Gustavo Moreira Kares

Fun to Learn

Using *Hello World()* videogame to motivate children in learning code

Bachelor of Culture and Arts

Game Design

2021

South-Eastern Finland
University of Applied Sciences

South-Eastern Finland University of Applied Sciences

Author (authors)	Degree title	Time
Gustavo Moreira Kares	Bachelor of Culture and Arts	November 2021

Thesis title

51 pages
10 pages of appendices

Fun to Learn
Using *Hello World()* video game to motivate children in learning code

Commissioned by

XAMK Game studios

Supervisors
Suvi Pylvänen

Abstract

The videogame industry has grown rapidly in the last years to lead the entertainment industry. In addition, considering how engaging videogames are, they have become tools for a variety of means, even in the educational context. However, the engagement found in entertainment games might not be successfully executed when it comes to learning games. This study aimed to understand learning games to design Hello World (), a learning game for Langinkosken Koulu (elementary school in Kotka).

The research analyzes the motivational factors from both the psychological and the game design perspectives. The theoretical foundations were established through an extensive literature review, questionnaires with the target audience, and two interviews with professionals. In this first part, the research defined learning games, how learning occurs and how to apply fun in the process.

The second part of this thesis explained how Hello World() applied the findings into the game design. The core mechanics were supported by the foundations established prior, and different features were designed to enhance the experience of the audience.

Hello World() succeed in parts. However, the project would need more time to iterate on the findings and implement its final version.

Keywords

game design, design process, player motivation, flow, self-determination theory, psychology of games, learning game, motivation, theory of fun

Acknowledgements

First, I would like to express my profound gratitude to my supervisor lecturer Suvi Pylvänen, who is also an inspiring model for my career. Thank you so much for the help, for advising me, for your kind words. You cannot imagine how your feedback was important for keeping me motivated, and how your knowledge guided keeping me calm. I am proud of what I could achieve, and I could not have done it without your help. I extend my gratitude to also the game design teaching staff.

In addition, I want to thank Maarit Vahvanen and Jani Ruotsalainen for the opportunity given in the internship which originated this study. I have learned so much and I could grow up as a person. Thank you for the trust, thank you for your promptitude in helping, and thank you for your time when I needed it. In addition, I owe my gratitude to Ph.D. Lauri Järvilehto, which I had the pleasure to interview and listen directly to his insights on learning games.

I also want to take the opportunity to thank my wife and my best friend, Elina Moreira Kares, who supported me through the process. Thank you for listening to me talking about my learnings, thank you for being on my side on my highs and my lows, and of course, thank you for the help with the Finnish language challenges.

Finally, but not least important, I would like to thank my internship colleagues and development team Aki Koivula, Arseenii Panov, Chae-Won Hong, Eric Littell, Hai Ha, Ida Rask, Laura Malinen, Miia Jeskanen, Roni Rissanen, Sirumilla Kotilainen, and Ville Tamminen. You guys are amazing, and we achieved so much with the development. Thank you, also Marcos Paulo, for our insightful conversations, for taking your time for the interview, and for being a great friend. I am thankful for my family, friends, and everyone who helped me directly or indirectly with this journey.

CONTENTS

1 INTRODUCTION

In recent years, with the rapid changes in society technologically, along with the demand for improving the educational process, new technologies and media formats have been used to support education. Video games have a high potential as learning tools, providing dynamic and interactive content (Torrent et al 2014). Games are an unquestionable phenomenon across the globe, and fun is normally the adjective attached to it. However, the concept of fun is personal and a hard metric. Additionally, when it comes to learning games, the perception might diverge from fun. The field of learning games is stagnated, and the games face a challenge to integrate the learn substances in their core (Järvilehto 2021).

Since 2016, coding is mandatory in the Finnish national curriculum for primary education. The implementation of the subject is embedded in the system as part of Math, and in other subjects as a so-called transversal competence. To follow the curriculum and develop logical thinking for the children, schools typically opt to use games, especially for 1st and 2nd graders. (Pallaskallio 2019.)

In the spring 2021 teachers from Kymenlaakso approached XAMK Game Studios to develop a game to teach code for 2nd up to 6th graders. The author of this thesis was in an internship as an Educational Leader from May to November of the same year. Twelve other selected students compose the team in charge to develop the project named *Hello World()*.

This thesis aims to understand the motivational factors for learning through games from both the psychological and the game design points of view. In the first part of the thesis, the theoretical foundations are established for what defines an educational game and how learning occurs. The second part discusses how *Hello World()* applied those foundations into the game design process of the project.

2 RESEARCH SETTING

This study describes the decisions behind the design process of the *Hello World()* game. The game is a commissioned project designed to engage Finnish students aged 8 to 12 from schools from the Kotka region. This wide audience, with different skills levels and in different stages of cognitive development, is the main factor that switched the project goal from teaching coding to motivating students in learning to code (more details in section 6.2). When mind mapping the topic (Figure 1), motivation appeared to be a central point for the study.

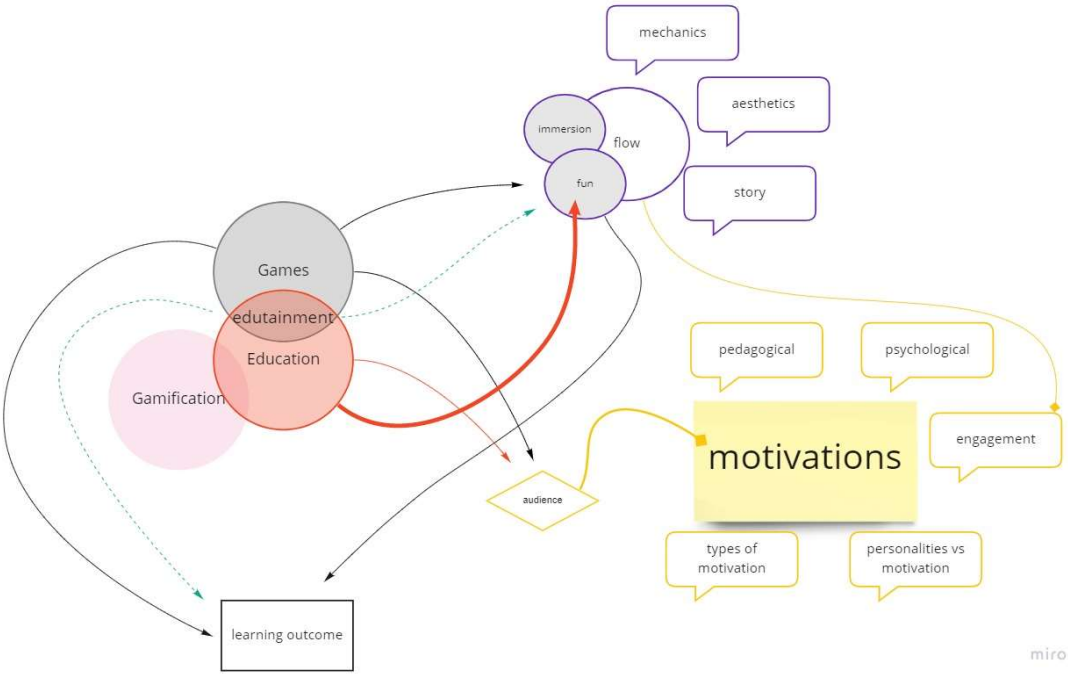


Figure 1. Mind map for the study (Moreira Kares 2021)

Motivation is often a key factor ignored in learning. In traditional “learning”, if the subject is too hard, little is done to rescue the learner from that position and that will demotivated the learner to learn. (Kellinger 2017.) Learning finds more success when a child feels motivated and engaged in the process. (Hirsh-Pasek et all 2009; Järvilehto 2014).

