

Master's Degree in Mobile Applications and Games

Master Thesis

# Games for dyscalculic children

by

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## ABSTRACT

One of the most popular school failures is the mathematical difficulty. Dyscalculia is a specific learning disability in mathematics, neurobiological basis that is characterized by a difficulty in numerical processing and calculation. Facing dyscalculia improves the rates of school failure and adopts specific methodologies to teach reading and understand numerical processes that have beneficial effects for the rest of students.

The goal of this project is to evaluate brain changes associated with the success of the intervention of dyscalculia applied to primary school children with math difficulties.

The method used to evaluate this is a videogame. This videogame consist in a set of 2D games that will evaluate concepts as numerical consciousness, mental number line and system base 10. This game will help the children improve their mathematical skills and help the doctors by doing a follow up of the children results. Depending on this results the doctor may modify the parameters of the game to adapt to the children skills.

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# 1. INTRODUCTION AND CONCEPTUALIZATION

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## 1.1. INTRODUCTION

School failure has a very high incidence in Spain. Data from 2012 place Spain in fourth place in values of academic failure, only behind Turkey, Malta and Portugal. Among the factors that contribute to school failure, are the difficulties in literacy and mathematics. In fact, the poor performance in reading processes and numerical processing is predictive of school failure, which improve the performance of students in these processes help reduce the school dropout rate. Facing and re-educating dyslexia and dyscalculia improve the rates of school failure and adopt specific methodologies to teach reading and understand numerical processes that have beneficial effects for the rest of students.

Dyscalculia is a specific learning disability in mathematics, neurobiological basis that is characterized by a difficulty in numerical processing and calculation in contrast to the difficulties in relation to other cognitive abilities, motivation and level of schooling. Has a strong hereditary load, is persistent and variable expression. The main problem is a neuropsychological deficit in number sense and at a neurobiological level this translates into primarily functional brain abnormalities in parietal regions of both hemispheres (intraparietal sulcus and adjacent areas). Given the chronic nature and impact of the disorder, the scientific literature is focused on demonstrating what interventions are most appropriate. It seems that focusing on consolidating the mental number line is what has more scientific evidence of effectiveness. However, it is not yet known exactly what the underlying brain mechanisms are the neuropsychological changes, and so far there are few focused on the study of the effects of the re-education of dyscalculia work on brain plasticity.

Prevalence studies show that developmental dyscalculia ranges from 3 to 6% (Ardila and Rosselli, 2002; *Neuropsychology Review*;12(4):179-231), similarly to the prevalence found in other developmental disorders, like developmental dyslexia or attention-deficit/hyperactivity disorder (Shalev, 2004; *Journal of Child Neurology*;19(10):765-771). In general, dyscalculia appears as an isolated and specific learning disability. However, about 25% have co-morbidity with other developmental disabilities, as developmental dyslexia.



## 1.2. GOALS

The main objective of the project is to evaluate brain changes associated with the success of the intervention of dyscalculia applied to primary school children with math difficulties. For evaluating this, the project consists in creating a simple 2D game that will help children improve their mathematical skills and also help the doctors to follow up their results.

A secondary objective of this project is to promote the use of serious games. A serious game is a game designed for a primary purpose other than pure entertainment. The objective of this game is none other than improving the children mathematical skills to help combating the dyscalculia. By doing this through an amusing 2D game the children will enjoy more learning math playing a game rather than doing boring conventional and regular exercises.

Another secondary objective is to improve the skills of programming and improve the use of Unity. Unity is a new game engine with a very promising future. Nowadays, a lot of companies use this game engine to create their games and everyday its use is more extended. Gaining experience with this program will come in handy for future projects. Also, the use of Unity will help me gaining experience with language programming C#, a language program which I have never used and it's getting more popular.

## 2. STATE OF DEVELOPMENT

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### 2.1. BENCHMARKING

#### 2.1.1. Criteria

The search criterion for this benchmarking has been established by the following concepts: games about dyscalculia, mathematical games and serious games.

This research helped getting helpful ideas and concepts for this project and to learn some general things about serious games.

#### 2.1.2. Benchmarking table

Table 2.1. Benchmarking Table

Name	URL	Description
<b>Dinamo Números</b>	<a href="http://dinamonumeros.com/">http://dinamonumeros.com/</a>	Online program for dyscalculic children
<b>Sum Points</b>	<a href="http://www.mathplayground.com/logic_sum_points.html">http://www.mathplayground.com/logic_sum_points.html</a>	Mathematical game where you have to subtract numbers
<b>2048</b>	<a href="http://2048game.com/">http://2048game.com/</a>	Game where you have to sum until 2048
<b>Smartick</b>	<a href="http://www.smartickmethod.com/">http://www.smartickmethod.com/</a>	Method to improve mathematical skills
<b>The Number Race</b>	<a href="http://www.thenumberrace.com/nr/home.php">http://www.thenumberrace.com/nr/home.php</a>	Game that let kids play with numbers
<b>Dybuster Calcularis</b>	<a href="http://www.dybuster.com/calcularis">http://www.dybuster.com/calcularis</a>	Help children to improve their mathematical skills

<b>Elfe and Mathis I</b>	<a href="http://www.psychometrica.de/rechenspiele1.html">http://www.psychometrica.de/rechenspiele1.html</a>	Program that trains basic numeric capabilities
<b>Number Sense</b>	<a href="http://www.number-sense.co.uk/index.html">http://www.number-sense.co.uk/index.html</a>	Math games and apps developed by Dr. Brian
<b>Sum Tracks</b>	<a href="http://www.mathplayground.com/logic_sum_tracks.html">http://www.mathplayground.com/logic_sum_tracks.html</a>	Game that improves level of subtraction and sum
<b>Penguin Jump Multiplication</b>	<a href="http://www.mathplayground.com/ASB_PenguinJumpMultiplication.html">http://www.mathplayground.com/ASB_PenguinJumpMultiplication.html</a>	Game to practice multiplication with penguins

### 2.1.3. Benchmarking conclusion

There are a lot of games that focus on improving math skills. After doing this benchmarking, we can extract some conclusions:

One very important factor that characterizes these games is the simplicity. A serious game can be as difficult as you want but if you are focusing your objective public to kids between 8-10 years the best fit is a simple game. The game can't be frustrating because the kid could get desperate and could not enjoy the game.

In terms of user interface, the best choice is a simple user interface without a lot of UI components and that have beautiful colors and design. Kids will enjoy more the games if they have an attractive interface with a beautiful colors than a boring interface with none attractive colors.



Fig 2.1.Simple interface of the 2048 game

On the other hand, the option to customize a character and the use of rewards is a very interesting option for motivating the kids. The customization of the player character is a good way to get that the kid feels more comfortable with the game, giving him the option to make the character look like he wants.



Fig 2.2. Customization of the character in the Smartick game

The rewards for doing well the work is a good way to motivate the children and make them happy for doing the exercises. In the *Smartick* game, the kids get stars by completing the session. These stars can be exchanged for items in a shop.

