group 3 (Customization only)	Group 4 (Animation & Customization)
Number of students per Group	12	15	24	21

Though arranging the groups in a completely random fashion is highly preferable for statistic purposes, it was discarded as a possibility because it was not feasible to retrieve students from all the different classrooms at the same time, given that each class has its own schedule. Therefore the groups were arranged by arbitrarily selecting students from a same classroom. Another reason for making groups exclusively between classmates was to minimize the inevitable contact between members from different groups throughout the experiment and between sessions.

Two instruments were used to quantify the experience. The first one is a pre- and post-tests, to make quantitative assessments about the students learning achievement, designed by Alcoholado et al.(Alcoholado, Nussbaum, Tagle, Gomez, Denardin, Susaeta, et al., 2011). It is a test with forty-five question assorted from additions, subtractions, multiplication and divisions, along the math contents set out by Chile's Ministry of Education (Mineduc, 2011) for grades 1 to 4.

The second instrument is a questionnaire aimed to take qualitative assessments on the students' satisfaction towards the game and the learning experience. The categories evaluated by the questionnaire were the following: Concentration, Goal Clarity, Feedback, Challenge, Immersion, Knowledge involvement and Emotional Involvement. The first six were selected according to the EGameFlow study as important factors involved in measuring learners' enjoyment of e-learning games (Fu, Su, & Yu, 2009), while the last one was included to measure the relevance of aesthetics and personal preferences in the game.

## **2.4 Results**

### **2.4.1 Pre and Post Tests results**

The quantitative learning results of the two half hour interventions, Table 4, are presented as the percentage of difference between pre- and post-test of correctly answered questions per experimental group. A one-way between independent groups analysis of covariance (ANCOVA) was conducted to adjust and compare the results obtained (last column of Table 4). The co-variable corresponded to the results on the pre-test, while the dependent value corresponded to the results on the post- test. The results of the statistical analysis showed no significant difference ( $F=0.9714$   $p >0.05$ ). This means that the difference between tests is not explained through the different groups. The possible causes of this outcome will be discussed on Section 2.5.

Table 4 displays the results from learning tests shown as percentage of correct answers for each group. The difference represents improvement between pre-test and post-test.

Table 4: Results from learning tests

	Pre-test	Result post-test	Difference between tests (Ancova adjusted)
Group 1 (Control group)	62.04%	67.41%	6.22%
Group 2 (Animation only)	64.59%	67.41%	1.71%
Group 3 (Customization only)	61.85%	65.93%	5.07%
Group 4 (Animation & Customization)	64.23%	68.68%	3.62%

#### 2.4.2. Questionnaires results

The results from the questionnaire for each group are shown on table 5, grouped by factors involved in measuring learner's enjoyment. The highest and lowest score in each category are white and dark grey, respectively.

Table 5: Results obtained in the questionnaires

	Group 1 (Control group)	Group 2 (Animation only)	Group 3 (Customization only)	Group 4 (Animation & Customization)
Concentration	58.33%	65.00%	58.33%	57.14%
Goal Clarity	58.33%	86.67%	79.17%	71.43%
Feedback	83.33%	83.33%	79.17%	76.19%
Challenge	62.50%	66.67%	64.58%	73.81%
Immersion	52.78%	62.22%	56.25%	58.73%
Knowledge Involvement	100.00%	90.00%	87.50%	90.48%
Emotional Involvement	80.21%	95.42%	92.97%	92.86%

A Kruskal-Wallis test was conducted over the results on table 5 to examine the difference between groups. This test is a non-parametric method analog to the one-way analysis of variance (ANOVA), used to test whether two or more samples originate from the same distribution. The results are shown on table 6, grouped by factors involved in measuring learner's enjoyment.

Table 6: Results obtained through a Kruskal-Wallis test over the data provided by the questionnaires

	Chi-squared	P-value
Concentration	0.9135	0.8222
Goal Clarity	3.1869	0.3637
Feedback	0.7754	0.8553
Challenge	2.1113	0.5496
Immersion	2.1017	0.5516
Knowledge Involvement	4.2895	0.2319
Emotional Involvement	8.6291	0.03465

Among the results on table 6, all factors tested (except for Emotional Involvement) obtained a p-value above 0.05, meaning that they are not statistically significant on a 0.05 significance level, so the variability between factors is not explained through the different groups (p-value corresponds to the probability of obtaining test results at least as extreme as observed, assuming that the null hypothesis is true).

However, Emotional Involvement scores p-value = 0.03465, with a significant result on a 0.05 significance level. A post-Hoc test was conducted to further the analysis between pairs of groups, using Pairwise comparisons using Mann-Whitney test with Bonferroni correction test. The results of this test are shown on table 7.

Table 7: Results obtained through a post-Hoc test over the data provided by the Kruskal-Wallis test over the questionnaires results.

	Group 1 (Control group)	Group 2 (Animation only)	Group 3 (Customization only)
Group 2 (Animation only)	0.135	-	-
Group 3 (Customization only)	0.272	1	-
Group 4 (Animation & Customization)	0.088	1	1

According to the results on table 7, although there is evidence of a significant difference in Emotional Involvement between groups through a Kruskal-Wallis test, the p-values obtained on the post-Hoc test by pairing the groups are all not statistically significant on a 0.05 significance level. Although there is evidence of a certain difference between groups concerning Emotional Involvement, it is not strong enough to establish a more precise comparison between groups.

## 2.5 Discussion and conclusions

Through our experimental results we expected to answer: concerning visual aesthetics, what are the factors that affect immersion in a classroom educational videogame?

In our approach through the pre- and post-test, our results proved to be not significant enough to make any decisive assessments. This is mostly due to the small size of our

test groups, which decreased due to several administrative problems during the experimental process that could not be avoided. Another possible cause was the short-term exposure to the software. Only two sessions proved to be not enough to have any significant impact. On the other hand, a greater number of sessions means designing a game that can withstand such schedule without becoming exceedingly uninteresting, which generally means a more significant graphic investment. Nevertheless, the differences perceived in our results are still worth to mention.

According to our results on the questionnaires analysis, investing on animations and/or customization did not have a statistically significant impact on concentration, goal clarity, feedback, challenge perceived, immersion or knowledge involvement.

Nevertheless, there is a noticeable (but also faint) impact when it comes to Emotional Involvement. Although a further analysis was not able to provide a solid comparison between our variables (thus discerning which one has a greater impact) it seems to point out that adding any sort of graphic improvement can potentially lead to a more emotionally involving experience for the children. This is an important point to take into consideration if we take into account affective learning.

We can conclude from this experience and considering its limitations that investing on graphical improvements such as animations and customization does not have a significant impact on learning in educational videogames; adding animations might not help the children reach a better understanding, but it will also not hinder the learning process. The graphical improvements were aimed to improve immersion, which they did in a certain measure, making a difference in the children emotional involvement.