2.1 Research questions

As the client's brief to the development team was to design a game that would teach coding for children, at first the primary question for the research was "*How to teach coding to children aged 8 up to 12?"*. Nonetheless, the wide audience for the project was perceived at first as a problem when defining the target group. In a macro perspective, biased by a day-to-day way of speaking, one might see no difference between an 8-year-old child from a 12-year-old one, or a 9-year-old either. However, as childhood is marked by rapid changes, to divide children into a group by age is impossible. Some might master an ability earlier than others, with wide variation-based factors making every child develop in their way (Fisher 2015).

Considering the rapid changes, on top of the possible differences in the development of children, a myriad of factors would have to be taken into consideration in the design process. However, a theory called Self-Determination Theory (SDT) proposed by Richard Ryan and Edward Deci (Ryan & Deci 2000), claims that there are three universal needs of the human psyche. When those three needs are satisfied, a human can achieve a state of motivation and happiness.

The Self-Determination Theory brought a new perspective for the design, therefore, for the research. As the needs described in the theory were universal, *Hello World()* would focus on those needs and would be designed to motivate students in learning to code. There are a variety of motivation theories that relate to games, such as the Quantic Foundry model (Yee 2016), also known as player's motivation. Finally, the study of those theories shaped the primary research question for this thesis, which is: ***How to design a learning game to motivate children aged 8 to 12 in the learning process?***

The side questions ***How do players perceive learning games?*** and ***How can this perception influence the Fun factor in the game?*** were originated based on the Autonomy need mentioned in the Self-Determination Theory. If the player

is possibly biased against a game labeled as educational, and “forced” to play a game (removing partially the Autonomy from the equation) could the bias affect the experience or motivation while playing the game?

2.2 Research methods

The research methods are two-fold. The first part of the research aims to understand the theoretical foundations of motivation, fun, and learning and how they are related. This is done through literature review and supported by interviews of two professionals in the field of learning games. The first interviewee is Marcos Paulo Rodrigues Lopes. Lopes is the CEO of Gaz Games Artes, a Brazilian company focused in develop edutainment. With 10 years of experience in the industry, Lopes has developed over 20 games used for training and education purposes and had insights into what worked and what did not work for those projects. The second interview is with Ph.D. Lauri Järvilehto. Järvilehto has an extensive curriculum in academia and the game industry. He has written several non-fiction bestseller books in Finland, including the book *Learning as Fun* used in this research. Additionally, he is the founder of Filosofian Akatemia (a research company on well-being and education), he has worked with Rovio (Finnish game company developer of *Angry Birds*[1] (2009)) and he is the co-founder of Lightneer (Finnish game company nowadays focused on mobile games but funded as a learning game company).

The second part of the research relates to the target group in order to understand what motivates the children aged 8 to 12 when they play games. During the design process benchmarking was selected to understand the game mechanics possibilities. Benchmarking itself was supported by Harris profile (Harris 1961). Additionally, a questionnaire was done with one 7 and another 11-year-old children. Subsequently, a questionnaire for the students of Langinkosken Koulu was prepared to be answered before the playtesting session. Finally, a third

[1] Angry Birds (2009) is a casual puzzle game evolving physics to launch birds to destroy the enemies. The enemies are normally covered by a structure made of different materials such as cement or wood. The player can destroy the structure in different ways to get high scores.

questionnaire for the same students was prepared to be answered after the project playtesting session.

Although this is project-based research, the literature review was yet a key research method. The review, when properly applied as a research method, can help to evaluate theories of certain areas and validate the accuracy of certain theories (Snyder 2019). The educational nature of *Hello World()* claimed for validation in its pedagogical aspects. Furthermore, the pedagogical aspects could become a risk for the project. The literature review helped ascertain whether other research has addressed and their possible solutions (Leedy 2019).

In addition, the author of this thesis had previous experiences developing learning games. The author also taught coding and game development to teenagers. Considering those facts, the author was seeking a new perspective on the topic to avoid being biased because of mentioned experiences. A preliminary literature review helped to determine the relevance of the topic and it also helped to get a new perspective (Leedy 2019).

3 GAME-BASED LEARNING

When talking about games, the most familiar type for one might be an entertainment game, games that one might play in day-to-day activities. Entertainment game is a commercial product for joy only, where the purpose is to entertain the player. Even though the learning with those games might occur, learning is not the intended goal in those cases but an incident (Boller & Kapp 2017). In this type of game, the educational aspects might not be aside, but it takes a minor role (Fisher 2015).

Games can help to develop certain skills by offering a challenge to be solved. That is the reason why many games designed for entertainment, e.g., *Minecraft*[2] *(2011),* are often used in schools. For a game to be labeled as educational the

[2] Minecraft (2011) is a sandbox 3d world made basically with cubes. Players have a nearly infinite world where is possible to craft tools, craft items, build and explore.

design should consider specifically the learning process. While using the game, the player will be exposed to a concept and then practice it. (Fisher 2015.)

Combining play with pedagogy is not something new. Children are natural learners. Through playing and through their curiosity, they absorb a lot of information (Dirksen 2012). The young of all species play in order to learn a new skill. Lion's cubs will play with each other as a practice of hunting when they become adults (Koster 2005). As a matter of fact, even learning with games is not something new. In ancient China, the game *Go*[3] was used as a tool to develop strategic thinking, especially in a military context (Jin & Low 2011).

According to Lopes (2021), there might not be a better way to learn than playing video games in the information age. In addition to teaching children at school (what might be the first thought related to learning games), games can also be used for training (serious games and simulations) or to help people engage in a new behavior (gamification) (Lopes 2021). Järvilehto (2014) discloses that the learning process has been gamified and gamification is one way to "put a learning game together".

3.1 Serious games, gamification, and nomenclatures

The UX consultant and psychologist Celia Hodent (2018) reinforces what Lopes (2021) pointed out with the possibilities of learning games. Hodent (2018) states that sometimes the label educational is under the use of *gamification*, or *serious games* for example. Hodent (2018) goes beyond and states that gamification and serious games often rely on extrinsic motivation, with rewards and such for an activity, conditioning the act of doing an activity to getting the reward. If the reward stops, the activity is very likely to stop as well. In fact, extrinsic rewards can backfire and demotivate. (Dirksen 2012.)

[3] Go is an ancient Chinese board game. Two players (white stone player & black stone player) taking turns to fight for board control either moving their stones or placing a new one. The game is complex and strategic.

Serious games, sometimes called instructional games, are games where the design intention is to help players in assessing new information or skill (Boller & Kapp 2017). Serious games often will use elements of fantasy, but they can be simulation games as well. Lopes (2021) exemplifies a serious game as simulation with a project where the client wanted to use a simulation for training because the real-life training would be much more expensive and riskier for their employees. The project itself used gamification elements to engage the player and differ the activity from the real-life job.