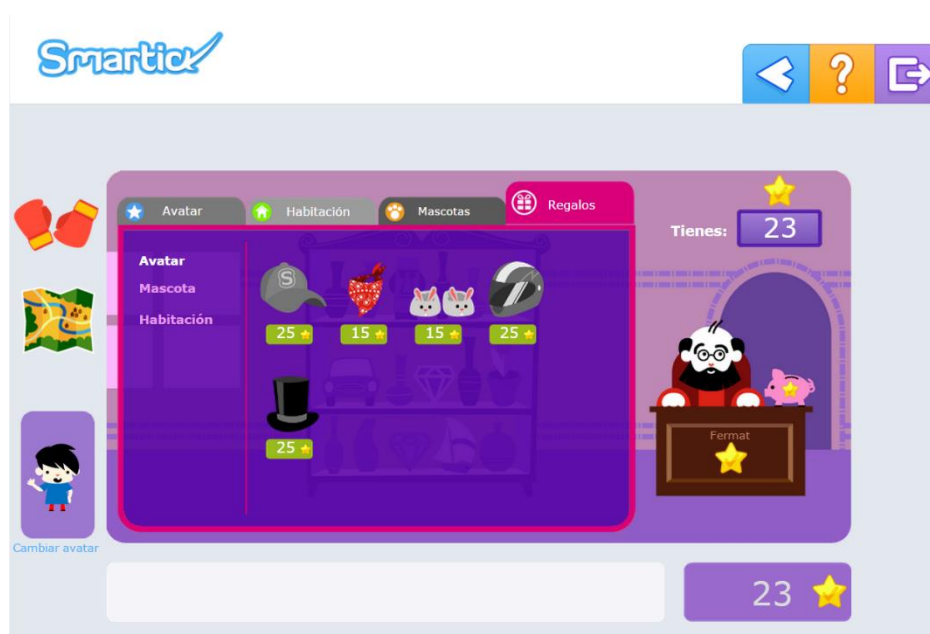


Fig 2.3. Shop in the Smartick game

## 2.2. TECHNOLOGY

### 2.2.1. Unity

Unity is a cross-platform game engine developed by Unity Technologies and used to develop video games for PC, consoles, mobile devices and websites.

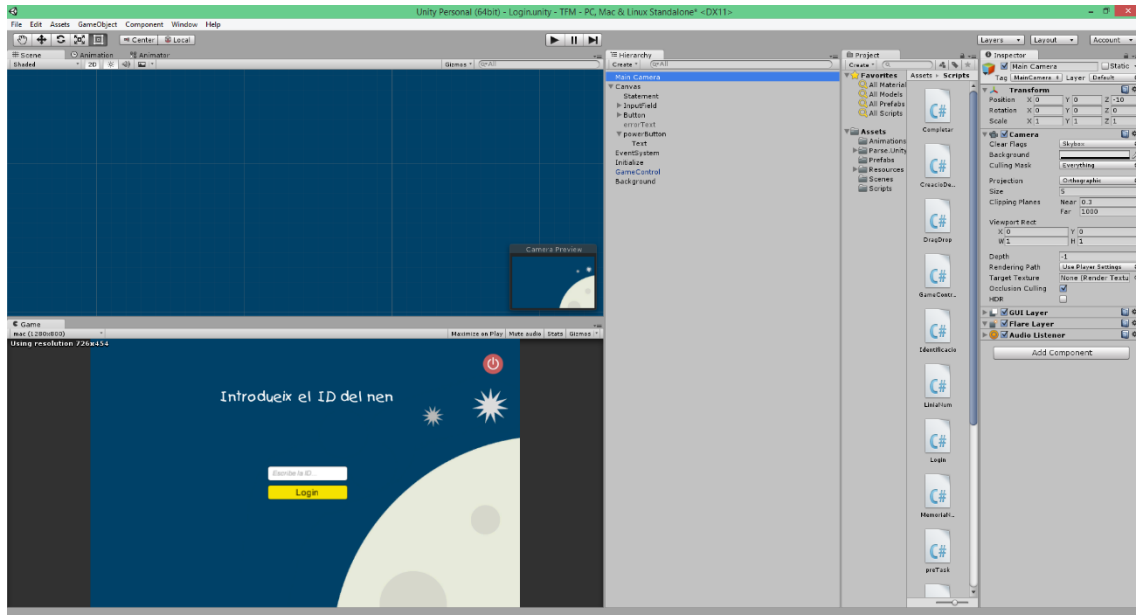


Fig 2.4. Unity interface

The game engine's scripting is built on Mono, the open-source implementation of the .NET Framework. Programmers can use UnityScript (a custom language with ECMAScript-inspired syntax, referred to as JavaScript by the software), C#, or Boo (which has a Python-inspired syntax). This project is all done in C#.

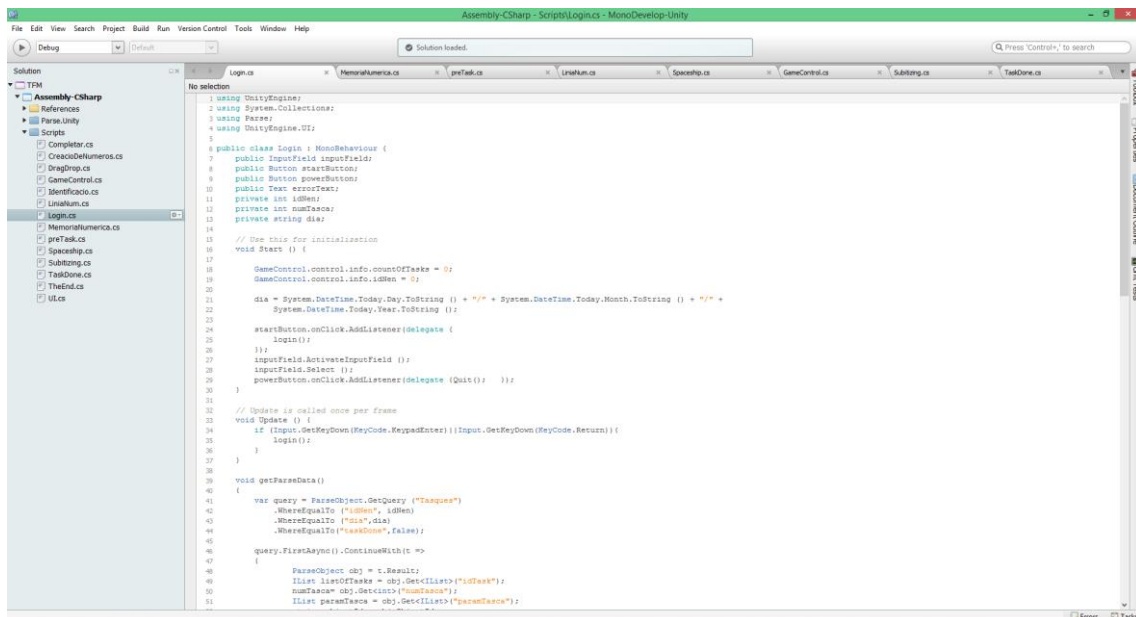


Fig 2.5. MonoDevelop interface

## 2.2.2. Parse

The database used to store all the data of the game is Parse.

