Màster universitari en **Formació del Professorat d'Educació Secundària Obligatòria i Batxillerat, Formació Professional i Ensenyament d'Idiomes**

Treball de fi de màster

Títol: Board games as a teaching tool for technology classes in Compulsory Secondary Education

Cognoms: Busom Figueres

Nom: Núria

Titulació: Màster en Formació del Professorat d'Educació Secundària Obligatòria i Batxillerat, Formació Professional i Ensenyament d'Idiomes

Especialitat: Tecnologia

Director/a: Montserrat Pérez

Data de lectura: 30.06.2016

UNIVERSITAT POLITÈCNICA DE CATALUNYA
BARCELONATECH
Institut de Ciències de l'Educació

Contents

List of Figures

List of Tables

– Prodesse et delectare

Horace, I BC

1 Introduction

1.1 Context

The widespread usage of the Internet and the loose management of the new technologies from a young age are two of the most important characteristics of the Generation Z or iGeneration, i. e. kids born from year 2000 on. These kids spend oodles of hours [And15, Wak15] watching television, playing video games or on social networks, from where they receive lots of stimuli.

It is unequivocal that not only these kids but also the whole society has evolved. Therefore the way of teaching must also evolve. The traditional way of teaching has expired.

Using games as a means of education is not a new conception, noblemen in Middle Age learnt war strategies by playing chess. However two new concepts have recently appeared: Gamification and game-based learning (GBL). Although they are sometimes taken for the same, they are not.

Gamification is the application of game elements such as badges recognition or points competition in non-game contexts, for example, in schools. The goal in schools is to motivate the students, so as they are willing to learn more. Sometimes this is got through competitions. Gamification is also used in business world in order to improve the productivity by motivating the employees [Pos14]. The studies show that the application of gamification have good results. On the other hand, GBL is the use of a game for teaching purposes.

A very basic example of gamification in classroom is something so easy as giving points for correct answers and active participation and keeping a ranking. GBL for teaching foreign languages is also straight-forward. Almost every game can be used as a tool for learning languages and the literature about it is extensive [FK06, Gau99, Scr11].

In addition, in the late 90's there was a board games boom (see Figure 1.1). Games became more and more popular and they started to be not only a hobby, but also a passion for many.

Almost everyone has at least once played Monopoly, Risk or Trivial, but these popular family games were just the beginning. Since the last century, this would has grown exponentially and now it is told that *we are living the board games' golden age* [Gua14].

Boargamegeek (BGG) [BGG] is an extensive game data base in the Internet and it holds photos, videos, reviews, session reports and it stores information about 84309 board games, 50542 role-playing games (RPG) and 35137 video games (as of June 10, 2016).

Mark Prensky [Pre01] defines video games as the *most engaging pastime in the history of mankind* due to twelve factors:

1. Games are a form of fun. That gives us enjoyment and pleasure.
2. Games are form of play. That gives us intense and passionate involvement.
3. Games have rules. That gives us structure.
4. Games have goals. That gives us motivation.