Further research should be aimed to observe if there is a significant learning improvement when immersion is focused not only on maintaining the players' interest in the game itself, but also on the learning activity; for example, instead of animating

characters and superfluous elements, using animations to illustrate how molecules assemble on an educational videogame about chemistry. Thus designing an immersive experience that should also be better focused on the learning objectives.

Another interesting issue is to evaluate the value of graphic improvement on long-term experiences. Although the game versions that were rich in graphic investment did not make any difference in learning compared to our control version in the short term, they certainly were considered more enjoyable experiences. Educational videogames aimed for multiple practical sessions over extended periods of time could profit of graphic improvement to keep the children interested in the academic activity and overlook repetitive tasks.

### **3. ACTIVITY DESIGN**

#### **3.1 Experiment design**

##### **3.1.1 Objectives**

The purpose of this chapter is to expand further over the content presented on chapter 2, starting from the proposed objectives.

To recapitulate, the research question goes as follows: When it comes to visual aesthetics, what are the factors that affect immersion in a classroom educational videogame? Following that question, the proposed hypothesis is that graphic improvements, such as animations and customization, have a noticeable effect over player interest and make games more immersive. As a follow up from the previous statement, we also propose that graphic improvement increases learning effectiveness, as a higher level of focus on the gaming activity also implies a higher level of focus on the learning activity.

One of the main objectives for the experimental design was to provide an appropriate medium to test and validate the hypothesis; thus the need to design a classroom educational videogame featuring variable aesthetic content.

Designing a whole new educational game and pedagogic rules from scratch was not an objective on this thesis. The basic gameplay and mechanics were adopted from another game featured on Rosas et al (2003) research. Methodologies and activity flow details concerning the learning experience that went beyond the scope of this research were also adopted from other previous research.

Along with the development of the game, the next main objective is to design an experimental setting that allows us to obtain results that can provide an answer to the

research question. This includes defining correct variables, how to test them, choosing which metrics should be used to measure their impact, and how to analyze the results.

### **3.1.2 Experimental variables and Metrics**

#### **3.1.2.1 Variables**

This section explains the reasoning behind the selection of variables on this research.

Variables such as sound or music were early discarded. Although audio is a variable on Andersen et al (2011) research and a valid asset from an aesthetic perspective, it was decided that too much noise on a classroom would be disruptive. Because it was not certain that headphones would be available for the children (or any complex hardware for that matter), this thesis is limited to the impact of visual improvements on a classroom educational video game.

Animations and customization were selected as variables to test the impact of graphic improvement over immersion and interest, and were introduced on section 3.2.4 of this document. It is important to establish that a variable can be considered as a graphic improvement when its presence only provides a more complex aesthetic experience, without interfering with style or functionality. The variables must not affect usability either.

The effect of animations over player interest was already tested on Andersen et al (2011) research with interesting results, and this thesis aims to confirm these results on the domain of classroom educational videogames.

Animations are not an imperative on videogames, but they enrich the overall experience without actually changing the visual style, thus qualifying as a graphic improvement.

Displaying animations implies the creation of animated content and the necessary software implementations to manage it, so it can be quite expensive. This thesis attempts to assert some of the benefits on player immersion of such cost.

On the other hand, customization provides a different perspective over the concept of graphic improvement. Like animations, it enriches the experience without changing the visual style and they imply a similar cost. But customization also allows the player to change the aesthetic experience according to his liking, by making decisions over different visual aspects of the game.

### **3.1.2.2 Metrics**

Asserting the impact of variables over subjective values (such as immersion) is not an easy task. Andersen et al research (2011) suggests a method of large scale testing, which is out of the scope of this investigation and available resources, and is not really adequate for a more controlled classroom environment.

Another viable method to measure immersion is using a questionnaire based on the EGameFlow study. The EGameFlow study is an attempt to develop a more rigorous scale that assesses user enjoyment of e-learning games (Fu et al, 2009). This scale consists of eight dimensions (or categories, as mentioned on the previous chapter): Social Interaction, Control, Immersion, Concentration, Goal Clarity, Feedback, Challenge, and Knowledge involvement. The first two categories (social interaction and control) were not considered for this research, as the game developed did not feature relevant social dynamics (such as cooperation), and control was not an issue either. Instead, a new category was included: Emotional involvement. This category aims to encompass the children impression on the game in an affective level. Adding this category is interesting because customization allows the user to change the game according to his liking, taking the experience a step closer to a personal level.

Other artifacts were also used along with the questionnaires, such as observation guidelines for surveys during practical sessions. These guidelines included some of the categories from EGameFlow. For example, a child being disruptive during the activity can be a sign of a poor concentration level. Unfortunately, the observation conditions during fieldwork were not favorable: only two or three people available to carry surveys with nine to twelve children at a time sitting on four different rows, each playing the game on its own screen. Also, the results provided similar information than the questionnaires results, so they were ultimately discarded. But this approach would be certainly interesting on future research under better conditions.

On the other hand, the MathMecha software was designed to provide activity logs featuring player progress. This information was not really relevant to measure player immersion, so little analysis was carried over it.

### 3.1.3 Activity Flow

Activity flow refers to the design and phases of the intervention itself. This was already described on section 2.3 of this document as part of experimental design. Figure 4 presents a diagram illustrating this point.

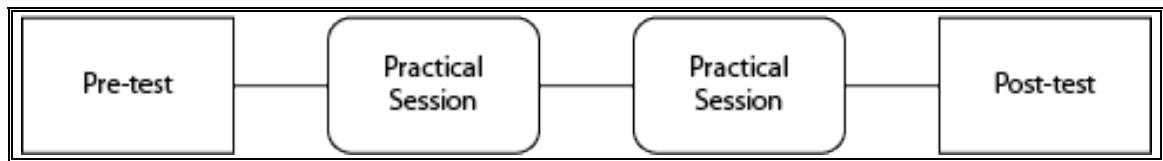


Figure 4: Representation of the activity flow

There was a one-week period between each phase. Only two practical sessions using the game software took place during this experiment. This could be the minimum

recommended number of practical sessions, as too few of them may not have a measurable impact. Thus increasing the number of practical sessions could be interesting for future research. Nevertheless, opportunities for that sort of testing heavily depend on school establishments and their availability.

The activity flow was mainly designed according to the previous work of Alcoholado et al (2012). This includes the one-week interval between phases, as well as the pre-test and post-test practice, and the practical session in between.

## **3.2 Software design**

### **3.2.1 Software objectives**

Before dwelling on the details concerning software development, it is important to reintroduce the software objectives that were presented on chapter 2 of this document.