### What is Parse?

Parse is the cloud app platform for Windows 8, Windows Phone 8, iOS, Android, Unity, JavaScript, and OS X. With Parse, you can add a scalable and powerful backend in minutes and launch a full-featured mobile or web app in record time without ever worrying about server management. Parse offers push notifications, social integration, data storage, and the ability to add rich custom logic to your app's backend with Cloud Code.

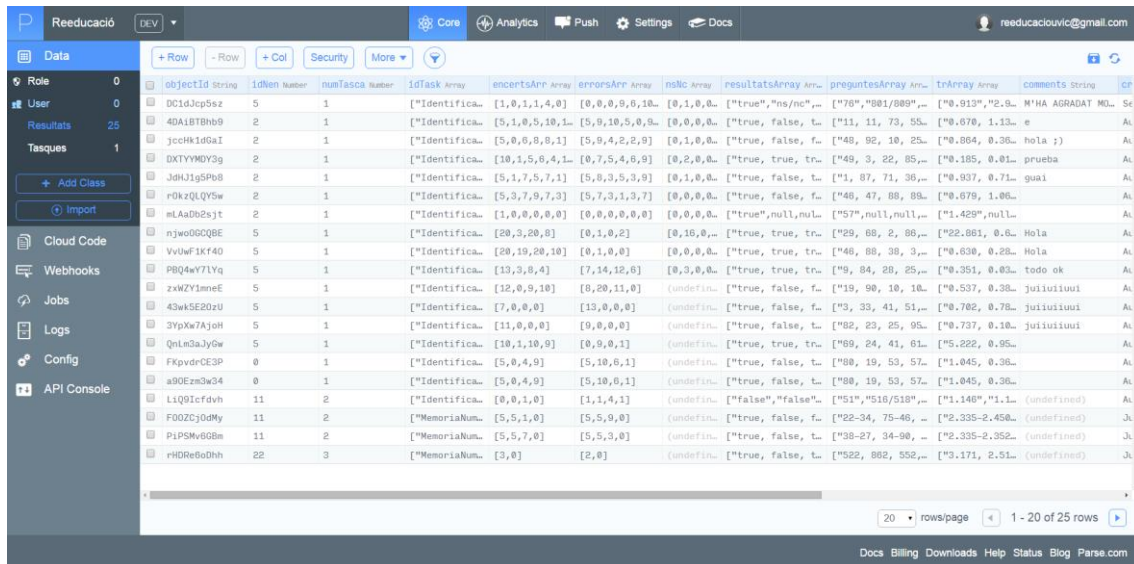


Fig 2.6. Parse interface

The data of this project is divided into 2 sections (or *classes*) in Parse: Resultats (Results) and Tasques (Tasks).

### Tasques

In this class is where the doctor plans the sessions of the kids.

idNen Number	numTasca Number	idTask Array	paramTasca Array	dia String	tasksDone Array	sessionDone Boolean
5	22	["Identificacio", "Completar", "Mem...]	["level=3, counts=1", "level=4, counts=...]	12/9/2015	[true, false, fals...	false
2	1	["Identificacio", "Completar", "Mem...]	["level=3, counts=1", "level=4, counts=...]	10/9/2015	[true, true, true, ...]	true

Fig 2.7. Parse class Tasques

This class has 7 important columns that the doctor has to fill:

1. idNen: this is the ID of the kid. This ID will be used in the program to log in.
2. numTasca: this will be an indicator or a count of the number of the tasks of that kid.
3. idTask: this is an array of the names of the tasks of that session.
4. paramTasca: this is an array of the parameters of every task defined in the array idTask. There are the following parameters:
  - a. Level: which indicate the level of the task
  - b. Counts: which indicate the number of exercises that that task will have.

Some tasks have extra parameters like:

- Complete: this task has the parameter *distance* that defines the distance between the 2 numbers.
- Mental number line: this task has the parameter *showMarks* that defines if the marks of the number line are visible or not.
- Number creation: this task has the parameter *showResults* that defines if the count of the number is visible or not.

5. Dia: the doctor has to write the day that this session has to be done in the format DD/MM/YYYY.
6. tasksDone: this column indicates which tasks of the session have been completed or not. The doctor does not has to fill this, it is updated every time the kid completes a task.
7. sessionDone: this indicates if the kid has completed the session. When the doctor program the session this will be *false* and when the kid has done all the tasks this will be updated and will be *true*.

## Resultats

In this class is where all the results data of the game are stored.

idNen	Number	numTasca	Number	idTask	Array	encertsArr	Array	errorsArr	Array	nsIc	Array	resultatsArray	Arr...	preguntesArray	Arr...	trArray	Array	comments	String
2		1		["Identifica...	[5,1,0,5,10,1...	[5,9,10,5,0,9]	[0,0,0,0...	["true, false, t...	["11, 11, 73, 55...	["0.670, 1.13...	e								
2		1		["Identifica...	[5,0,6,8,8,1]	[5,9,4,2,2,9]	[0,1,0,0...	["true, false, f...	["48, 92, 10, 25...	["0.864, 0.36...	hola ;)								
2		1		["Identifica...	[10,1,5,6,4,1...	[0,7,5,4,6,9]	[0,2,0,0...	["true, true, tr...	["49, 3, 22, 85...	["0.185, 0.01...	prueba								

Fig 2.8. Parse class Resultats. \*Note that these are the same numTasca for the same idNen, this is because this was done for testing

The doctor has not to fill any column of this class. All the data is updated to Parse when the kid is playing the game. Every time the kid finish one task, its results are uploaded to the database.