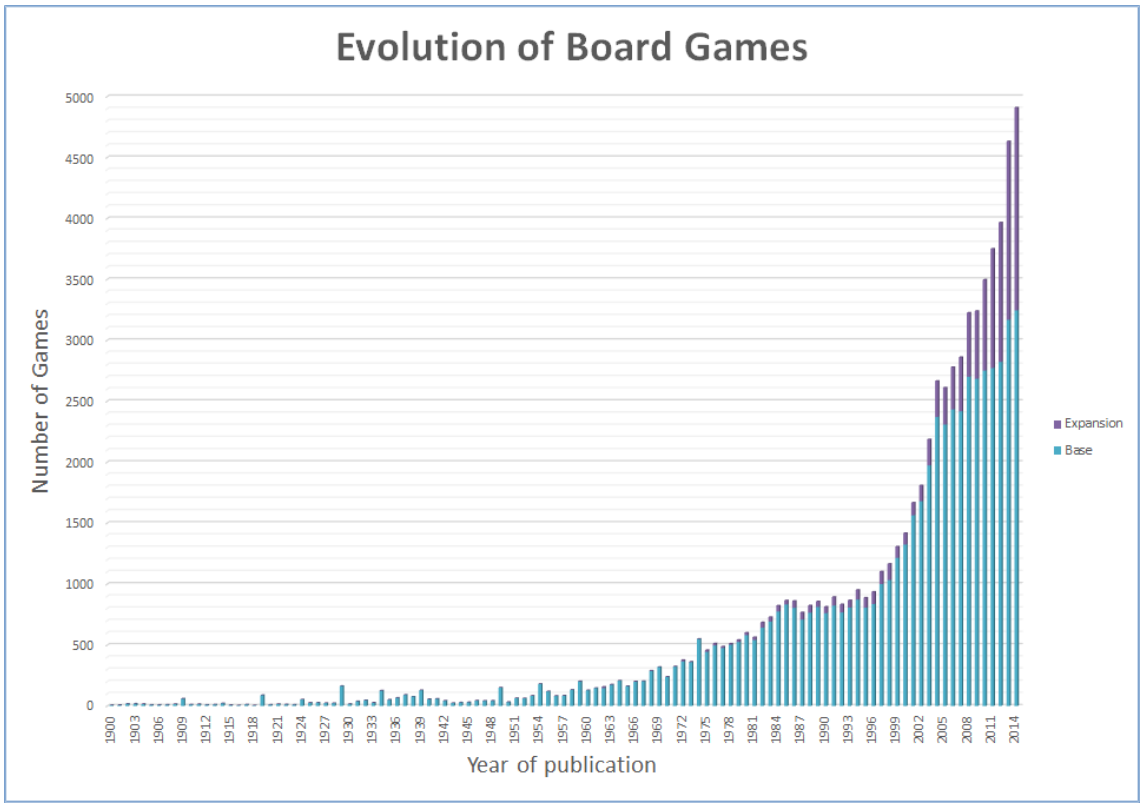


Figure 1.1: Board games (with expansions) 1900-2014

5. Games are interactive. That gives us doing.
6. Games are adaptive. That gives us flow.
7. Games have outcomes and feedback. That gives us learning.
8. Games have win states. That gives us ego gratification.
9. Games have conflict/competition/challenge/opposition. That gives us adrenaline.
10. Games have problem solving. That sparks our creativity.
11. Games have interaction. That gives us social groups.
12. Games have representation and story. That gives us emotion.

Although these factors are described for video games, they can also be applied on board games and we can profit from these features and use them for educational intentions.

The use of games as a teaching tool is extensively documented in the literature [BNOK07, Kap12, HS11, Pre01, TL98].

The term *game* is usually used for video, role-playing, card or board games. Albeit its use may have the same benefits, board games are not so frequently used as a teaching tool. Therefore the literature in this field is not extensive. Moreover it is hard to find games to teach technology. The aim of this Master Thesis is to find some good board games that can be used for teaching technological topics in Compulsory Secondary Education.

1.2 Goals of this Master Thesis

The goals of this Master thesis are listed below:

- Search and study some existing proposals that use board games as a teaching tool.
- Contextualize game boards in didactics.

- Identify useful games for teaching technology and classify them taking into account the curricular contents in Compulsory Secondary Education, which they refer to.
- Acquire new didactic methods for teaching technology.
- Apply the technological process in order to create a new game, which can be used for teaching technology in Compulsory Secondary Education.
- Propose an activity using the new game.
- Evaluate the activity, from the content and the methodological point of view.

1.3 Outline

In Chapter 2 the technological curriculum concepts and competencies in Compulsory Secondary Education are revised. Then, in Chapter 3 some existing games that can be used as a teaching tool for those curriculum concepts are listed and their rules are briefly explained. For some topics in the curriculum it has been impossible to find a suitable game. Chapter 4 deals with these topics in a new game based on the existing game Party & Co, named Techno in Co.. However this game is still in a very early developing phase and it had been impossible to test it in a real scenario. Chapter 5 presents an experience carried out during the training in a school, where the board game RoboRally was used in an introductory Robotics lesson. Finally, in Chapter 6 the conclusions and future work are discussed.

– Tell me and I will forget. Show me and I may remerber. Involve me and I will learn.

Benjamin Franklin

2 Technological Curriculum and Competencies

In Catalonia, education is compulsory for all children with ages between 6 and 16 years. They start at 6 primary school (Primària), that lasts for 6 years and, at 12, they start compulsory secondary education (ESO: Educació Secundària Obligatòria) (ESO), that lasts for 4 years more.

This chapter is barely a list of the main curricular topics of Technology taught in ESO, as well as the competencies. Although these topics and competencies are further explained in the curriculum [Gen15a], this list can not be found in English to the best of my knowledge.

In Chapter 3 and 4 some games that can be used for teaching some of these topics and that fulfil some of these competencies are explained. Below, they are underlined and highlighted in bold, respectively.

2.1 Technological curriculum

2.1.1 First year

T1.1 Technological process

- Technological process. Stages.
- Problem analysis.
- Information research through digital tools.

T1.2 Technologies processes development

- Definition of technology.
- Technical project and technical memory.
- Execution, evaluation and communication of the technical project.
- Use of digital tools.

T1.3 **Object design and construction**

- Materials and forms.
- Scale, sketch and projections.
- Measurement tools.
- Technical machines and security norms.
- Object construction using different materials, tools and techniques.
- Digital tools for object design.

T1.4 **Materials**

- Properties, uses and applications of basic materials: paper and wood.
- Properties, uses and applications of technical materials: metals, plastics, textile and stony materials.
- Sustainable use of materials.

2.1.2 Second year

T2.1 Technological process

- Technological product execution planning.
- Multi-view orthographic projection.
- Digital tools for project communication.

T2.2 **Electricity**

- Basic circuits.
- Direct and alternating current.
- Energy production.
- Renewable energy.

T2.3 Processes and transformations of everyday life

- Raw materials: obtaining and transformation.
- Packaging, labelling, transporting and storing.
- Virtual business.

T2.4 Programming languages

- Algorithmic.
- Basic programming languages.
- Program structure.
- Program flow.
- Programming using visual programming languages.