Gamification is a relatively new trend and is yet to be defined for the industry according to Lopes (2021). The process of transforming “boring” content into a full videogame sometimes is called gamification. Yet according to Lopes (2021), gamification overlaps with serious games definition and does not bring the whole idea of it especially when it is used in a non-digital context. The most acceptable definition for gamification is the use of game elements in a system, but not the creation of the entire game (Boller & Kapp 2017). For example, a customer loyalty program to collect points can be perceived as gamification and yet does not fit into a game definition. Lopes (2021) suggests englobing all definitions into one, as edutainment. Edutainment represents any media, games included, that promotes learning in a fun manner (Tang et all. 2009). In fact, to draw a clear line, and to define the boundary between games and their classification such as in Figure 2, may be hard and even a question of perspective (Martens & Müller 2017).

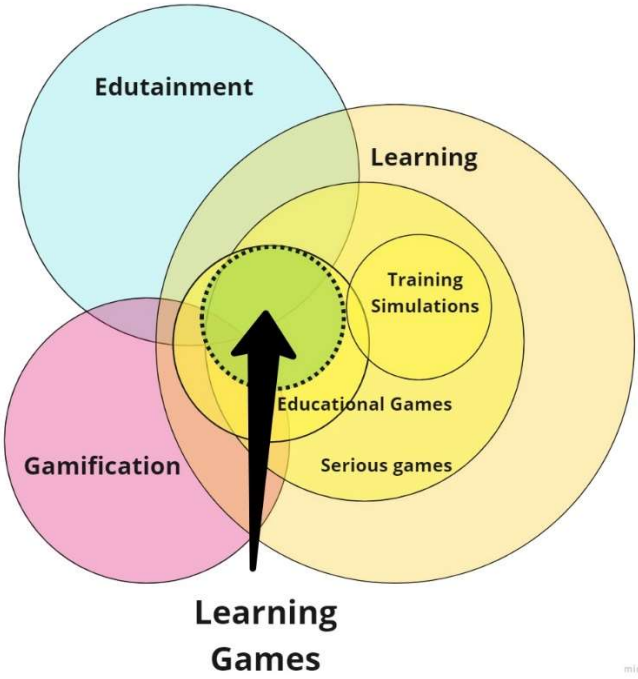


Figure 2. The different nomenclatures (adapted from Tang et al. 2009)

For Hodent (2018), however, serious games and gamification are an inexact use of the label *educational* whether either the product is not truly educational or not fun, or both. Hodent (2018) yet exemplifies stating that to add “cute” animated graphics on math does not turn it into something fun, neither focusing on rewards such as badges. Education, or educational, is about transferring what one learned to other domains. There is no certification process to be “educational” in the current state of the industry, no measurement of the transfer of skill from a game to the target context. The majority of the so-called “educational games” often rely on old pedagogical methodologies that can do more harm than good. (Hodent 2018.) Järvilehto (2021) reinforces saying “there are products out there that they claim to have a pedagogical impact, but they actually don’t”. Furthermore, there is a movement that started around 2010 from avoiding talking about educational (system-centric) and talking more about learning (learner centric). Learning is the ideal outcome of the educational system, but it does not always arise from there. As a matter of fact, for quite a substantial amount of people, the system creates just frustrating and stressful experiences. (Järvilehto 2021.)

3.2 Teaching versus Testing

Education-centric is, for example, the idea of teaching concepts in a linear fashion assuming that everybody will learn at the same pace. “As long as the teacher has taught arithmetic, we think it is a successful operation in learning”. (Järvilehto 2021.) Often, some games will just test what the players already know with a pretty art as its first layer (Lopes 2021), and those are “testing games” (Kapp et al. 2014), also called the “broccoli and chocolate” approach (Kellinger 2017).

Innumerous learning games will use “broccoli and chocolate”. Broccoli represents the information that is passed to the player, while chocolate represents a short video game that the player can play, after passing through the probation that they mastered the knowledge, usually assessed with a quiz. The problem is that those *games* have the learning part unrelated to the overall game structure, becoming more like an interactive quiz. Learning should be embedded in the game context. (Kellinger 2017.)

When the game is separated from the learning content, it does not create the same sense of engagement, and connection as something like *Angry Birds* (2009). A successful learning game, first of all, needs to be a great game, and have to create a sense of engagement, and finally, the game needs to be about the subject to learn. (Järvilehto 2021.)

Notwithstanding, Lopes (2021) alerts that sometimes those practices, “broccoli and chocolate” and “interactive quiz”, are what a client wants in the project. Arguments can be presented but the client has the final word. In a project currently in development, Lopes (2021) describes a situation where the quiz was forced into the project for a teacher to validate if the players are actually learning.

3.3 Different Types of Learning

Lopes (2021) pointed out that a game designer is also a teaching designer. The main job of a game designer is to teach the player how the game works without overloading the player. Although, when it comes to learning games, it is important that the game designer understand a bit of psychology, pedagogical practices, and actual scientific research behind how people learn (Järvilehto 2021).

In addition, Lopes (2021) mentioned the different types of learning (Visual, Auditory, and Kinesthetic, aka VAK) and how games cover most of them, suggesting that is one of the reasons why games are efficient in education. Yet, it is important to accentuate that there is little to no scientific evidence about learning styles as the assumptions cannot be proved and/or measured (Dirksen 2012).

At its core, the learning styles idea addresses the individual process in learning, that not everyone will learn in the same way. Additionally, there is a suggestion to adapt the learning method depending on the subject. To teach about car mechanics, for example, audiobooks should not be the single approach (Dirksen 2012). Part of teaching is to match the content individually according to the student's needs, interests, prior knowledge, and learning styles (Fisher 2015).

The learning pyramid (Figure 3), also known as "the learning cone", as Lopes (2021) points out, illustrates an overall efficiency in different approaches for knowledge retention. Moreover, the pyramid (Figure 3) is also used to classify learning into active learning and passive learning.