In this class there are 10 important columns:

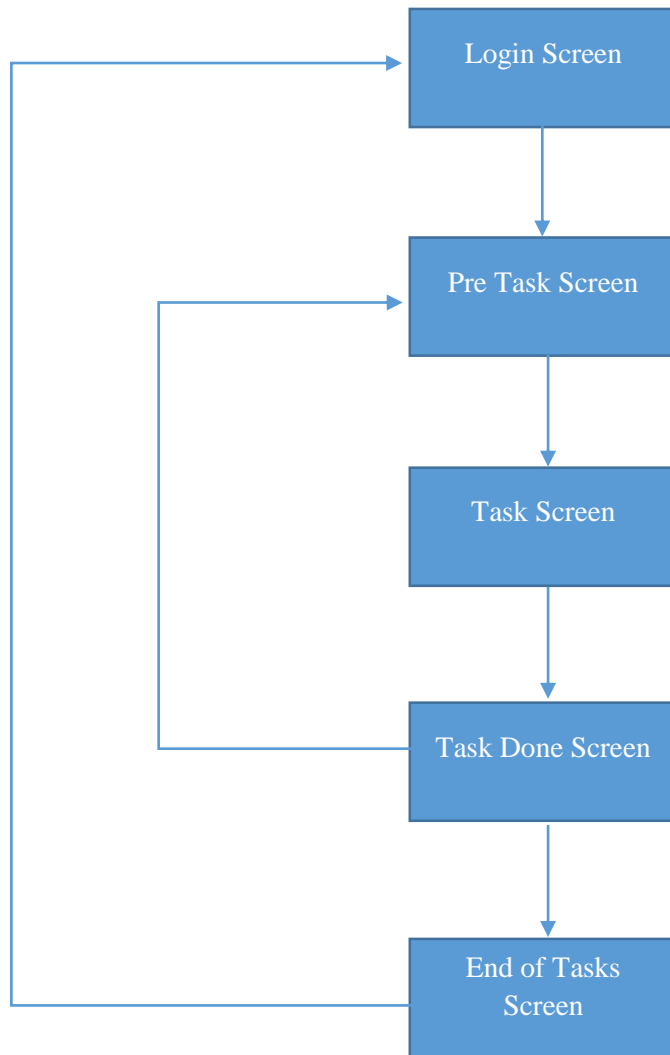
1. idNen: the same as the one in class Tasques.
2. numTasca: the same as the one in class Tasques.
3. idTask: the same as the one in class Tasques.
4. encertsArr: this array stores all the successes of the session. Its position in the array corresponds to the task in the respectively position of idTask array.
5. errorsArr: this array stores all the failures of the session. Its position in the array corresponds to the task in the respectively position of idTask array.
6. nsNc: this array stores all the doesn't know/doesn't answers of the session. Its position in the array corresponds to the task in the respectively position of idTask array.
7. resultatsArray: this array stores all the results in Boolean format of the session. Its position in the array corresponds to the task in the respectively position of idTask array.
8. preguntesArray: this array stores all the numbers asked in each task of the session. Its position in the array corresponds to the task in the respectively position of idTask array.
9. trArray: this array stores all the reaction times of the session. Its position in the array corresponds to the task in the respectively position of idTask array.
10. Comments: if the fathers of the kid want to send some comments to the doctor.



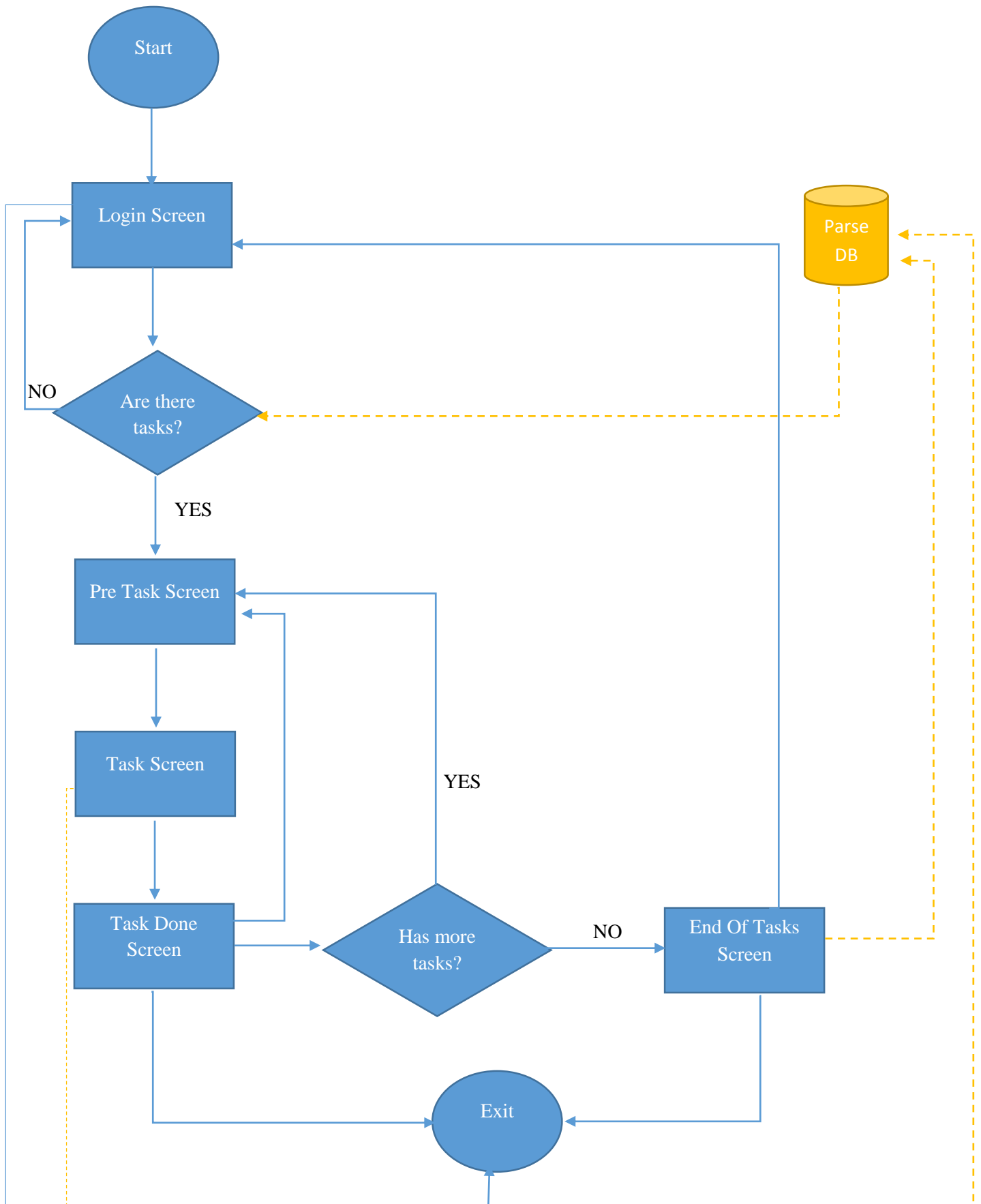
### 3. Architecture Information

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#### 3.1. Game Flow



### 3.2. Flow diagram



## 4. Game

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### 4.1. DESCRIPTION OF THE GAME

The game is a 2D multiplatform game developed in Unity. The game consists in a single game with different mathematical and arithmetical tasks that will evaluate different parameters like the reaction time and number of successes and failures of the kid. This data will be stored in the online database Parse which will facilitate the doctor to make a follow up of the reeducation of the kids.

We will evaluate the following concepts:

- Numerical consciousness
- Mental number line
- System base 10

#### Numerical consciousness

The numerical consciousness is the ability to recognize numbers and know the value of each one of them, both absolute and relative. This knowledge is essential to make comparisons, estimates, calculations and searching for intermediate numbers.