2.1.3 Third year

T3.1 Technological process

- Technological process planning.
- Costs calculation using spreadsheets.
- Marketing plan.
- Sustainability estimation.

T3.2 Structures

- Function and features of a structure.
- Types of structures.
- Types of stress.
- Structural elements and stress of quotidian objects.
- Stress analysis.
- Design, construction and evaluation of basic structures.

T3.3 Machines and mechanisms

- Analysis of quotidian basic constructions.
- Heat engines. Traditional and alternative fuel.

- Transmission and transformation of movement mechanisms.
- Digital analysis of mechanisms.
- Design, development and evaluation of projects with mechanisms.

T3.4 Communication

- Wired and wireless communication.
- Analogue and digital communication.
- Communication networks
- Electronics.

T3.5 **Applications programming**

- Constants and variables.
- Arithmetic, logic and relational operators.
- Functions.
- While and if structures.
- Basic applications programming.

2.1.4 Fourth year

T4.1 House building

- House building basics: location, buying/renting, energy saving.
- Access building protocols.
- Buildings installations.
- Building maintenance and repair.
- Energy saving.

T4.2 Communications

- Wired and wireless communications: connexions.
- Types of communication networks.

T4.3 **Electronics, pneumatics and hydraulics**

- Digital and analogue circuits.
- Boleean algebra and logic gates.
- Hydraulics and pneumatics: basics.
- Circuit simulators.
- Circuits design and construction.

T4.4 Control and automatisms

- Control elements: sensors, actuators and remote controls.
- Automatic systems: elements and operation.
- Automatic systems design and construction.
- Automatic machines and robots.
- Robots design, construction and programming.

2.2 Competencies

2.2.1 Key competencies in secondary school

According to [Gen15b], the key competencies in secondary school are:

KC1 **Competence in linguistic communication.**

KC2 **Cultural awareness and expression.**

KC3 Digital competence.

KC4 **Mathematical competence.**

KC5 Learning to learn.

KC6 Sense of initiative and entrepreneurship.

KC7 **Competence in the knowledge and interaction with the physical and natural world.**

KC8 **Social and civic competence.**

2.2.2 Subject-specific competencies in Technology

According to [Gen15b], the three subject-specific competencies in Technology are:

SC1 To use technological objects in the everyday life by knowing their operation, maintenance and actions to be done in order to minimize the risks in manipulation and environmental impact.

SC2 To analyse technological systems of industrial importance, to evaluate their personal and social advantages, as well as, their impact on healthiness and on the environment.

SC3 **To design and to construct simple technological objects to solve a problem and to evaluate the suitability of the result.**

– The goal is to win, but it is the goal that is important, not the winning.

Reiner Knizia

3 Some useful existing games

There exist some board games that can be used in technology classes without making any change in their rules. Due to their backgrounds or mechanics, they are perfect for introducing a topic or even for developing it further. Moreover there also exist some games that can be easily adapted also for this purpose. Some of these games are listed below and their rules are briefly explained in Subsection 3.1 and in Subsection 3.2, respectively.

At the end of the chapter two tables relating these games and the curricular concepts and competencies from Chapter 2 are presented.

3.1 Existing games

3.1.1 b00Le0

b00Le0 is a 2-player card game that combines strategy and concepts of Boolean logic. Each player races to build her logic pyramid before the opponent.

The game starts with a binary number in the middle of the table. Players take turns placing logical gates cards underneath and between two bits from the previous binary number. The played card must resolve to a valid output. For example, beneath a 1 and a 0 it can be played a card AND (0), OR(1) and XOR(1). If the output is invalid, then the card is discarded.

Figure 3.1: b00Le0 pyramid. Source: BGG

3.1.2 Ricochet Robots

In Ricochet Robots [Ran99] the main mechanism is grid movement, which implies abstract strategy.

The board represents a maze (Figure 3.2). In each turn, a color-coded target is revealed and placed in the middle of the board. Then, players may get the target within the fewest movements. The tricky point is that once a robot starts moving, it will continue until it finds an obstacle, which can be a wall or another robot.

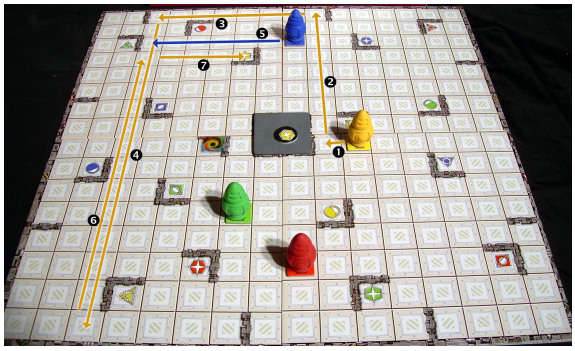


Figure 3.2: Ricochet Robots. Source: BGG

3.1.3 Roborally

In RoboRally [Gar94] each player controls a robot in a dangerous race along the board, which represents a factory floor. Over the board there are some numbered flags that robots must visit in order. The first player claiming all the checkpoints in the correct order wins. More than one round may be needed.

Each round consists of 5 phases and in each phase players program the instructions, move the robots and the board elements are resolved.