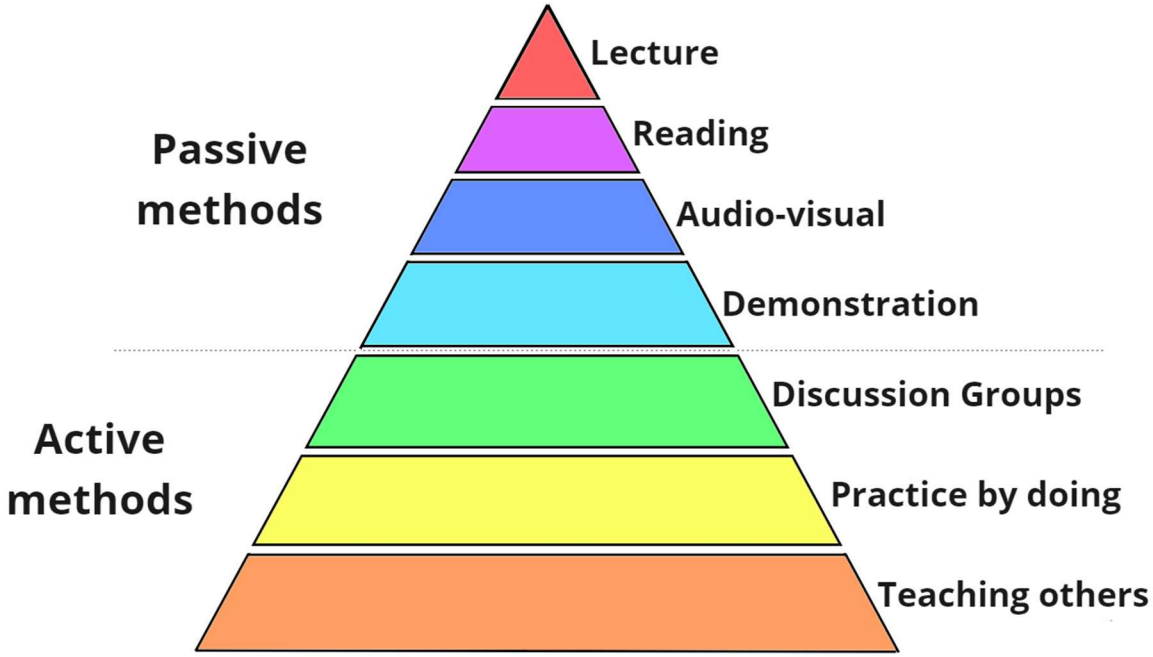


Figure 3. The Learning Cone of experience (adapted from Dale 1969)

However, it is important to acknowledge that recent studies have shown that the widely used model has no empirical evidence to support it. Despite the model being modified and modernized, the model fails to keep up with the current standards of cognitive psychology. Yet, the idea of experience-based learning (active methods) is still fresh and modern. (Letrud & Hernes 2018.)

A video game is an active method, the player learns by doing. Active learning is the ideal model of modern learning, where the role of the teacher is to facilitate and support the learning process (Järvilehto 2014). Hodent (2018) points out that in an approach where the learner has a meaningful context and actively constructs the knowledge (called the constructionist approach), the learner is more likely to transfer the knowledge. Learning is about transferring knowledge.

Another common way to classify types of learning and the transfer knowledge process is Bloom's Taxonomy. Bloom's taxonomy was developed by a committee at the University of Chicago with the idea of three domains to cover learning objectives (Kapp et al. 2014). The three domains are the cognitive domain, the affective domain, and the psychomotor domain. In this research, only the

cognitive domain will be acknowledged, due to scope constraints. In Figure 4, the taxonomies for the cognitive domain are enlisted with its definition.

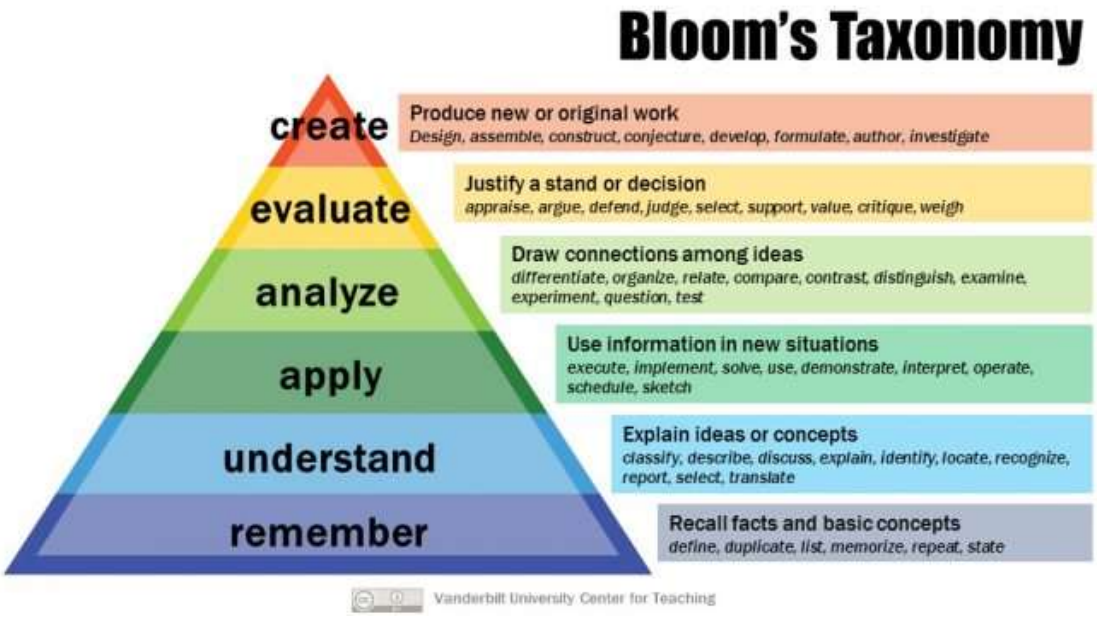


Figure 4. Bloom's Taxonomy (Armstrong 2010)

Game activities can also be correlated with the list in the cognitive domain and its associated verbs as in Table 1 (Kapp et al. 2014).

Table 1. Bloom's cognitive domain and associated verbs (Kapp et al. 2014)

Bloom's taxonomy	Associated verbs	Sample game activities
Creating	Assemble, Construct, Create, Design, Develop, Formulate, Write, Generate, Plan, Produce	Building, building your own game
Evaluating	Appraise, Argue, Defend, Judge, Select, Support, Value, Evaluate, Critiquing, Checking	Strategy
Analyzing	Compare, Contrast, Differentiate, Discriminate, Distinguish, Examine,	Allocating resources

	Experiment, Question, Organize, Attribute	
Applying	Demonstrate, Dramatize, Employ, Illustrate, Operate, Schedule, Sketch, Solve, Use, Execute, Implement	Role playing
Understanding	Classify, identify locate, recognize, report, select, interpret, exemplify, summarize, intercompare, explain	Puzzle solving, exploring
Remembering	Define, Duplicate, List, Memorize, Recall, Repeat, Recognize	Matching, collecting

Note that *remembering* is the base of the pyramid, and is exactly what the previously discussed “testing games” and “broccoli and chocolate” approaches tend to fit in. For *Hello World()* design, a mix of genres and mechanics were chosen to use more “verbs” therefore approaching the pyramid as a whole (section 6.1).

Hodent (2018) explains that video games give a meaningful and playful context, leading educators to use options like *Minecraft* (2011). Yet according to Hodent (2018), *Minecraft* (2011) offers possibilities for the learner/player to explore and build their selves any object or shape, and for the teacher offers a wide range of learning goals. A context is offered, then the player can make connections and understand how the elements interact with each other, to finally understand the system not isolated but as a whole (Kellinger 2017).

Alongside *Minecraft* (2011), games as *Dance Dance Revolution* [4](2009) are educational or beneficial in nontraditional ways. Those games foster STEAM

[4] Dance Dance Revolution (2009) is a series of dancing video game as the name suggest. Arrows appear on the screen according to the music beat, and players follow the arrows stepping into a

(Science, Technology, Engineering, Arts, and Math) (Fisher 2015). STEAM education is about encouraging the learner, especially children, to seek answers through a scientific process. The scientific process is about curiosity, which leads to a discovery, which leads to hypothesis formation to finally leading to testing that hypothesis. Children need to develop the desire to find out the answer on their own (Fisher 2015). STEAM can encourage such behavior, although, as Hodent (2018) points out, there is no behavior without motivation.