For evaluating the numerical consciousness we have made 4 tasks:

1. **Subitizing:** the ability to recognize numbers of objects without having to count them. The maximum is up to 10.

The task is to introduce random sets of points on the screen for 1 second, then the child must decide how many there were choosing between three possibilities. We measure success/error and the reaction time. There are two levels:

- Level 1: until 5 points on the screen.



Fig 4.1.Subitizing, level 1

- Level 2: between 6 and 10 points on the screen.



Fig 4.2.Subitizing, level 2

2. **Identifying numbers:** random numbers out screen and the child should say what number it is. The coach (parent) click 'success' or 'failure' (with the mouse) as fast as you can. The right button of the mouse is failure and the left button is success. The program will measure success/error and the reaction time. There are different levels:

- Level 1: From 0 to 10
- Level 2: From 0 to 20
- Level 3: From 0 to 100
- Level 4: From 100 to 1000
- Level 5: From 1000 to 10000



Fig 4.3. Identifying numbers, level 3



Fig 4.4. Identifying numbers, level 5

3. **Complete:** given two numbers the child has to guess which number goes in the middle. For example, the number between 4 and 6 is 5. The distance between the 2 numbers can be changed. The child has to write them using a keyboard. The program will measure success/error and the reaction time.

The numbers are grouped into different levels:

- Level 1: From 0 to 10
- Level 2: From 0 to 20
- Level 3: From 0 to 100
- Level 4: From 100 to 1000
- Level 5: From 1000 to 10000

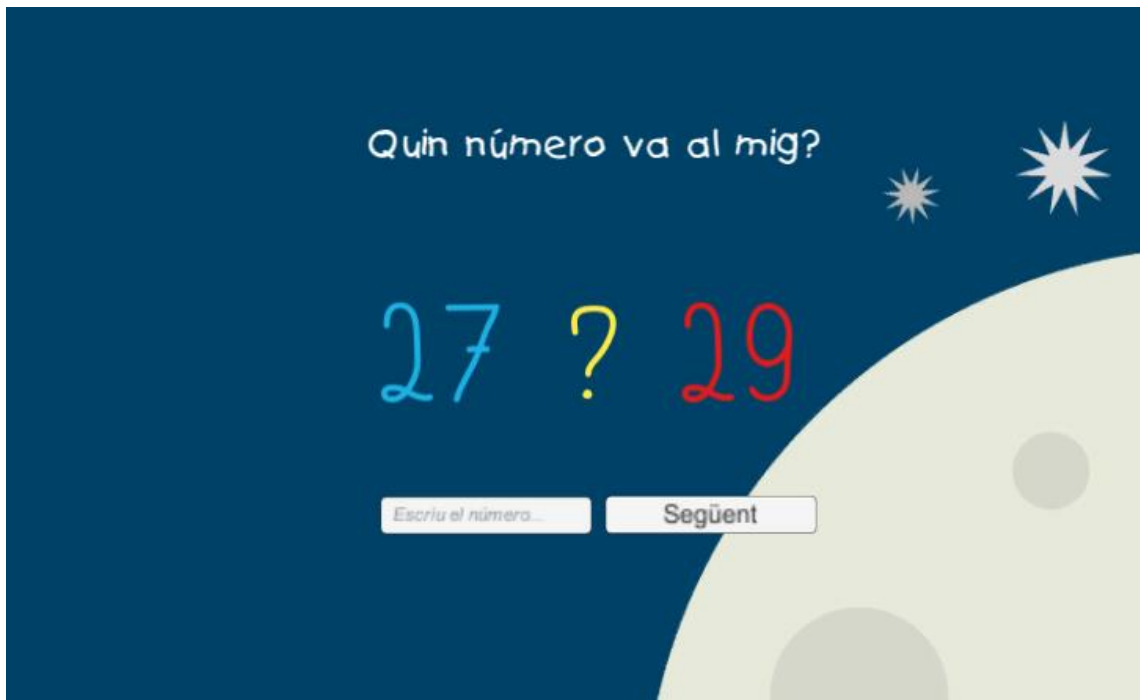


Fig 4.5.Complete, level 3 with a distance of 2



Fig 4.6.Complete, level 5 with a distance of 8

4. **Numeric working memory:** random numbers are presented on screen and the task is to remind them once they have disappeared. The program will ask which number was located in a specific position. The coach will click the right button (failure) or the left button (success) of the mouse to annotate the results. We measure success/error, and the reaction time.

The number of submitted numbers and the size of them measures the degree of difficulty. There are 6 levels:

- Level 1: 2 numbers less than 10
- Level 2: 2 numbers from 10 to 100
- Level 3: 2 numbers from 100 to 1000
- Level 4: 3 numbers less than 10
- Level 5: 3 numbers from 10 to 100
- Level 6: 3 numbers from 100 to 1000



Fig 4.7. Numeric working memory, level 6





Fig 4.8. Numeric working memory

### Mental number line

The mental number line is the ordered mental representation of all numbers, so that each of them keeps their individuality. The integrity of the mental number line is key to calculate the distance between a number and the rest, and facilitates the testing of exact and approximate calculation.

The task of the mental number line work positioning numerical figures in a line. It will do different levels of complexity that will come defined by:

- Presence or absence of marks
- Presence or absence of numbers in the marks

There are 4 levels that are defined by the range of the line:

- Level 1: the line goes from 0 to 10
- Level 2: the line goes from 0 to 20
- Level 3: the line goes from 0 to 100
- Level 4: the line goes from 0 to 1000

The child has to use the keyboard to move horizontally the rocket into the number that is asked. The rocket is affected by the gravity so it is falling down.

We measure success/error. It is considered success if the rocket lands between a number 10% up and 10% down of the total line. For example if the line goes up to 1000, the 10% is 100 so if the number asked is 555, the accepted landing range of the rocket is between the numbers 455 and 655.



Fig 4.9. Mental number line, level 4 with presence of marks



Fig 4.10. Mental number line, level 4 without marks

## System base 10

The system base 10 is grouping tens, key in processes of composition and decomposition of numbers. The base system 10 facilitates exact and approximate calculation.

We evaluate the system base 10 by one task:

1. **Creation of numbers:** creating numbers from units, tens and hundreds. There will appear numbers on the screen and the child has to build that numbers dragging units, tens or hundreds. Units are represented by a green alien, tens are represented by a red alien and hundreds are represented by a yellow alien. The child has to drag these aliens to the spaceship. In the left there is a reminder of the equivalencies. There's the possibility to show the count of the number or not.

The numbers are grouped into different levels:

- Level 1: From 1 to 10
- Level 2: From 10 to 20
- Level 3: From 1 to 100
- Level 4: From 100 to 1000

We measure success/error and the reaction time.