In order to move the robot through the board, players must program the instructions. Each robot has a register with 5 positions, that must be filled with 5 facedown program cards out of the 9 drawn. The 7 possible movement cards are: move forward 3, 2, or 1 spaces, move backward 1 space, turn 90 degrees right, turn 90 degrees left or turn 180 degrees. These cards also have a priority number.

Each player reveals the first instruction simultaneously and the movements are resolved in priority order: the highest number moves first. If a robot runs into another one, it can push it off course. Although if this occurs, any card can not be reprogrammed.

Afterwards, robots fire lasers and factory elements, such as conveyor belts or board lasers, are switched on. These can cause damage points and resulting in decreasing the number of drawn cards or even fixing some of them.

The other cards are resolved following the same instructions.

Figure 3.3: RoboRally. Source: BGG

3.1.4 Timeline: Inventions

In Timeline: Inventions [Her10] players place cards forming a time line sequence.

Each card represents an invention of the humankind history. On one side there is a drawing and the name of an invention and on the other side there additionally the year when it was invented.

The game starts with a card in the middle of the table showing the year and each player receives four cards faceup so the year can not be seen. Players take turns placing cards in the time line row. Once the player plays a card in the row, she reveals the date on it. If the card is in correct chronological order with respect to the others, the card stays. Otherwise, the card is removed from the play and the player draws a new card. The first player to get rid of all her cards, wins.

Figure 3.4: Timeline. Source: BGG

3.2 Adaptable games

3.2.1 Trivial Pursuit

In Trivial Pursuit [Unc81] players answer questions about six different categories: science, history, geography, arts, spectacles, and hobbies and sports.

Adapting this game is straight-forward if all questions refer to technological topics. In *Una caja mágica* [Jav13] some instructions and question samples can be found.

3.2.2 Time's Up!

Time's Up! [Sar99] is a card game played in three rounds. In each round, team members take turns trying to get their team mates to guess as many terms as possible. In round 1, players describe the name using as many as words as they need. Round 2 and 3 are played with the same cards, but in the former round only saying one word is allowed, while in the latter no words are allowed, only gesture.

This adaptation is also straight-forward if all the terms are related to technological concepts.

3.2.3 Scattergories

In Scattergories [Unc88] players may fill out a category list with words starting with the letter that appears on the rolled die. The more words, the more points.

This game can be easily adapted, replacing the traditional categories by the lessons given in class.

3.2.4 Eat poop You cat

Eat poop You cat [Unc84] is a drawing game, for which only paper and pencils are required. Each player takes a piece of paper and writes a sentence at the top. Next, each player passes the paper to her left and each player draws the sentence. Afterwards, each player folds the paper so only the drawing is

visible and passes it to the left. Now, each player writes a sentence interpreting the drawing, folds the drawing and passes to the left,... This continues until each players receives her original sentence.

At the end, players unfold the paper.

Students may be required to write sentences involving technological concepts.

Figure 3.5: Eat poop You cat. Source: BGG

3.3 Relation between games and topics and competences in ESO

The relations between games presented in Section 3.1 and topics taught in ESO listed in Chapter 2 are shown in Table 3.1. Games listed in Section 3.2 can be applied to any topic. Games are listed in alphabetical order.

	T1.{1-3}	T1.2	T1.3	T1.4	T2.2	T2.3	T2.4	T3.2	T3.3	T3.4	T3.5	T4.1	T4.2	T4.3	T4.4
b00Le0	·	·	·	·	·	·	·	·	·	·	✓	·	·	✓	·
Ricochet Robots	·	·	·	·	·	·	✓	·	·	·	✓	·	·	·	✓
RoboRally	·	·	·	·	·	·	✓	·	·	·	✓	·	·	·	✓
Timeline	·	✓	·	·	·	·	·	·	·	·	·	·	·	·	·

Table 3.1: Relation of games and topics taught in ESO

Below, the relations between games presented in Section 3.2 and in Section 3.1 and competencies in ESO are shown in Table 3.2. Games are listed in alphabetical order.

	KC1	KC2	KC3	KC4	KC5	KC6	KC7	KC8	SC1	SC2	SC3
b00Le0	·	·	·	✓	·	·	✓	✓	·	·	·
Eat poop You cat	✓	✓	·	·	·	·	·	✓	·	·	·
Ricochet robots	·	·	·	✓	·	·	·	✓	·	·	·
RoboRally	·	·	·	✓	·	✓	·	✓	·	·	·
Scattergories	✓	·	·	·	·	·	·	✓	·	·	·
Timeline	·	·	·	·	·	·	✓	✓	·	·	·
Time's Up!	✓	·	·	·	·	·	·	✓	·	·	·
Trivial Pursuit	✓	✓	·	·	·	·	·	✓	·	·	·

Table 3.2: Relation of games and competencies in ESO

– Men do not quit playing because they grow old; they grow old because they quit playing.

Oliver Wendell Holmes

4 Techno in Co.

This chapter presents a prototype of a game that may be used in ESO to teach some curricular concepts of Technology.

4.1 Game

Techno in Co. is a self created game inspired on Party & Co [Unc93] made out of 5 different categories: electricity, tools, transmission and transformation of movement, materials and recycling and combinational logic.