The game needs to:

- Provide a set of arithmetic problems (additions, subtractions, etc.) following an established set of pedagogic rules and increasing difficulty level.
- Feature animations and customization, as well as the possibility of disabling them, thus providing four different versions of the same game. This also means developing software with four possible settings, instead of four independent versions.
- Adjustable difficulty level for each child.
- Usable in a school environment (compatible with the available systems).
- Data retrieval of relevant information.

The following sections of this document give and insight on how these objectives were met, including the reasoning behind relevant decision-making.

### 3.2.2 Game Brief

#### 3.2.2.1 Game Story, theme and flow

A general description of the game of MathMecha was already provided on chapter 2 (section 2.2.1). As mentioned on that section, the game premise is that a giant monster is attacking a city. The player must then answer correctly a series of arithmetic equations in order to assemble a giant robot and defeat the monster. Figure 5 shows the game screenshots that narrate the plot.

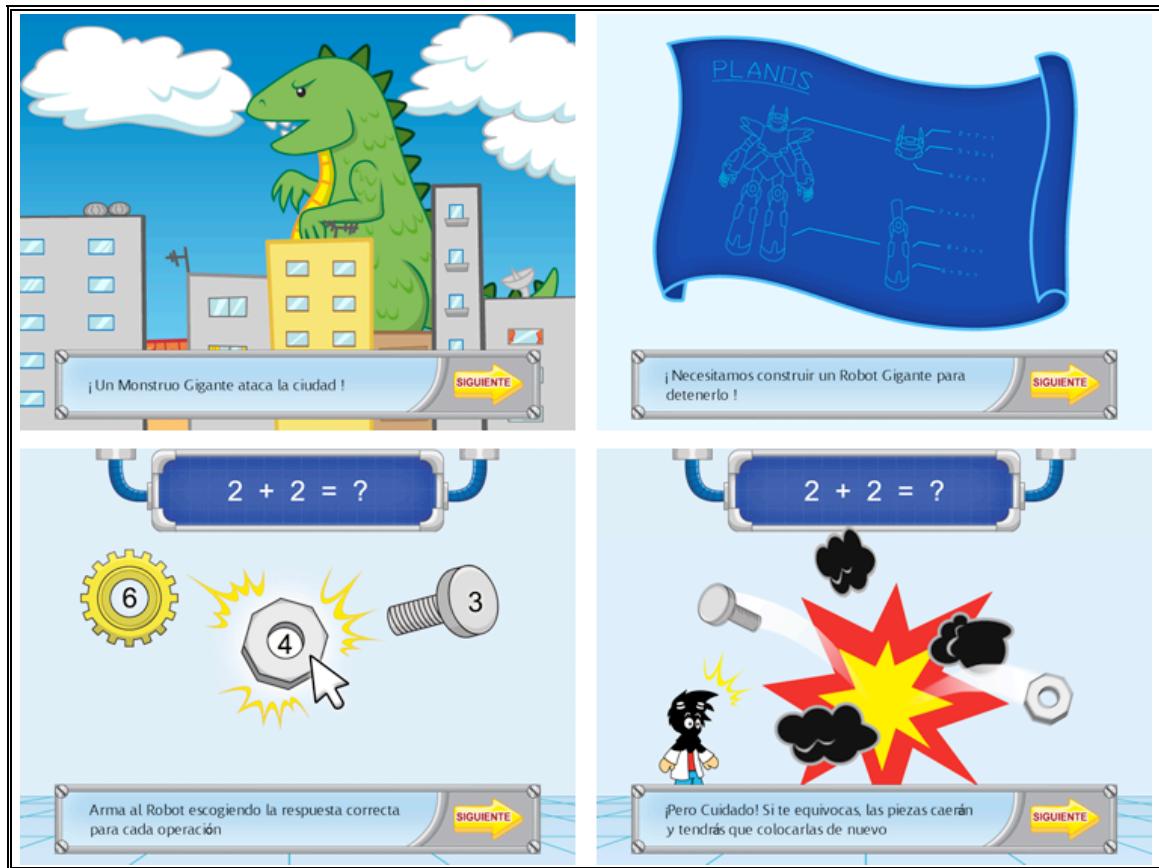


Figure 5: Introduction sequence of the game MathMecha

The game theme is centered on robots with a cartoony style. This provides certain advantages. First of all, the game theme is attractive to third graders. Second, featuring robots simplifies solving graphic issues caused by our experimental variables. For instance, when animating cartoon robots the joints may look more rigid and less exact, providing a larger margin over what can be animated without looking awkward. Customization also benefits from this theme, as robots with interchangeable parts are a simple way to include this kind of feature.

MathMecha's game flow (or how the game proceeds from story sequences to playable levels and so on) was briefly introduced on chapter 2 (section 2.2.1). The diagram on figure 6 illustrates this flow.

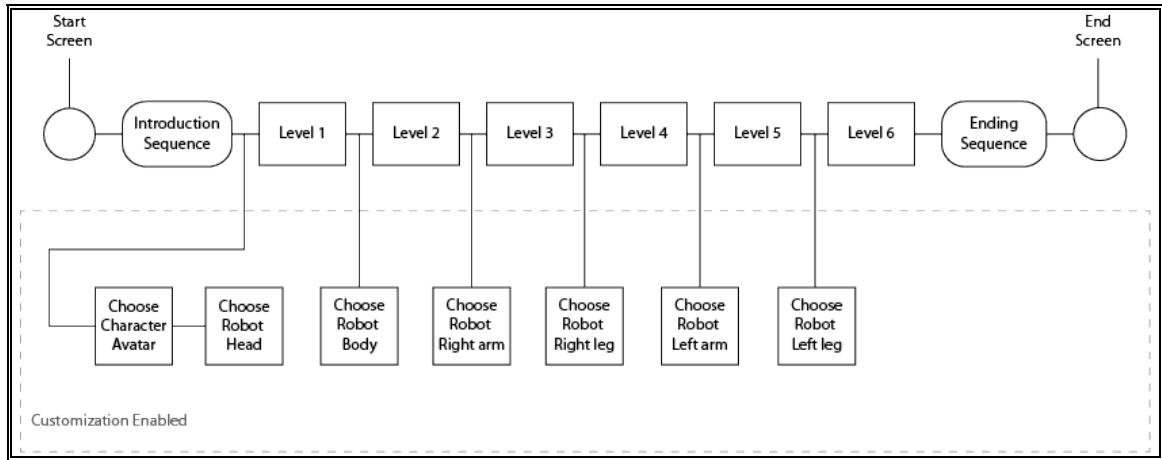


Figure 6: Diagram representing the game flow of the game MathMecha.

The game flow is slightly different if the player is allowed to make choices, as some instances are only available if customization variable is enabled. But from a theme and gameplay perspective the game remains the same.