3.4 Motivation in Learning

When discussing gamification earlier, extrinsic motivation is briefly mentioned. To deepen, extrinsic motivation is to execute A purely to obtain a reward B. Opposingly there is the intrinsic motivation, which is to execute A purely for the pleasure of doing it. The extrinsic motivation was and still is embedded in the learning with conditioning or instrumental learning. Instrumental learning is an efficient way to learn through punishments and rewards systems (Hodent 2018).

As stated in section 3.1, the problem with rewards in extrinsic motivation is that they do not hold the motivation for long. On the other side, punishments, used in instrumental learning, can induce stress and/or aggression (Hodent 2018). In a learning environment like a classroom, a student's mistake yet can result in a lower grade as punishment, and often that is interpreted by the learner as a judgment from the teacher towards them. The tool (grade) that is made for feedback backfires the system discouraging students in use it (Gee 2003).

Video games, however, more often than not become a playground for trials and errors. Some video games even can encourage mistakes through humorous interactions. The mistakes are seen as an opportunity to learn. Video games, often, encourage the player to test their hypothesis in order to discover the answer (Kellinger 2017), as proposed with STEAM education as well. That is called the "Psychosocial Moratorium Principle". The principle applies when the

---

platform specially designed for the game. The platform has nine buttons: a central button surrounded by its eight cardinal directions.

learner is in a space where real-world consequences are lowered, and risks can be taken (Gee 2003).

Placed in a “fantasy” world, the players have the freedom they need to make mistakes, as Lopes (2021) suggests. Fantasy in particular is another key factor to enhance motivation. When the fantasy is interesting, the content itself becomes interesting, especially when the fantasy is embedded with the learning content (Choi & Baek 2013). Fantasy allows players to perform a safe testing on their skills and knowledge, and even understand how their input interacts in different contexts. Beyond, Fantasy when combined with challenge and curiosity can enhance intrinsic motivation (Kapp et al. 2014).

Especially in children, fantasy is used to assimilate an experience with minimal effort, without the demands from the real world (Piaget 1951). Fantasy is a natural answer in young species to facilitate the learning process, like lion’s cubs playing (Koster 2005). Through fantasy and play children assimilate reality, experiment, explore, and learn (Hodent 2018). Small children especially are natural learners, absorbing a substantial amount of information out in the environment purely through playing and by their curiosity (Dirksen 2012). Humans are curious, inquisitive, and playful animals, eager to learn and explore (Ryan & Deci 2000).

One way in which fantasy can be delivered is through stories. Stories and analogies are powerful tools for teaching (Järvilehto 2014). Stories are sequential, and a logical sequence of events provides organization for the learner. A story also has characters with personalities and conflicts making it more memorable. (Dirksen 2012.) Finally, if a story explains a concept with something familiar to a person, it makes it easier to attach the new information into the semantic network already existent in the learner’s brain. For example, Schrodinger instead of using complex quantum physics terminologies explained his theory with a story of a cat in a box. (Järvilehto 2014.) This phenomenon occurs because when a piece of information is stored in the brain, it will interact

with other information. The brain is constantly reorganizing and rearranging the information. (Dirksen 2012.)

Additionally, whenever a story starts, one is presented with questions that can catch their attention. The questions can vary from “What is the point of this story?” or predictions such as “Will this be like that other story where character X will do Y as well?”. The story creates suspense and is not supposed to be boring. Whenever a story starts, the assumption is that that is going to be interesting and fun. (Dirksen 2012.)

4 GAME DESIGN AND THEORIES OF FUN

There is no recipe for fun. Fun is a vague term; people have a different perspective of what they think is fun. Using a term such as “engagement”, referring to the ability of the game to be engaging, can help the development team better break down the concept. Nonetheless, psychology can help to understand how the brain works and what makes a game *fun*. (Hodent 2018.)

4.1 Engagement and Flow

To keep the player engaged, there are two major issues to avoid: the game needs to offer the *right* amount of challenge, neither too easy nor too hard, and the challenge should have the *right* pace, not changing too quickly or too slowly (Koster 2005). Offering the *right* amount of challenge can be hard, but the Theory of Flow from Mihaly Csíkszentmihály (1990) offers a better understanding of it.

Csíkszentmihály is a renowned psychologist that coined the term flow, for when the *right* amount of challenge is offered to a person. Flow in Csíkszentmihály’s (1990) eyes is a state of immersion that raises when a person is engaged in an activity. When a person enters this state, the person is intrinsically motivated to the activity to a point that nothing else seems to matter and this person just wants to do such activity only for their own sake. The theory is illustrated in Figure 5.

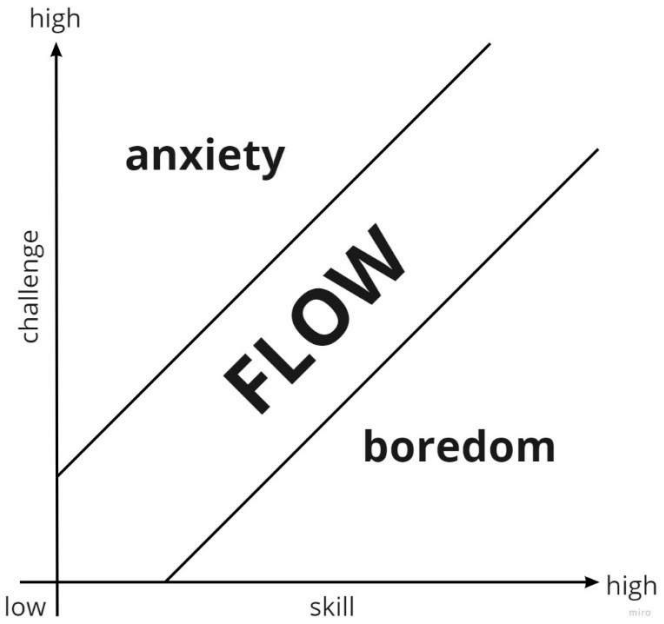


Figure 5. The Flow (adapted from Csikszentmihalyi 1990)

In the flow theory, if the level of skill is higher than the challenge, this causes boredom. Opposing to that, when the level of challenge is higher than the level of skill, the result is anxiety, which can lead to burnout. In other words, if a game is too easy the player will feel bored, and if a game is too hard the player will most likely stop playing it.

In an educational context, on the one hand, the more an activity resembles the real world, the harder it is for a novice to learn the system as the cognitive load would be too high. On the other hand, the less fidelity the activity has with the real world, the harder it is for the learner to transfer their learning to the real world. To learn optimally one needs to stay in the flow. (Kellinger 2017.)

Although, it is important to provide something that will demand cognitively speaking, some friction in the material. When one is in a situation that confronts their assumptions and they must actively reorganize their misconceptions, that will arguably help them to learn. (Dirksen 2012.)