Fig 4.11. Creation of numbers, level 2 with the count of number



Fig 4.12. Creation of numbers, level 4 without the count of number

## 4.2. Definition of the objective public

This project is done for the kids that have between 8 and 10 years old with math difficulty. These kids will proceed from the Learning Disorders Unit (UTAE) of the Hospital Fundació Sant Joan de Deu and the schools that have an agreement with the UTAE.

## 4.3. Project requirements

The requirements established by the doctor for doing this project were the following ones:

1. Do a game for the project “Plasticitat cerebral associada a la intervenció reeducadora intensiva en nens amb dificultats en matemàtiques. Evidència per ressonància magnètica cerebral” which has been funded in the program Recercaixa 2014.
2. The project will be based in the results published by Kucian’s team (<http://www.ncbi.nlm.nih.gov/pubmed/21295145>) and Brian Butterworth’s team ([www.mathematicalbrain.com](http://www.mathematicalbrain.com)).

3. This game will work the following concepts: mental number line, system base 10, composition and decomposition and addition and subtraction in mental arithmetic.
4. The game must have an environment. The environment established is the universe/space.
5. The step from one task to another will be automatic, depending on the performance. The doctor (or reeducator) can change, in the back office, the planning and assign a task depending on the monitorization.
6. The game will have best user interface than other dyscalculia softwares.
7. The game will be multiplatform
8. The game will have a back office

# 5. Screens Design

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## Login screen

The first screen of the game is the login screen, where the father of the kid has to enter the ID of the kid. If the kid doesn't have any pendent task or there are no tasks for him, a text will be displayed out warning this.

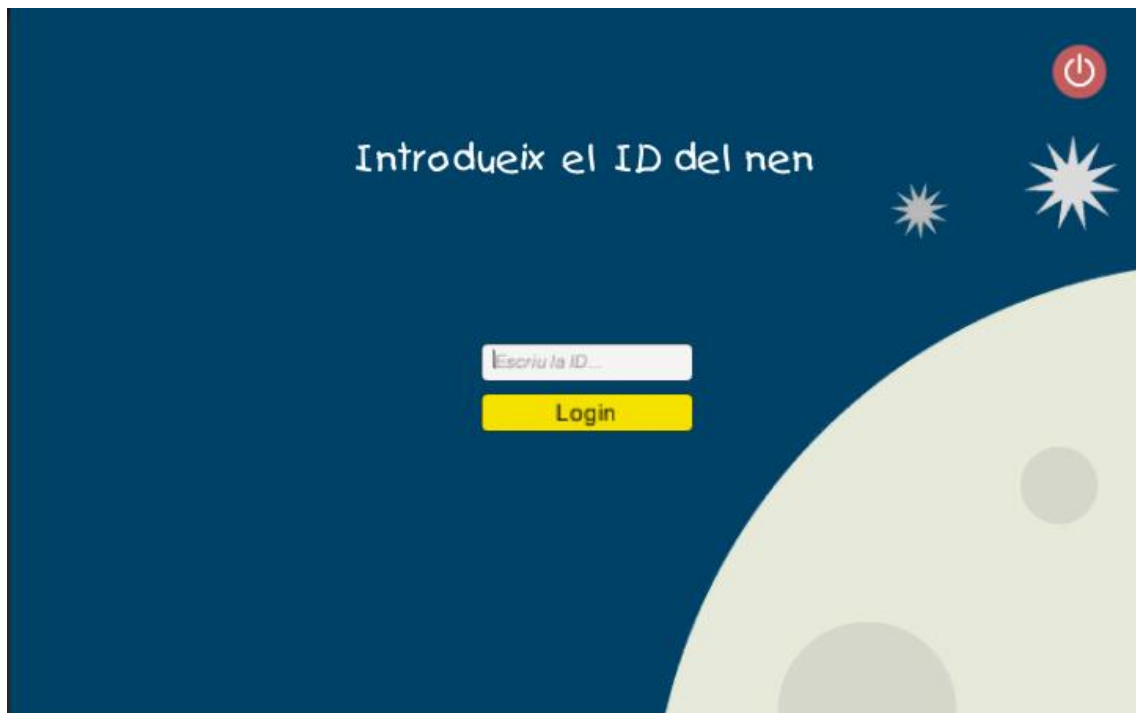


Fig 5.1. Login Screen

## Pre-Task Screen

When the user has logged in, the pre-task screen enters to scene. This screen is an information screen where an alien explains the instructions of the next task. In the following example the task that is going to do the kid is the task Identificació.

When the kid is ready, the father will click the button and the task will start.



Fig 5.2. Pre Task Screen

### Task Screen

This is the screen of the task, where the kid plays with the different tasks that have been explained before. Some examples:

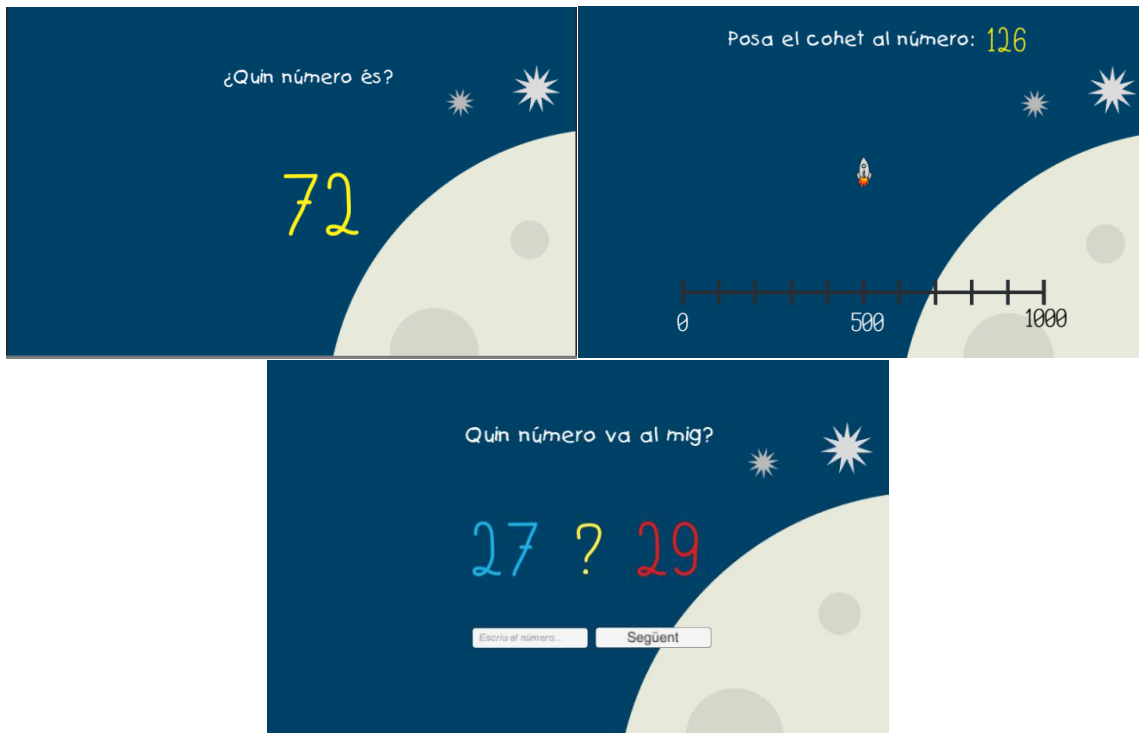


Fig 5.3. Some tasks screens

### Task Done Screen

When the kid finishes one task, this screen is loaded. In this screen there are one animated text that congratulates the kid for completing the task, 3 buttons (one of them is the power button) and a rocket. Every time that this screen loads, the rocket starts moving from the last position that entered this screen to the next position. This depends on the number of tasks of the session. When the kid finishes the session the rocket will reach the center of the moon.