### **3.2.2.2 Gameplay and game mechanics**

MathMecha's simple gameplay was inspired by Rosas et al research (2003) and adapted to a mouse friendly point-and-click mechanic:

- An arithmetic problem appears at the top of the screen.
- Three possible alternatives are shown just below, where only one is correct.
- If the player clicks on the right answer, the next problem appears.
- If the player clicks on the wrong answer, the arithmetic problem remains until solved.
- If the player answers correctly 10 problems, he can advance to the next level.
- As a penalty, each error gives a one-problem setback (so with one mistake, the player needs to solve eleven problems to advance).

The need for a penalty comes from a problem faced during testing. Some players, out of frustration or on a whim, clicked randomly on the alternatives hoping to get the right answer instead of trying to solve the problems. The use of a penalty discourages this sort of behavior. It also makes more unlikely for players to clear a level without actually trying. The randomly clicking exploit could be useful on further research to look out for patterns that indicate player frustration.

The penalty and winning conditions are also quite severe because the player is given only three alternatives to answer instead of a more flexible input system (though the alternatives system is more consistent with the game theme and gameplay).

### **3.2.3 Graphic User Interface**

The Graphic User Interface (GUI) of MathMecha provides different information and options to the player depending on his current game state. There are four possible state categories:

- The start or end of the game
- When the player needs to make a customization choice
- The game levels
- The story sequences

This section presents these four possible layouts and their elements.

### 3.2.3.1 Game Start GUI and Game End GUI

The MathMecha game launches a simple Start screen when initiated. Besides the background image, this GUI only features a single button to start the game. If the game is completed, a similar End screen is displayed. This screen has a different background image and also features a single button that closes the application. Figure 7 displays these two screens.



Figure 7: MathMecha's Start screen (left) and End screen (right).

### 3.2.3.2 Customization choice GUI

If customization is enabled, the player will need to make decisions concerning his avatar's appearance and the robot model he or she prefers to assemble. These decisions are always between two possible choices. In these cases, the GUI displays a brief sentence at the top of the screen explaining the choice to be made. The two possible options are also displayed. The player must click on one of these options. Only then a button will appear at the bottom of the screen for confirming his decision and go to the next game state. Figure 8 presents two different screenshots for this case.



Figure 8: Screenshots from MathMecha corresponding to character selection (left) and robot part selection (right)

This GUI is not available if customization is disabled.

### 3.2.3.3 Game level GUI

The game level GUI of MathMecha is presented by Figure 9.

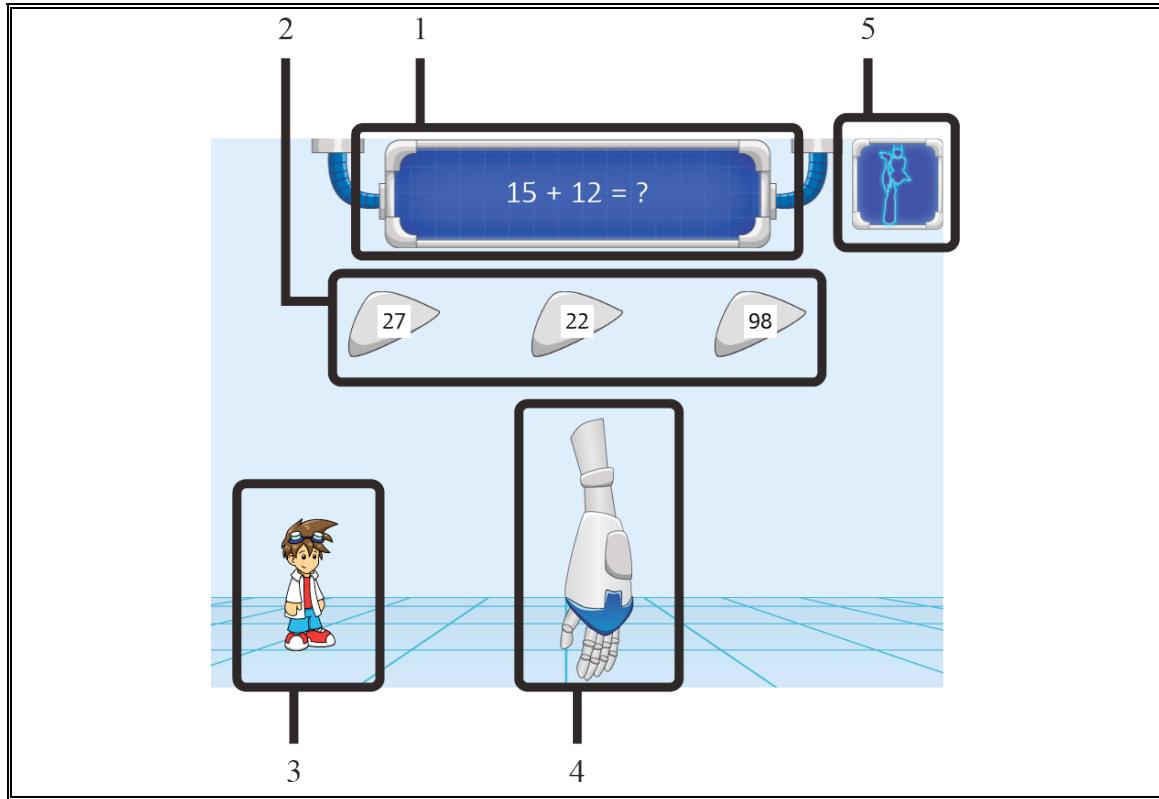


Figure 9: Screenshot from a MathMecha level

According to Figure 9, this GUI can be divided into 5 elements. The arithmetic panel (1) is where the current arithmetic question is displayed. Right below it are three possible clickable alternatives (2). The player's character is displayed on the lower left corner of the screen (3). The current robot part being assembled is displayed at the lower middle of the screen (4). The progress screen at the top right corner (5) shows the robot parts that were already assembled and can be enlarged by the player's mouse over. User interaction is limited to clicking alternatives or checking the progress screen. The GUI layout and its functions are the same whether animation or customization are enabled or disabled.

#### 3.2.3.4 Story sequence GUI

The story sequence GUI behaves like a slide show interface. An image is displayed on the screen along with a short sentence at the bottom. There is a button at the lower right corner of the screen to proceed to the next slide. Figure 10 shows a possible story sequence corresponding to the end of the MathMecha game.