4.2 The Fun, The Brain and The Learning

To some extent, all the games teach the player something. A game is a problem to solve. To solve the problem while playing a game, the brain will try to understand and/or recognize a pattern. The fun arises out of mastery and comprehension of such a pattern. (Koster 2005.)

The enjoyment, or fun, in the biological point of view, is when the brain releases the group of hormones called endorphins. The release can be done through aesthetic appreciation or physical stimuli for example. When a person learns something new or masters a task, the human brain will release endorphins into the system. Therefore, fun itself is the act of learning something new. (Koster 2005.)

Along with endorphins, other hormones as dopamine have their role in understanding the relationship between *fun* and *learning*. As a matter of fact, neuroscience and psychology had shown how emotions and mood influence the ability to solve creative problems among other issues. (Anderson 2011.)

In the flow theory, Csíkszentmihály (1990) used anxiety to describe a challenge higher than a skill. In fact, what happens in the brain when the level of anxiety is high is that the anxiety induces an alert and focused state on the brain, and that is achieved by releasing norepinephrine in the system (Anderson 2011).

Additionally, in a pleasant and or rewarding situation, the human brain wants to induce interest, achieved by releasing dopamine in the system. However, with a high level of dopamine released, focusing becomes a harder task (Anderson 2011).

The journey through the flow would be achieved by dosing the anxiety level to release a little norepinephrine and inducing the brain to focus. While learning, endorphin is released. Finally, the rewarding after the challenge is dopamine. Fun is the whole process, the cognitive process to convert fear into happiness through

surprise. Initially, the learner can feel anxious and confused, then with some discovery that helps the challenge, the learner will feel happy, as illustrated in Figure 6 (Hoffman 2015).

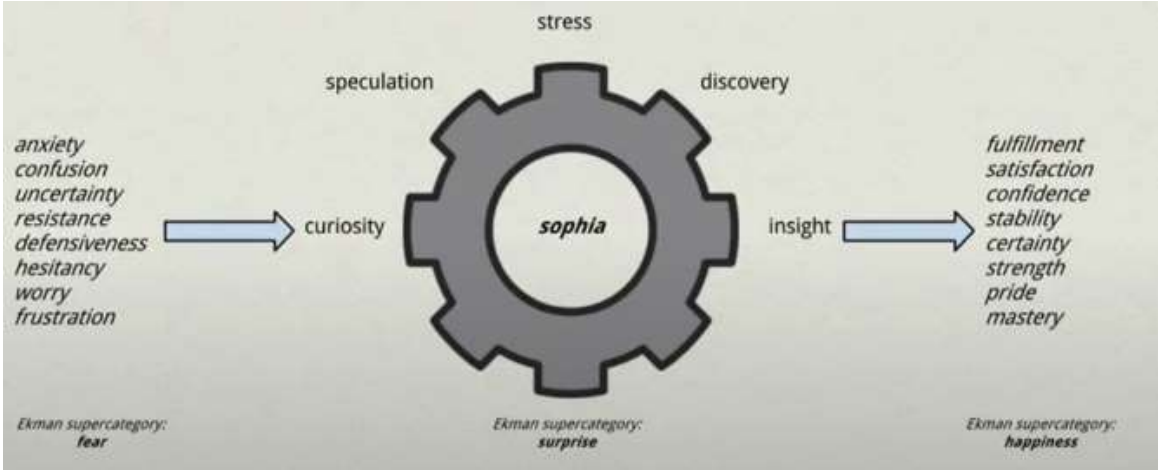


Figure 6. Conversion of fear into fun (Hoffman 2015)

Emotion, as a matter of fact, can affect the level of attention given to an activity. Motivation also affects the level of attention. The more one person is motivated to do an activity, the more attention this person will give to such activity to finally retain the information more efficiently. The level of attention and emotion evolved in the process has a direct impact on the quality of knowledge that is being acquired. (Hodent 2018.)

When the level of attention is high, the information will go from sensory memory to short-term memory. Sensory memory is the memory that filters everything one perceives and senses. Short-term memory holds the ideas long enough to act. Most things will be discarded when in short-term memory, but some will pass to long-term memory. Finally, long-term memory is where the information is properly stored. (Dirksen 2012.) Additionally, as discussed before with the story and fantasy, when a person is interested in the subject to be learned, the information will be connected easily with previously existing information. Engagement is a key factor in generating new memories. (Järvilehto 2014.)

4.3 Self-Determination Theory

Designers can encourage a desirable user behavior; in other words, they can motivate the user. That can be achieved by focusing on core intrinsic motivations innate to humans. (Anderson 2011.) “Self-determination theory” (SDT) is the predominant theory behind intrinsic motivation (Hodent 2018). When an activity satisfies a person’s needs for competence, autonomy, and relatedness, this person will be internally driven to do it (Ryan & Deci 2000).

Intrinsically motivated students will learn a lot on their own. If a student is motivated to learn, regardless of his experience and the quality of the experience, the student will learn. On the other hand, if a student knows what to do but chooses not to do it, they are unmotivated and will be a challenge even if exposed to the best learning experience. (Dirksen 2012.) When designing for intrinsic motivation the three elements, autonomy, competence, and relatedness, should be considered (Kapp et all. 2014).

Autonomy

Autonomy can influence behavior and performance, having a significant impact on productivity and wellbeing (Pink 2009). Overly controlled students, for example, will face problems in learning when the learning is complex, conceptual, or evolves creative processing (Ryan & Deci 2000). Control opposes autonomy and leads to passivity and conformity, while autonomy leads to engagement (Pink 2009).

Autonomy however can be misinterpreted as independence. Independence can be perceived as a culture of individualism. Autonomy is to act according to one’s own choice (Pink 2009), to have a sense of control and choices (Kapp et all. 2014), a form of self-expression as well as an ability to make meaningful choices (Hodent 2018). To feel autonomous means to feel that one’s actions will have a direct impact on one’s own life (Järvilehto 2014).

Competence

Competence, also called mastery, is the bridge that connects Csíkszentmihály's (1990) Flow's theory and Self-determination theory. The desire to master an activity is driven by the relation between the feedback and the goal on Flow (Pink 2009). It is important for the learner to feel confident in their skill level to accomplish a goal, to feel that the path is clear and that they are capable of overcoming it (Kapp et all. 2014). It does not mean that the path has to be easy. On the contrary, the sense of mastery is directly correlated with the amount of effort put into an activity (Järvilehto 2014).

As mentioned before, a little bit of friction is needed (Dirksen 2012). Players can fail, die, and make mistakes a few times in a section, as long they can understand what happened and how to improve to make progress. Sense of progression is one of the main pillars of intrinsic motivation. (Hodent 2018.)

Relatedness

Relatedness is the need for humans to relate themselves with other humans. The need goes beyond relatedness. Humans want to feel that they belong to a group (belongingness), they have an emotional need to give and to receive the attention of the group, whether is a group of friends, family, or co-workers. (Pink 2009.)

Humans are social. Either through competition or cooperation, games can enhance the relatedness aspect (Hodent 2018). If on the one hand competition is a social mechanism; on the other hand, not everyone is competitive. Direct competition can demotivate people. (Dirksen 2012.)