When the rocket has reached the next point, the 2 buttons of the center appear. The left one (purple) is to repeat the task that has been done and the right one (yellow) proceeds to the next task. The yellow button will move to the Pre Task screen and then the cycle of Pre Task Screen - Task Screen - Task Done Screen will start again.



Fig 5.4. Task Done Screen



## End of Tasks Screen

When the user has finished all the tasks of the session and in the Task Done screen clicks the yellow button to go to the next level, this screen will be loaded. In this screen there is a text congratulating the kid and an input field to send any comments the parents have to say to the doctors. If the user press the button *Envia*, the text in the input field will be send to Parse and the game will be redirected to the Login screen.



Fig 5.5. End of Tasks Screen

## 6. Cost of the Project

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Total hours spent in the project (from June 2015 to September 2015) = 200h approx.

Hours spent designing the levels = 50h

Hours spent programming the levels = 150h

Designer salary =  $32\text{€}/\text{h} \times 50\text{h} = 1600\text{€}$

Programmer salary =  $37.5\text{ €}/\text{h} \times 150\text{h} = 5625\text{€}$

Cost of the computer used = 53 €

Cost of using the computer used for developing this project =  $4\text{€}/\text{month} \times 3 = 12\text{€}$

Total cost of the project =  $5625\text{ €} + 1600\text{€} + 53\text{€} + 12\text{€} = 7290\text{ €}$

# 7. Conclusions

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## 7.1. General Conclusions

Doing a simple 2D game is not as easy as someone could think. Before starting the creation of the game there has to be planned all the characteristics that the game will have and be sure to have a solid idea defined. When the idea is clear, then it's the time to think about the design and the interface. Doing all of this in a specialized team with members that have different roles it's easier and faster than doing it as a single team. I've worked in this project as a single programmer with the help of the tutor and it's a shame that we don't have more time because there are a lot of features that we want to implement but we don't have more time to do it.

One of the objectives of this project was to improve the skills about using Unity and learn a bit about the programming language C#. This has been accomplished with good results. I've learned a lot of things and discovered some tricks about the game engine Unity that will help and will facilitate me for doing possible future projects. Also, the use of this program has helped me to get in touch with a programming language that I've never used, the C#. This language will come in handy in the future because nowadays it's getting a real importance in the videogame market.

## 7.2. Future implementations

The first idea of this game is to be a web browser game, where the fathers and kids can access through a webpage. One of the next implementations will be port this game to smartphones and tablets. There are some ideas like make an app separately from the game where the fathers can control the session of the kid and don't interrupt the kid while playing.

Another future implementation will be the use of gamification making a custom character or player and a custom rocket for every kid. The kid will choose the aspect and color of the rocket and player and view it through the game. Furthermore, another implementation related with this, will be a shop where the kids will buy, with money of the game, clothes and other things to customize the character.

And of course more and more tasks.

# 8. ANNEXES

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## A.1. Benchmarking games reviews

### A.1.1. Sum Tracks

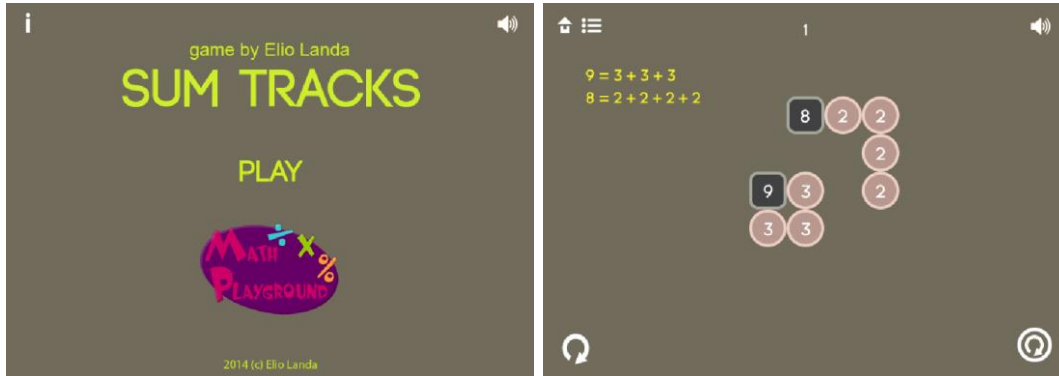


Fig A.1. Sum Tracks game

- Description

Sum Tracks is a web game developed by Elio Landa. The methodology of this game is easy: drag square number tiles over the round ones to decrease their value. The objective is to reduce all square number tiles to zero. The player will have to choose between numerous pathways and decide which the better one is.

- Strengths

The strengths of this game are that it is a game with a simple methodology and also that it makes the player think a lot to decide which pathway to take to reduce all square number tiles to zero. In some levels the player can step the same number (painted in blue) more than one time, so the difficult increments.

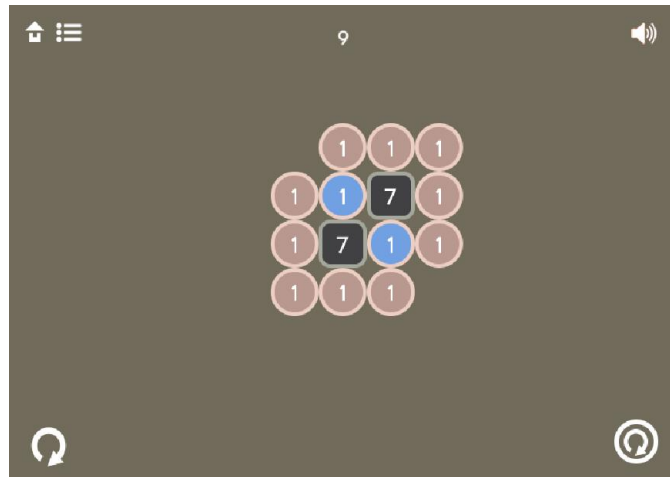


Fig A.2. Sum Tracks game

- Weaknesses

It has a limited number of levels. Once the 45 levels are done, you complete the game. So it's not a game for spending a lot of time on it, once you've completed it, it is done. Another weakness of this game is that there are no lives. You can use the undo button to go one step back as many times as you want. This game with lives or hearts will be better so will make the user think carefully which pathway choose to beat the game without losing a live.