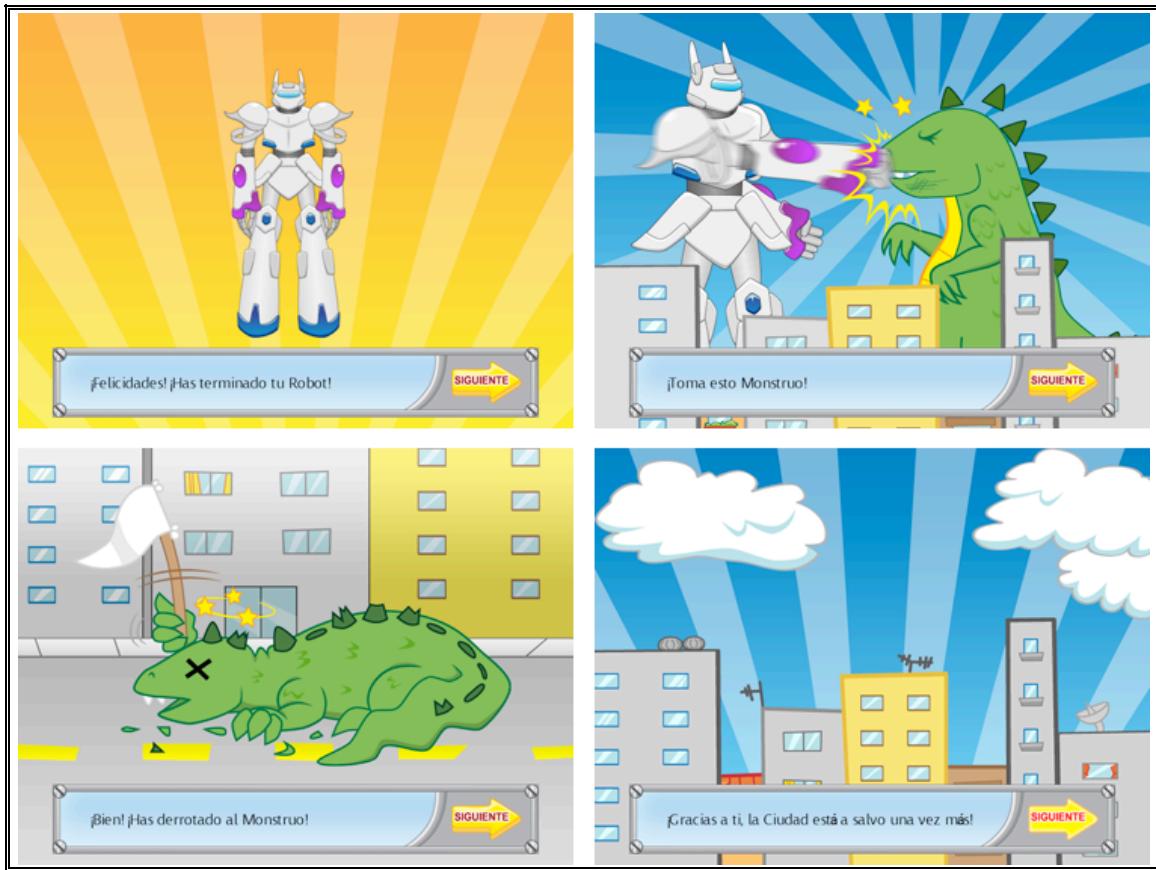


Figure 10: Story ending sequence from MathMecha

### 3.2.4 Graphic Content

When selecting the experimental variables for this thesis (animation and customization) the focus was on selecting graphic features that improved and enriched the aesthetic

experience, without deviating from the overall graphic style. Nevertheless, there are other considerations and issues to take into account when it comes to graphic content.

For instance, animations are a common device to provide user feedback. Disabling them can create issues over usability, which is not the focus of this investigation. To prevent this, the game version not featuring animations provides an alternative feedback. In MathMecha, when a player answers correctly a success animation is displayed (the player character jumps out of joy, the robot sparkles, among others). If animated content is not enabled, a green check icon briefly appears (or a red cross, if the answer is not correct).

The design of different robot models with fully interchangeable parts also represented a challenge. Fully interchangeable part means that each robot part from each model must fit correctly with the other available parts and have a final correct and cohesive look. This is no small issue, as it becomes increasingly complex the more customizable elements and options are available; testing all the possible outcomes to guarantee a cohesive look is no small task either.

Another issue comes from each new customizable elements included in the game, as it may imply the inclusion of new animated content as well (provided that the new element needs to be animated at some point). Such is the case of the robot parts, each displaying a short animation at the end of their level.

In conclusion, customization imposes serious constraints over graphic content, as it may considerably increase the workload for graphic content.

Figure 11 shows the two available characters in MathMecha for the player to choose from, along with some of their animations.

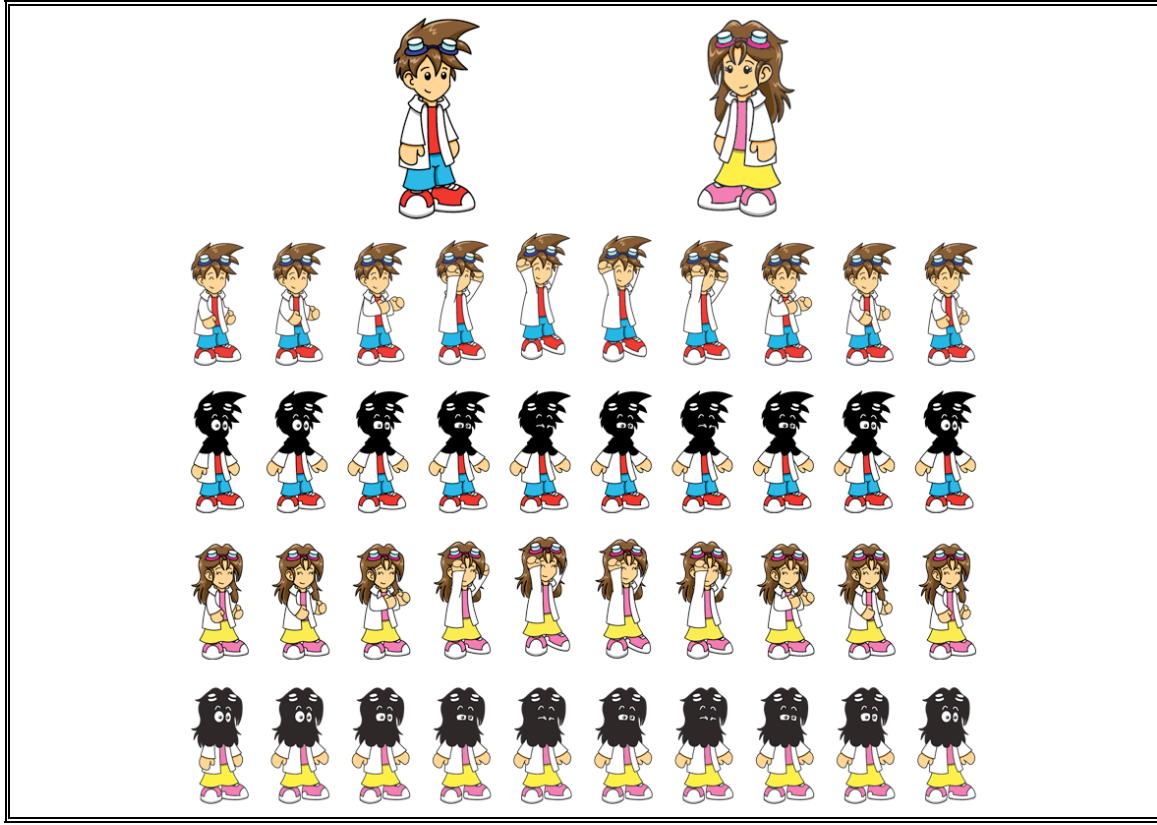


Figure 11: The two characters available in MathMecha for the player to choose as avatar, as well as their respective success or failure animation (displayed frame by frame)

Figure 12 shows one of the available animations for a robot part, frame by frame.