Relatedness is crucial in the learning process as one of the most efficient ways to learn is to share knowledge (Järvilehto 2014). Additionally, when someone is interacting with another person, or if one believes that on the other side is a live person (in the case of fantasy settings), they pay more attention, and therefore they learn more (Dirksen 2012).

4.4 Player's Motivation Models

Socializing can be perceived as a player motivation alongside many other factors as explained by Yee (2016). Nick Yee is a co-founder of Quantic Foundry, a market research company focused on gamer motivation. Yee (2016) alongside his co-workers, did a factor analysis through an extensive literature review about motivation (whether called players taxonomies, models of fun, or player's motivation) to propose a new model. In the proposal model, 12 unique motivations were found and paired with their correlations. There are 6 pairs of motivations separated into 3 clusters as illustrated in Figure 7.

Action "Boom!"	Social "Let's Play"	Mastery "Let Me Think"	Achievement "I Want More"	Immersion "Once Upon a Time"	Creativity "What If?"
Destruction	Competition	Challenge	Completion	Fantasy	Design
Excitement	Community	Strategy	Power	Story	Discovery

Figure 7. Quantic Foundry's motivation clusters (Yee 2019)

Yee (2019) points out that the model fills in a negative space in the industry. The negative space refers to the bias existent in the gaming industry. The bias is driven by the idea of a hardcore audience and where a high score in a motivation X is perceived as more valuable. To say, if a player scores high in Strategy, that would be perceived as the player wants more strategy games. Opposing to that, low scores in Strategy would be perceived as a non-hardcore player. Yee (2019) yet explains indicators such as Myers-Briggs suggests a rather binary accommodation of personality, whether a person is either extrovert or introvert, for example. In reality, the distribution of the population falls into a bell curve. An illustration comparing both distributions is illustrated in Figure 8.

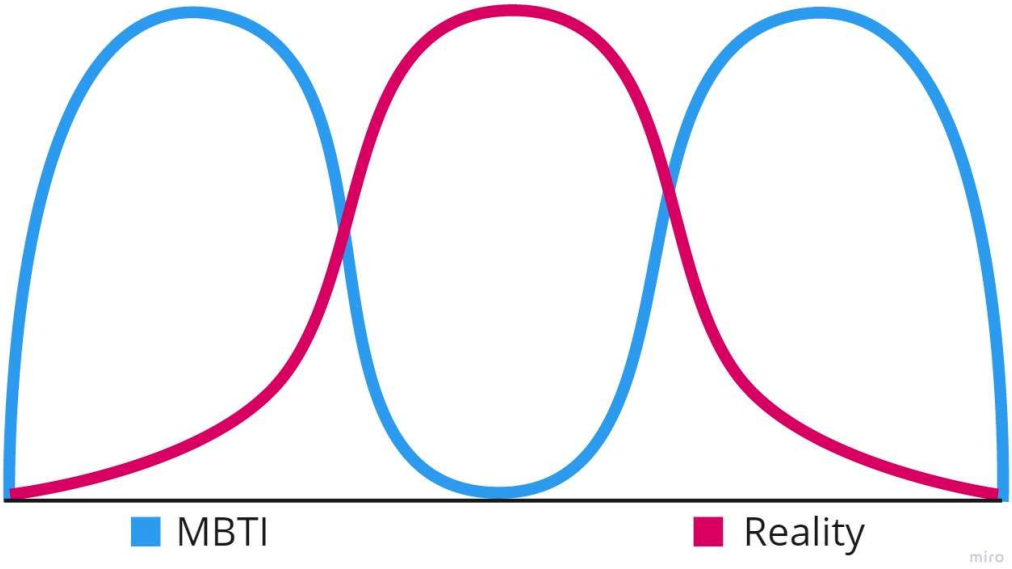


Figure 8. Distribution of a population according to Myers-Briggs Type Indicator (MBTI) (in blue) versus the real distribution (in red) (adapted from Yee 2019)

In the Quantic Foundry model, each of the 12 unique motivations accommodates a spectrum with low-end and high-end. In addition, the model addresses that people with a low-end score are not lesser than people with a high-end score (Yee 2019). While designing the personas for *Hello World()* the Quantic Foundry model was taken into consideration.

5 DEFINING THE PROJECT

On the 10th of May 2021, under XAMK Game Studios supervision, the author of this thesis and 11 other students started in the internship that originated *Hello World()*. The author was enlisted as an Educational Lead/Level Designer. Although, due to the lack of a figure leading the game design position, the author assumed the role after talking with the team. Originally, the project would be running until the second week of August. Due to the attention given to other projects running in parallel with *Hello World()*, the development team discussed with the commissioner a possible extension of the deadline. A new agreement was done where after mid-August the team would keep on working on a prototype until December. In December, the state of the project would be checked to come to a new decision regarding its future. By the time this report is being done, *Hello World()* is still under development.

In the first brainstorm session of the project, the development team considered to making a game similar to *Baba is You* (2019) and here discussed in section 5.3. However, the decision was done purely to meet the first deadline and was not considering the target audience. The team decided to hold the project and to research more about the audience preferences. In parallel, a benchmarking on learning material was agreed to be done in order to understand what is already in the market to teach coding.

5.1 Benchmarking

Due to the educational aspects of the project, the benchmarking of *Hello World()* consisted of two categories. The first category is for entertainment games with different mechanics. The second category is for edutainment and similar materials on coding for children. Three main factors were considered while selecting materials for the second category of benchmarking mentioned above:

I. The material should not fit into the “broccoli and chocolate” approach.
II. The material should offer entertainment as a big share of the content.
III. The material should have been already used for teaching in some context.

Teachers from Langinkosken Koulu indicated *Dragon Box Algebra* (2013) and *Hello Ruby: Adventures in Coding* (Liukas 2015) as a starting point. *Scratch* (2007) was added to the list, finally with *Baba is You* (2019) and *while True: Learn()* (2018). The latest additions were also used during the questionnaires with the children for comparison purposes. Harris profile methodology was applied in those materials to evaluate their relevance (Appendix 1).

The elements of evaluation were:

- *Interactivity*: how much interaction is there.
- *Content*: how much programming is there.
- *Accessibility*: how easy is to use it.
- *Availability*: how easy is it for the children to access the material.
- *Uniqueness*: how much the material differs from other similar.

- *Story*: how much of story and how easy to connect with the story is it.
- *Gameplay*: how engaging is the gameplay.
- *Extra activities*: how much extra the material offers.
- *Relevance*: how much relevance is the material for the project and children.

Note that all those materials contributed somehow to the course of this project. The nomenclature of material was chosen to facilitate the comparison of a book to a video game for example. Due to the scope constraints for this report, only *Hello Ruby: Adventures in Coding*, will be detailed in the benchmarking.

Hello Ruby: Adventures in Coding

Hello Ruby: Adventures in Coding is a book that simplifies programming for children. *Hello Ruby* was written originally in Finnish by Linda Liukas (2015). With a successful methodology, the book was translated into several languages, including English (version used in the research).

The book is separated into two parts, story and activity. When separating the story from the activities, Liukas (2015) makes the learning explicit. Lessons learned and to be learned should be highlighted to anchor the experience as a generator of discussion points (Kapp 2012).