4.1.1 Aim of the game

The game is played during some time, that must be previously accorded. After this time, the player with the highest number of cards wins.

4.1.2 Game components

The following components are needed to play Techno in Co.:

- 1 6D die

Figure 4.1: A die. Source: thegamecrafter

- Game cards

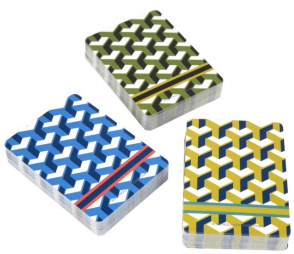


Figure 4.2: Cards. Source: jaysonhome

- Something to draw and to draw on

Figure 4.3: Blackboard and chalk. Source: clker

- 1 educational kit of gears

Figure 4.4: Educational kit. Source: aliexpress

- Different resistances

Figure 4.5: Resistance. Source: interface-z

- A resistor colour code calculator chart

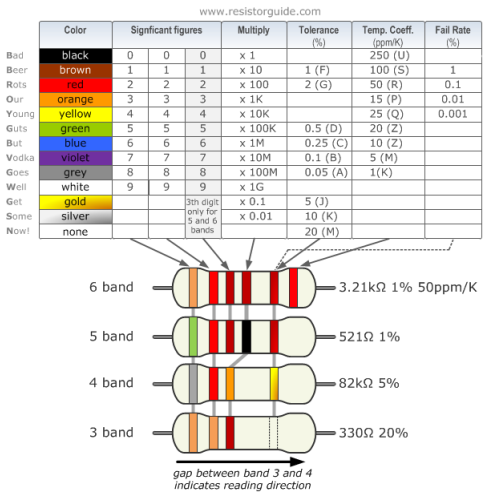


Figure 4.6: Resistor colour code. Source: resistorguide

- 6 coloured boxes: blue, green, yellow, red, brown, grey

Figure 4.7: Recycling boxes. Source: captain-fussybuckets

- Rubbish items cards

Figure 4.8: Rubbish items collected from magazines and publicity. Source: notimeforflashcards

4.1.3 Game setup

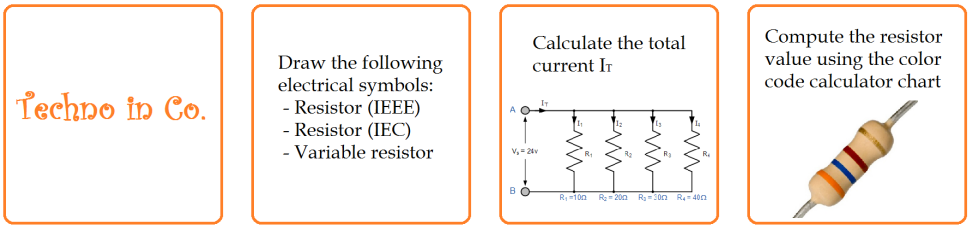
1. Shuffle each card deck separately and put them in the middle of the table.
2. Place the die and the rest of components next to the decks.

4.1.4 Rules

The team with the youngest player starts.

Game round

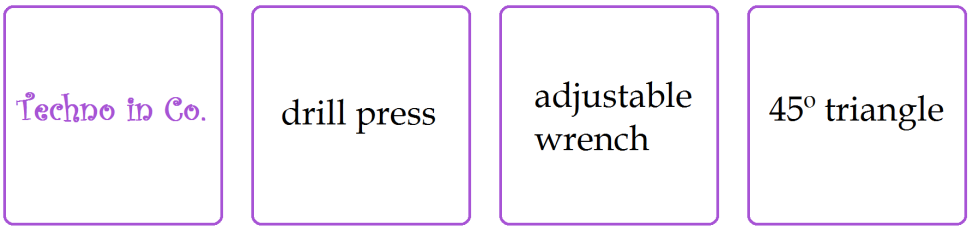
1. Roll the die.
    1. Electricity: draw circuits with some features, draw circuit elements, read resistance values,...



(a) Back orange card (b) Front orange card (c) Front orange card (d) Front orange card

Figure 4.9: Some orange cards

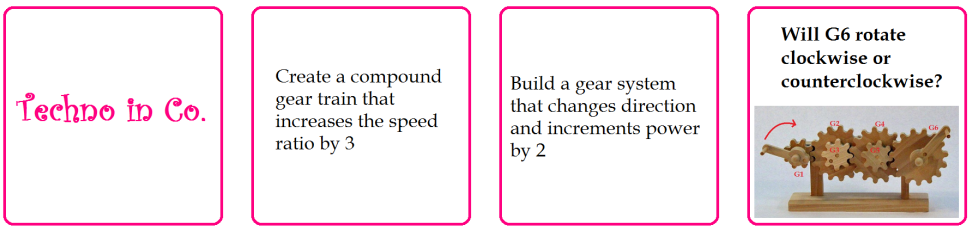
2. Tools: describe workshop or drawing tools. Two members of a team describe the term forming a sentence, taking turns at adding a word each. The other team members try to guess the word.