Figure 12: Right arm animation sample (frame by frame) from a robot model.

### 3.2.5 Software development and architecture

#### 3.2.5.1 Development

The game was developed using Microsoft framework XNA 3.1, a framework developed by Microsoft based on the .NET Framework 2.0. The programming language used was C#. XNA provides a useful set of tools and libraries for the development of games both

on computers using Microsoft operative system Windows or Microsoft gaming console Xbox 360.

Computer systems can support XNA based games if they meet the requirements for the XNA framework:

- Running on Microsoft operating system Windows XP or later.
- A graphic card that supports Shader Model 1.1 (at minimum) and DirectX 9.0c.

Hardware requirements can be particularly harder to meet for older systems with no compatible graphic card.

An alternative for future research could be to develop games on web-based platforms that run on Internet browsers, thus removing limitations upon operating systems and some hardware requirements.

The development team of MathMecha consisted of two people. One of them was in charge of software design, architecture and implementation. The other was almost exclusively involved with implementation.

### **3.2.3.2 Software Architecture**

Because the XNA framework already provides a basic architecture for game developing purposes, this section will only refer to the additional classes implemented on the MathMecha project.

For the most part, the software flow consists on alternating between the four possible types of screens described on section 3.2.3 of this document (start screen, story screens, levels, and ending screen). The software behavior and user input is managed according to the current screen type.

To adjust the difficulty for each child, the software starts by reading an XML file with the required information and then sets the parameters accordingly. This information include:

- Starting difficulty level
- Enable/disable animations

- Enable/disable customization
- Number of scenes that must be skipped (for the purpose of starting the game at any further level).

The .NET framework provides the necessary libraries to handle XML files by default. The advantage of reading an external file over the implementation of an in-game menu is that it is easier to prepare in advance a custom file for each child than setting and keeping track of roughly a dozen computers by session.

Figure 13 displays a general scheme of MathMecha's software architecture. The classes and components were grouped in modules for clarity.

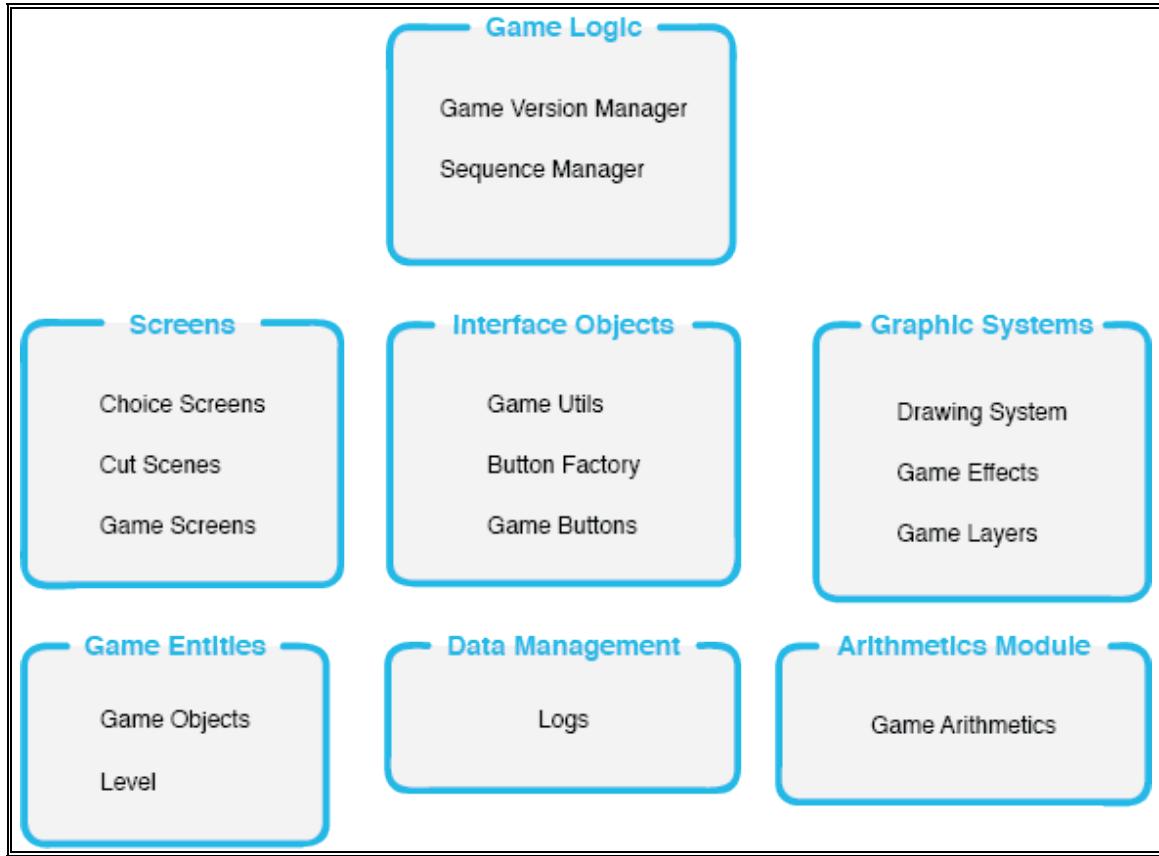


Figure 13: Diagram illustrating the components and classes from the MathMecha software, grouped by functionality

The Game Logic module includes the components in charge of loading the needed version of the game (with or without animations, etc.) and managing the program overall sequence, such as moving from the introduction screens to the first level and so on.

The Screens module encompasses the passive screens of the game (where there is no real gameplay), such as the Choice screens or story screens (or cut scenes). Their role is to load the needed components and buttons, as well as manage the user interface and input accordingly.

On the other hand, the Game entities module includes the components involved on the active parts of the software, such as levels and their gameplay. Game entities include, for example, the robot part being assembled.