#### A.1.2. Smartick



Fig A.3. Smartick game

- Description

Smartick is a method of learning that through math, increases mental agility, computing power and strengthens concentration and study habits, helping the child reach his full potential. Smartick is one of the best choices to complement the student's training in

mathematics, improving the computational power and mental agility in an efficient and fun way.

- Strengths

Smartick is a very powerful method/program. The web is very smooth and the layout is excellent. There are a lot of different exercises that adapt in real time to the progress of the kid. Smartick only requires an average time of 15 minutes per day and this company offers an educational tutor that will care and solve any doubts of the parent or child within 24 hours.

One another very important strength is that there are rewards: when the kid finishes the session of the day, the kid gets some stars that can be exchanged for some items in the shop. This is an important motivator factor for the kids. The kids can also create a custom character, choosing between a different faces, hairs, etc. There is also a map where the kids can go to different places like a shop or a gym.



Fig A.4. Smartick game

- Weaknesses

This tool is very useful for kids and I think that it has not many weaknesses. It is a very useful and powerful application.

### A.1.3. Sum Points

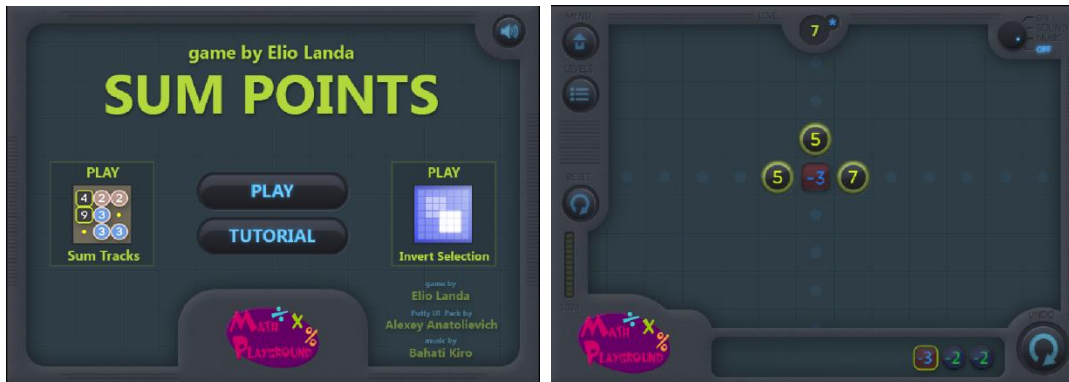


Fig A.5. Sum Points game

- Description

Sum Points is a web game created by Elio Landa. The objective of the game is easy: get the target number to zero by placing subtraction discs on the grid. Blue discs work along diagonal lines and red discs work along horizontal and vertical lines.

- Strengths

The major strengths of this game are that it is a simple game and easy to play. Also is good that you have to think where to put the discs so this makes your brain work hard. At the first levels seems very easy but at higher levels the thing gets complicated. The player will have to use carefully the red and blue discs having in mind the vertical or diagonal lines.



Fig A.6. Sum Points game

- Weaknesses

The most important weakness is that it has only 41 levels. So it's not a game for spending a lot of time on it, once you've beaten it, it is done.

Another weakness of this game is that there are no lives. You can use the undo button to go one step back as many times as you want. This game with lives or hearts will be better so will make the user think carefully where to put the discs to beat the game without losing a live.

#### A.1.4. The Number Race



Fig A.7. The Number Race game

- Description

The Number Race is a computer game that let the kids play with numbers while training basic concepts of number and arithmetic like number formats (concrete sets, digits and number words), counting (practice with number 1-40) and addition and subtraction (range 1-10).

- Strengths

The major strength of this game is that it has been scientifically tested. The efficacy of this program has been tested in several studies and most of them have been published in scientific papers like: Wilson, A. J., Revkin, S. K., Cohen, D., Cohen, L., & Dehaene, S. (2006). An open trial assessment of “the number race”, an adaptive computer game for remediation of dyscalculia. *Behavioral and Brain Functions*, 2 (20).



On another strength is that the game gives the choice to choose different characters for the kid and the opportunity to unlock other in the future. So it's not a short game and it's replayable.

- Weaknesses

The user interface could be better, it looks like the old games. Nowadays this could be more modern.

Another weakness is that the game is only in English. It would be better if it were Multilanguage.

Also, the only option to play the game is downloading it and playing it offline. So there is no a web version or smartphone version and there's no online database so doctors can't do an online research and take care of the kids.

#### A.1.5. Penguin Jump Multiplication

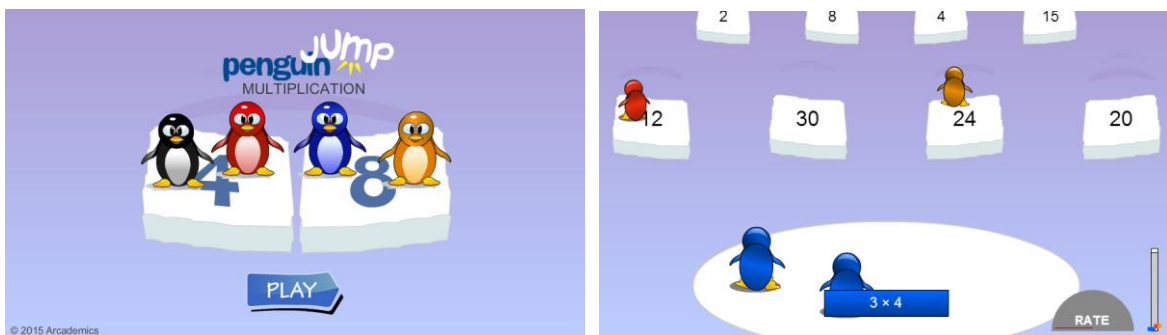


Fig A.8. Penguin Jump Multiplication game

- Description

Penguin Jump Multiplication is an online web game where the players can practice multiplication facts with penguins. The methodology is very simple: a multiplication is asked and the player has to click the correct result in the next 4 squares. If the result is not correct, the penguin falls into the water, if the result is correct the penguin can move to the next square and this until the finish line.



Fig A.9. Penguin Jump Multiplication game

- Strengths

The strengths of this game are that it is a very simple game with an easy gameplay and that it is an online game. The player compete against other players in real time so he can see where the other players are at the time. This will make the user to think very fast the answer for being the first to get to the finish line.

- Weaknesses

One weakness of this game is that there are no rewards by getting first to the finish line. When the player has reached the end, then another race begins but with no continuity to the previous race. So this game is for playing only two or three times and no play more.

Also, the player has not the possibility to register and to customize the character and there is not a ranking.

## 9. References

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