(a) Back purple card (b) Front purple card (c) Front purple card (d) Front purple card

Figure 4.10: Some purple cards

3. Transmission and transformation of movement: construct a mechanism like the one described on the card.



(a) Back pink card (b) Front pink card (c) Front pink card (d) Front pink card

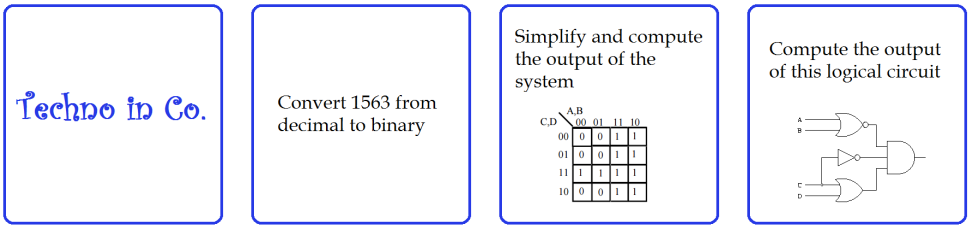
Figure 4.11: Some pink cards

4. Materials & recycling: draw 10 card materials and throw each card in the corresponding color box representing recycling bins.

(a) Back green card (b) Front green card (c) Front green card (d) Front green card

Figure 4.12: Some green cards

5. Combinational logic: decimal into binary and binary to decimal conversion, truth tables, Karnaugh maps,...



(a) Back blue card (b) Front blue card (c) Front blue card (d) Front blue card

Figure 4.13: Some blue cards

6. Choose the category you want.

2. Perform the action. If the answer is correct, you receive 1 victory point.

3. Hand the die over to the next team.

A summary of the curriculum concepts that can be taught using Techno in Co. are listed in Table 4.2, as well as the competencies fulfilled are shown in Table 4.1:

	T1.{1-3}	T1.2	T1.3	T1.4	T2.2	T2.3	T2.4	T3.2	T3.3	T3.4	T3.5	T4.1	T4.2	T4.3	T4.4
Techno in Co.	·	·	✓	✓	✓	·	·	·	·	·	✓	·	·	✓	·

Table 4.1: Relation of Techno in Co. and topics taught in ESO

	KC1	KC2	KC3	KC4	KC5	KC6	KC7	KC8	SC1	SC2	SC3
Techno in Co.	✓	✓	·	✓	·	·	✓	✓	·	·	✓

Table 4.2: Relation of Techno in Co. and Competencies in ESO

4.2 Activity

Unfortunately this game has not been tested yet due to logistic problems: my training was carried out in 3 ESO and some necessary concepts are taught the following year. However a suitable activity using it is presented below.

This game is thought to be played at the end of Compulsory Secondary Education in order to review some concepts of Technology learnt during the last four years. It should be played in groups of 5, since there are 5 different game categories.

Two weeks before playing, each member of the group is told to be in charge of one of the categories, i.e. each student should deeply review the assigned topic. In this way, they have a whole week to review concepts, then they have a session to ask questions and another week to study.

The competition should be engaging enough to motivate kids to study, but they can also be told that they will get extra points for the subject if they have a good score in the game.

– Do androids dream of electric sheep?

Phillip K. Dick

5 Case of Study

This chapter presents a case of study carried out during my training. It focus on testing if there is any improvement in performance, focusing and behaviour in a group of pupils when using a board game as a teaching tool. This group is compared to other two, who had the same sessions except for the previous board game classroom.

5.1 Methodology and methods

This study was carried out in a private school in Spain in three grade 9 (equivalent to 3º ESO in Spain) classrooms with pupils aged 14-16 years old during the school year 2015-2016.

The study aim to address the following research question:

- Does using a board game as a teaching tool in a introductory lesson increment students' motivation?

5.1.1 Participants

A total of 83 participant students, 43 female and 40 male, ranged from 14 to 16 years old, with the majority of them 15 and divided in three classrooms were taught Robotics for the first time. The size of the groups is almost equal: 27 pupils in group A, 26 in group B and 30 in group C, as well as the proportion female-male, which was 13-14 in group A, 14-12 in group B and 16-14 in group C.

5.1.2 Instruments and procedures

Three sets of the board game RoboRally [Gar94]. The rules of this game are explained in Chapter 3.

The lesson structure was the same for the three groups:

- An introductory explanatory session. A show presentation with some theoretical concepts and some funny videos.
- A whole session for assembling the robot. This is made in group of 3-4 pupils.
- Four sessions programming the robot, where students may solve 10 challenges. This is done within the same groups.
- A test.

However, group C had a previous extra session, where they played RoboRally. This session was intended to teach some important robotics concepts, such as algorithmics, i.e. the importance of executing instructions in the proper order and in an efficient way.

Although the mark is not the aim of this study, it is a requirement from the school and may be used as an indicator in this investigation. The final mark (M) was computed as follows:

$$M = 20\% \text{ behaviour } + 30\% \text{ rubric } + 40\% \text{ challenges } + 10\% \text{ test}, \tag{5.1}$$

where:

- *behaviour* is a subjective mark where the teacher takes into account the motivation, participation and good behaviour of the pupil in the classroom.
- *rubric* represents the mark that each pupil has auto-assigned through the rubric that filled out after each session about her own participation, focusing and team-working. The rubric is shown in Table 5.1.
- *challenge* is the number of exercises completed during the four sessions. This mark is the same for all members within the group.
- *test* is the mark of a little exam about some basic robotics concepts, such as identifying sensors or programming blocs. This test was carried out using Kahoot! [Gam12].