The Interface object module includes artifacts such as buttons and panels. For example, game utils include the top panel displayed when playing a level. The buttons are generated according to a simple version of the factory architectural pattern. All button objects have a similar behavior but different appearance or position. A factory class manages the creation of each of these buttons depending on which one is needed.

The Graphic system module includes the classes involved with managing graphic assets and components, like sprites and their animation. All graphic content is loaded at the beginning of the game and managed by a single class, to avoid loading pauses at mid game, as the number of graphic assets is not significant enough to cause any sort of overload on standard computers.

The Arithmetic module is in charge of providing the questions (additions, subtractions, etc.) presented during the game. The arithmetic problems are generated according to the set of rules explained on the previous chapter. This module is also in charge of generating the alternatives for possible answers. It is possible to further expand the complexity of the questions and answers by modifying this module alone.

The Data management module includes log related objects. The software continually outputs an activity log on run time to keep track of relevant information. This includes the game version, the questions prompted, the answers given by the user, etc. The information retrieved was mostly used to keep track of the children progress through our sessions.

### **3.3 Fieldwork**

#### **3.3.1 Fieldwork procedure**

Because of the human resources available, the number of people handling sessions ranged from two to three (with the possibility of a backup member in case of emergency). The pre and post-test were taken on regular classrooms, with the help of the homeroom teachers.

For each practical session, a group of children (from 8 to 12) was escorted from its classroom to the computer lab. Sometimes a teacher's aid would come along to provide assistance. These groups only included children belonging to the same testing group, to prevent confusion among them ("why is my classmate playing a different game than me?"). Ideally, children from one testing group should not interchange information with children from another, so their opinions remain independent and unbiased from one another. But only so much can be done to minimize this risk in a school environment and through a two-week testing period.

Once in the computer lab, each child was accommodated into his/her personal station, and the game set to his/her personal profile and difficulty level. Then a brief explanation about the activity was given to them.

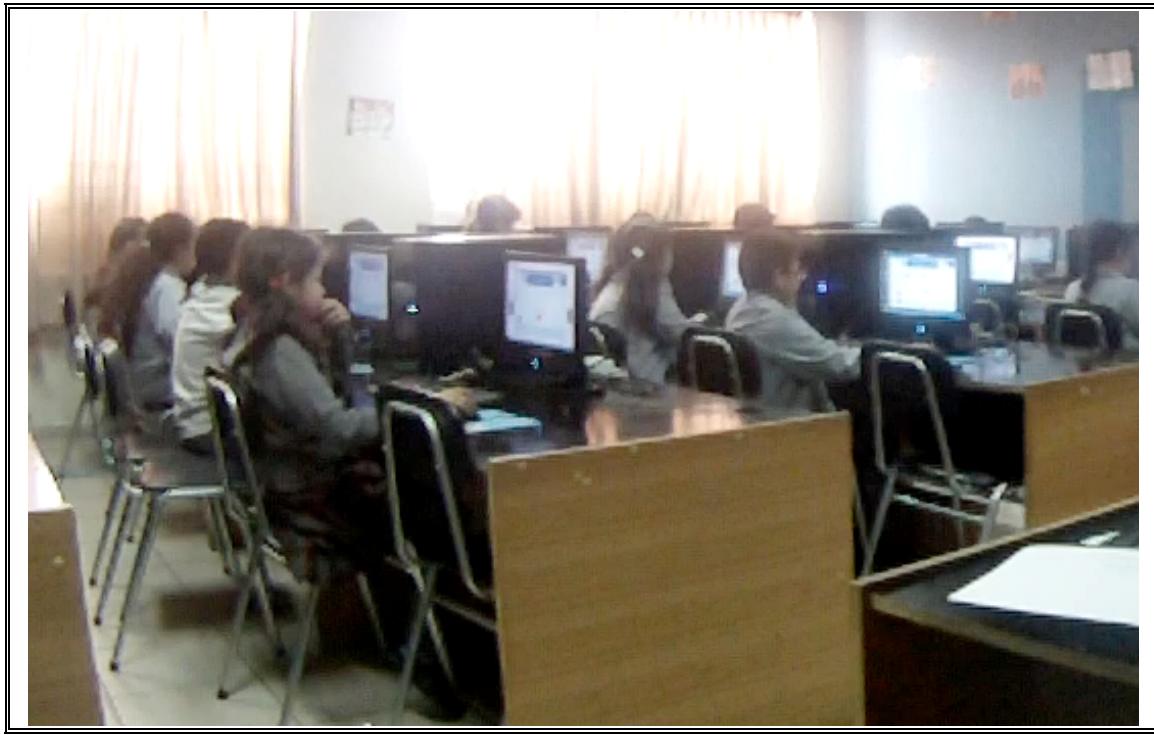


Figure 14: Picture of the children playing MathMecha on the computer laboratory

At the end of the practical sessions, the children were handled the questionnaires.

### 3.3.2 Fieldwork experiences and challenges

Before the actual experiment, the MathMecha game was tested on a similar school environment to minimize risks. Most of the hardware problems were detected and corrected (if possible) on this phase, setting the bar on minimum computer system requirements for the actual experiment. For example, it was discovered a liability concerning game sprite size. This forced a modification over maximum sprite dimensions and had some repercussions over how animations were handled, as they feature among the largest game sprites.

Different issues were faced during the testing process. On the second week of the process, one of the homeroom teachers refused to let children scheduled for testing leave the classroom (because they were behind on their own class schedule). A make up session was immediately scheduled, but with similar unexpected conflicts. This incident greatly undermined the final size of the testing groups, particularly the control group. The testing period was also on a tight schedule because the school administration could not afford to grant more of their students' time on this sort of activity. This was mainly because the school system included an exam period approximately two weeks after the experiment was initially scheduled to end. Though this fact was taken into consideration when scheduling the activity (so there was a small margin for possible make up sessions if need aroused, as it was the case).

Other problems revolved around last minute absences from members of the observation team. This kind of situation was managed through replacement with a backup member.

It must be also taken into consideration that, during the period this research took place, most school establishments in the country were unavailable due to student protests. A considerable effort was put onto finding a testing environment that met the minimum criteria, and San Carlos de Aragón School was the only viable choice. This research took hold of that opportunity, although there was always a chance that the establishment was taken by the students during their protests. That would have resulted on the cancelation of the experiment, postponing it to the next year.

### **3.4 Conclusions**

The research team managed to design an activity aimed to test the effects of graphic improvements on educative classroom videogames over immersion and player interest. This was achieved by combining elements from different previous works, particularly

Alcoholado et al (2012) and Andersen et al (2011) research, towards testing on a different scope.