	Name 1	Name 2	Name 3	Name 4
Participated actively in group work				
Maintained focus on the task				
Took care of material and tidied up at the end				
Used English (foreign language) for communication				
Provided positive feedback to other group members				
Total score				
Always or most of the time:3 Sometimes:2 Never or hardly never:1				

Table 5.1: Rubric for auto-evaluation

5.1.3 Data analysis

The results of the investigation are presented below.

Table 5.2 shows the final marks mean obtained by each group.

	Group A	Group B	Group C
Marks	7.6	7.1	8.3

Table 5.2: Marks of the students

Moreover, Table 5.3 shows the number of challenges solved by teams. The results are also presented in percentage because the number of teams varies depending on the class.

	Group A		Group B		Group C	
0-2	0	0%	0	0%	0	0%
3	0	0%	1	14.29%	0	0%
4	1	14.29%	0	0%	0	0%
5	2	28.57%	1	14.29%	1	12.5%
6	0	0%	2	28.57%	1	12.5%
7	1	14.29%	1	14.29%	0	0%
8	1	14.29%	1	14.29%	3	37.5%
9	2	28.57%	1	14.29%	2	25%
10	0	0%	0	0%	1	12.5%

Table 5.3: Frequency of the number of challenges solved

Additionally, Figure 5.1 shows the evolution of the marks average for each group.

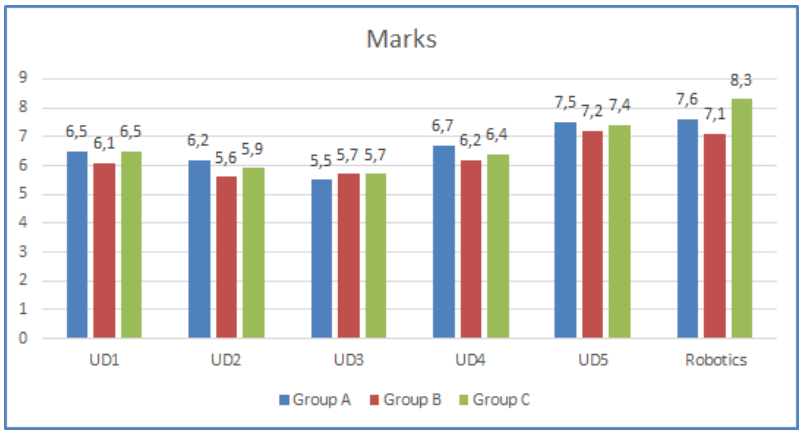


Figure 5.1: Evolution of the marks average

5.2 Findings and Discussion

Does using a board game as a teaching tool in a introductory lesson increment students' motivation? Motivation in education mark have been widely studied from a huge variety of aspects, for example auto-efficiency [Ban97], expectation and value of work [WE00] or the auto-concept [GMB03].

One of the most widely used models for quantifying motivation is the expectation-value model [WE00]. This model argues that election, persistence and human performance can be explained through auto-efficiency, i.e. the capability perception of carrying out a task.

Although this model is extensively used, it was not used in this study. The persistence, teamworking, focusing and responsibility were assessed using the rubric showed in Table 5.1.

The auto-efficiency was better assessed in the group who played the game in the previous session, group C.

In part, marks were better in group C because the subjective mark was higher and also because they solved more challenges than the other groups. This may be caused because they were more motivated or because they usually get better marks.

In Figure 5.1 can be seen the evolution of marks along the year for each group. In general, the three groups have similar means but just comparing the attitude while programming, the difference was manifest: they were more focused and they work harder.

– Our whole life is solving puzzles.

Erno Rubik

6
Conclusions and Future Work

This chapter summarizes the Master Thesis, discusses its findings and contributions, points out limitations of the current work, and also outlines directions for future research.

Some existing proposals that use board games as a teaching tool has been studied throughout this Master Thesis. Although there exist many studies about this topic, there is a huge lack of proposals applied to technological topics in Compulsory Secondary Education. They are specially focused on teaching a second language.

In this dissertation, some existing board games have been contextualized in technological didactics, remarking for which curricular contents could be suitable and which competencies fulfil. There have been presented also some games that can be easily adapted to teach technology.

Despite the search and research of games that may be used as a teaching tool for Technology, it has been impossible to find any game to teach some curricular concepts. To make up for this lack, a game named Techno in Co. has been designed and presented in this dissertation. Even so a deeper research should be carried out in order to complete the list for all curricular concepts.

Although Techno in Co. could not be tested in class, an activity using it has been presented in this Master Thesis. In the future, this game may be further developed, tested in a real context and evaluated as a methodological tool.

However, in this dissertation a case of study is presented. The board game RoboRally was used in a real scenario with students of 3 ESO and this experience was compared to two other classes, where they had the same lesson plan as the former class, except for the game session. This activity is analysed and the results show that the students, which had this extra session were more focused and motivated. The methodology and evaluation for this experience should be further tested and improved in the future.

Acronyms

BGG Board game geek. 1

ESO Educació secundària obligatòria (Compulsory Secondary Education). 5

GBL Game-based learning. 1

RPG Role-playing games. 1

List of Board Games

[Gar94] Richard Garfield. Robo Rally, 1994.
https://boardgamegeek.com/boardgame/18/robo-rally (Last accessed June 2016).

[Her10] Frédéric Herny. Timeline: Inventions, 2010.
https://boardgamegeek.com/boardgame/85256/timeline-inventions (Last accessed June 2016).

[Ran99] Alex Randolph. Ricochet Robots, 1999.
https://boardgamegeek.com/boardgame/51/ricochet-robots (Last accessed June 2016).

[Sar99] Peter Sarrett. Time's Up!, 1999.
https://boardgamegeek.com/boardgame/1353/times (Last accessed June 2016).

[Unc81] Uncredited. Trivial Pursuit, 1981.
https://boardgamegeek.com/boardgame/2952/trivial-pursuit (Last accessed June 2016).

[Unc84] Uncredited. Eat poop You cat, 1984.
https://boardgamegeek.com/boardgame/30618/eat-poop-you-cat (Last accessed June 2016).

[Unc88] Uncredited. Scattergories, 1988.
https://boardgamegeek.com/boardgame/2381/scattergories (Last accessed June 2016).

[Unc93] Uncredited. Party & Co., 1993.
https://boardgamegeek.com/boardgame/13972/party-co (Last accessed June 2016).

Bibliography and Webography

[And15] Elizabeth Anderson. Teenagers spend 27 hours a week online: how internet use has ballooned in the last decade, May 2015. Retrieved from The Telegraph, http://goo.gl/xS1dwe (Last accessed June 2016).

[Ban97] A. Bandura. *Self-efficacy: The exercise of control*. Freeman, 1997.

[BGG] Board game geek (bgg). https://boardgamegeek.com/.

[BNOK07] D. Burgos, C. v. Nimwegen, H. v. Oostendorp, and R. Koper. Game-based learning and the role of feedback. A case of study. *Advanced Technology for Learning*, 4, 2007.

[FK06] W. M. Florence and Alvin C. M. Kwan. Online vocabulary games as a tool for teaching and learning English vocabulary. *Media innovations in education: input and outcome in the new society*, 43(3):233–249, 2006.

[Gam12] Computer Games. Kahoot!, 2012. https://getkahoot.com/ (Last accessed June 2016).

[Gau99] Hyacinth Gaudart. Games as Teaching Tools for Teaching English to Speakers of Other Languages. *Simulation gaming*, 30(3):283–291, 1999.

[Gen15a] Generalitat de Catalunya. Currículum educació secundària obligatòria. Technical report, Departament d'Educació, 2015. Retrieved from Gencat, http://goo.gl/LS8DZc (Last accessed June 2016).

[Gen15b] Generalitat de Catalunya, Departament d'Ensenyament. Competències bàsiques de l'àmbit cientificotecnològic, 2015. Retrieved from Gencat, http://goo.gl/sEjDNU (Last accessed June 2016).

[GMB03] F. Guay, H. W. Marsh, and M. Boivin. Academic self-concept and academic achievement: Developmental perspectives on their causal ordering. *Journal of Educational Psychology*, 95(1):124–136, 2003.

[Gua14] The Guardian. Board games' golden age: sociable, brilliant and driven by the internet, 2014. Retrieved from The Guardian, https://goo.gl/V7wFeK (Last accessed June 2016).

[HS11] M. Hamada and S. Sato. A Game-based Learning system for theory of Computation using Lego NXT Robot. *Procedia Computer Science*, 4:1944–1959, 2011.

[Jav13] Javier. Building a Trivia game. https://goo.gl/C1uEmV (Last accessed June 2016), 2013.

[Kap12] K. M. Kapp. *The Gamification of Learning and Instruction: game-based methods and strategies for training and education*. John Wiley & Sons, 2012.

[Pos14] Rachel Post. Game on: could gamification help business change behaviour?, 2014. Retrieved from The Guardian, http://goo.gl/XJ7LRq (Last accessed June 2016).

[Pre01] M. Prensky. *Digital game based learning*. McGraw Hill, 2001. pp. 05-1.

[Scr11] Jim Scrivener. *Learning Teaching*. Macmillan Books for teachers, 2011.

[TL98] M. M. Tanner and T. M. Lindquist. Using Monopoly and team-games-tournaments in accounting education: A cooperative learning teaching resource. *Accounting Education*, 7(2):139–162, 1998.

[Wak15] Jane Wakefield. Children spend six hours or more a day on screens, March 2015. Retrieved from BBC news,http://goo.gl/s0zSe0 (Last accessed June 2016).

[WE00] Allan Wigfield and Jacquelynne S. Eccles. Expectancy–value theory of achievement motivation. *Contemporary Educational Psychology*, 25(1):68 – 81, 2000.