The experimental results showed that the presence of animations and customization on educational classroom videogames has no statistically relevant effect over immersion or learning, at least at the present scale of the experiment. This evidence refutes this research's hypothesis. There is nonetheless a noticeable effect over the players' emotional involvement.

Most of what was learned during this experience involved resources management. One of the main objectives was to give some perspective over the value of investing on better graphic material for educational videogames. Aesthetics comes to play a more significant role on software development process, taking its toll over workload.

But the most daunting issues revolved around achieving the set objectives with only a small team for developing and testing, as well as managing scarce resources, such as the time frame given by the school for testing. Preparation was key to succeed, as well as contingency plans against unexpected events.

The experience showed there is still a lot of room for improvement, from gameplay issues to environmental conditions and metrics. The experimental results suggest that future research focusing on aesthetics and emotional involvement could be promising. Another option for future research is to perform the same experiment again with a greater number of practical sessions, supposing a greater exposure to the game may result on more noticeable effects. In particular, testing the use of aesthetic resources as means for replay value.

This experience was also limited to a game focused on arithmetic and problem solving. Other disciplines that depend heavily on visual aids could profit from graphic

investment further than the abstract realm of mathematics. Further research could explore the value of aesthetic improvement over games covering such academic subject.

In conclusion, through the development of this research it was possible to design and test an educational activity to explore the effect of aesthetic variables over player interest and involvement on educational classroom videogames. The results obtained encourage further work on this area, as it is still necessary to validate our conclusions further, and some interesting venues remain unexplored.

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## APPENDIX

### E-mail of acknowledgement of submission

**From:** Computers in Human Behavior  
**Sent:** 03-05-2012 14:39  
**To:** Miguel Nussbaum; [miguel.nussbaum@gmail.com](mailto:miguel.nussbaum@gmail.com)  
**Subject:** Your PDF has been built and requires approval

Computers in Human Behavior

Dear Dr. Miguel Nussbaum,

The PDF for your submission, "Exploring the relevance of Visual Aesthetics in Educational Videogames", is ready for viewing.

Please login to the Elsevier Editorial System as an Author to view and approve the PDF of your submission.

url: <http://ees.elsevier.com/chb/>  
Your username is: mnussbaum

Your submission must be approved in order to complete the submission process and send the manuscript to the Computers in Human Behavior editorial office. Please view the submission before approving it, to be certain that it is free of any errors. You will also need to confirm that you have read and agree with the Elsevier Ethics in Publishing statement before you can submit your article.

Thank you for your time and patience.

Kind regards,

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Computers in Human Behavior

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For any technical queries about using EES, please contact Elsevier Author Support at [authorsupport@elsevier.com](mailto:authorsupport@elsevier.com)

**Questionnaire**

Nombre: \_\_\_\_\_

Colegio: \_\_\_\_\_

Curso: \_\_\_\_\_

Por favor, responde las siguientes preguntas. Rellena el círculo junto a la respuesta que mejor representa lo que sientes

1. Estuve concentrado durante el juego

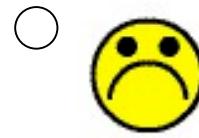
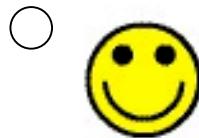


Sí

Más o menos

No

2. En cada momento del juego, ¿siempre supe lo que tenía que hacer?



Sí

No

3. Me cansé mientras jugaba



Sí

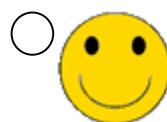


Más o menos



No

4. Me daba cuenta cuando me equivocaba



Sí



Más o menos



No

5. El juego era fácil



Sí

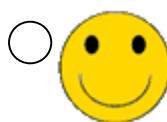


Más o menos

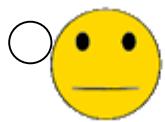


No

6. El tiempo pasó rápido mientras jugaba



Sí

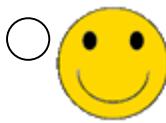


Más o menos



No

7. Olvidé que estaba en clases mientras jugaba



Sí



Más o menos



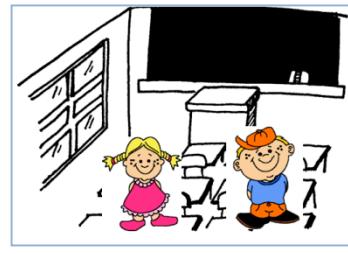
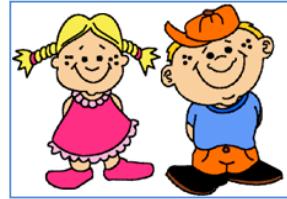
No

8. Escuché los ruidos de la sala y del patio mientras jugaba

Sí

No

9. Me sentí como un personaje del juego mientras jugaba



Si

No tanto

No

10. Olvidé que tenía el mouse en la mano mientras jugaba



Si



No

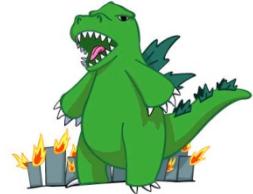
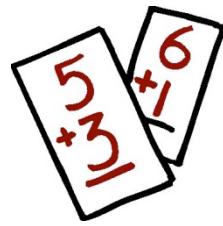
11. Mientras jugaba, pensaba en cuánto faltaba para salir a recreo

dreamgraffiti.com

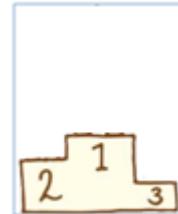
No

Si

12. ¿Qué aprendí durante el juego?



13. Mientras jugaba, pensaba en que iba a ganar el juego



Si

No

14.

Quiero saber cómo continúa la historia



Si

No

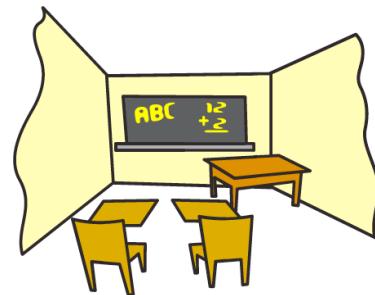
15. Lo pasé bien mientras jugaba



Si

No

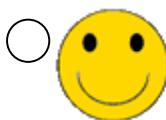
16. Quiero jugar de nuevo



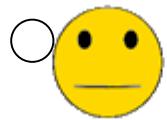
Si

No

17. Es entretenido jugar



Sí



Más o menos



No

18. Jugué con todas mis ganas



Sí

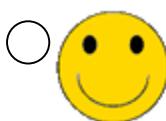


Más o menos

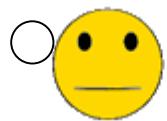


No

19. El juego es bonito



Sí

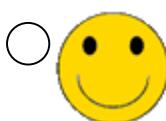


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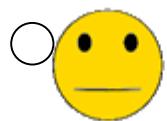


No

20. Me gustó el Robot que armé



Sí



Más o menos



No