Liukas (2015) seems to instigate the curiosity of the audience by using easter eggs (hidden messages) and a few concepts during the story. For example, in one episode in the story, Liukas (2015) uses a relatively complex loop/if statement as part of the story: “If the hole is empty, drop in one carrot seed. If there’s already a seed, move on. Keep going until hit the end of the row, then move to the next row. Repeat the whole thing five times.”. The episode can be easily adapted to a programming language as C# for example. (Figure 9).

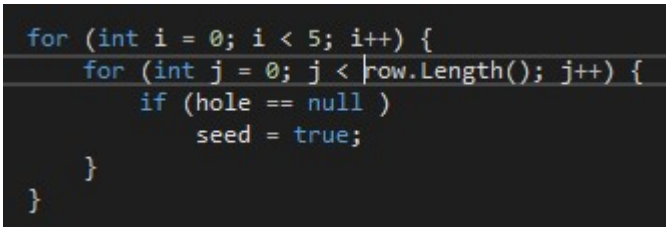


Figure 9. Piece of story from *Hello Ruby* (Liukas 2015) adapted to the language script C# (Moreira Kares 2021)

If Liukas (2015) stopped the story to break down the episode into code and explained the concepts of a loop, array, variables, and conditionals, a part of breaking the immersion, the children could easily feel overwhelmed by the information. By just contextualizing the programming in the story, Liukas (2015) leaves a breadcrumb trail to the final explanation. Breadcrumb trail is about leaving tips (breadcrumbs) guiding the learner to the desired direction and is also about instigating one's curiosity.

Additionally, the book uses easter eggs, to complement the breadcrumb trail in the learning. Characters such as the protagonist itself Ruby, Python, Snow Leopard, and penguins, are references to the programming world: Ruby and Python are programming languages, and Snow Leopard and penguins are references to operational systems. The book also counts with a list of activities and exercises to develop skills used in programming and to explain key concepts such as loops and functions.

5.2 Target Audience: the Development of Children aged 8 to 12

According to the ISFE (2020) statistics, young girls that play video games are three times more likely to pursue a career in Science, Technology, Engineering, and Math (STEM) than girls that do not play. A majority of children starting at the age of 8 and older play video games occasionally at least. Such phenomenon is partially explained by the fact that they want to exercise their independence, therefore exercise their choice of the media they consume. From 7 up to 9-year-old, children start to mature and want to express their own opinions through their preferences. Educational games will be competing with entertainment games, and there are significantly more entertainment games. (Fisher 2015.)

After the age of 9, the so-called “tweens”, will normally stop consuming “children’s” media, like “children’s” programming to be replaced by casual and family programming. This also happens with their game choices. Games based on TV shows that are familiar to them and games based on new IP are the preferrable types to be played. Learning games take a hard hit and are very unlikely to be played on their own. (Fisher 2015.) Additionally, Järvilehto (2021) mentioned how his children would naturally gravitate towards entertainment games and would only play learning games if no more options were presented to them. Important to mention that such observation from Järvilehto (2021) came from a non-scientific perspective as he pointed out.

Motivation, however, plays a big role in what to consume. In general, children have a significant number of things competing for their attention, and if they do not like an activity or encounter a problem early, they will put it down. If the activity fits something familiar, such as their favorite character, they will *stay* longer (Fisher 2015).

The preference for entertainment games also appeared during the discussions with the target audience for *Hello World()* (discussed in Section 5.3), and for that reason, during the design process of *Hello World()*, the fun factor/content is placed above the Learning factor/content. Lopes (2021) points out a similar approach for the latest learning game being developed by Gaz Games. Lopes (2021) states that the intended design is focusing on motivating students to play the game because the game is fun, rather than students playing the game because they have to do it.

5.3 First Questionnaire

Concerning a deep understanding of the target audience, the questionnaire was prepared to be done within the school. The questionnaire is prepared with a narrative behind it (Appendix 2) in order to generate interest in the respondent. As presented in section 3.4, a story can be a powerful tool to catch one’s

attention, and the questionnaire was perceived as an opportunity to apply the theory. The team tested the questionnaire with 2 children, aged 7 and 11, finding success with the feedback. Both children felt, in their words, “important” while answering it.

The questionnaire consisted of 18 questions. Respondents were asked about video games, school, and their hobbies. Regarding video games, the questions aimed to map what video games were popular among the age. Additionally, respondents were asked to explain a reason why they like the video game of their preference. The school-related questions aimed to understand the preferences towards the school subjects. Finally, the questions related to their hobbies it is irrelevant for this study but were made for a different project run by the same team. The questionnaire is a mix of open-ended (9) and closed-ended (9) questions, being 12 questions of mandatory answers.

Ideally, the questionnaire was to be answered by students from 2nd grade until 6th graders from Langinkosken Koulu. However, the release of the questionnaire concurred with the school holidays after a delayed research permission. However, the commissioner provided five lists from different classrooms where the students enlisted their favorite games. The data previously collected while testing the questionnaire was then decided to be final data due to the project deadline. Additionally, the data would be combined with the list of games the development team had available.

The list was proven to be extremely valuable. Through the games played was possible to extract information such as the main platform used to play. Combining the list of all the video games mentioned in the questionnaire with the list provided by the commissioner, in total there are 57 different titles. Those 57 titles were organized into categories according to their fit into the Quantic Foundry model (2016). The titles seemed to have a strong appeal towards social.

When organizing the titles through game genre, none of the games were categorized as a puzzle. The analysis was crucial and became the base

argument to move the project away from the idea to the game similar to *Baba is You* (2019).

Another interesting finding is regarding the PEGI system. 63% of the games (36) were rated PEGI 12. Which is not proportional to the age of the audience, as many of the games came from 3rd and 4th graders answers. That reinforces the arguments presented in section 5.2 regarding children aged 9+ moving away from children's media. Regarding the 2 answers for the questionnaire, those answers shaped the creation of the personas (Appendix 3).

6 FUN AND MOTIVATION OF *HELLO WORLD()* GAME

One of the biggest challenges for the project as mentioned before was the design to accommodate a wide spectrum of audiences. A wide audience does not refer exclusively to the age difference, but also different skill levels. Frequently a learning design is expected to accommodate different levels of learners. For one that is being first introduced to a concept, the learning experience needs to give a lot of guidance, a careful introduction, show achievable goals, and gradually increase the difficulty. For a student already consider an "expert", the learning experience might evolve specific concepts and a particular route. (Dirksen 2012.)

A low entrance barrier and a high ceiling were some of the first factors to be considered when designing *Hello World()*. The learner should have access to the information whenever they need it, independent of their skill level. Multiple ways to make progress should be presented in such a way that the learner can rely on their strength to solve a problem (Gee 2003).

Additionally, reflecting on what is presented before in section 3.3 regarding STEAM, the team had clear that the game should be about planning and testing the plan. Learning is a cycle: the learner reflects, forms a hypothesis, tests the hypothesis, and then reflects according to the hypothesis (Gee 2003).

Finally, when a game session is too long, learners might find it hard to focus. A short and focused timeframe should improve retention. Furthermore, the game should avoid cognitive overload by avoiding complexity. Finally, the game should consider that the learner might encounter difficulties therefore the game should include tips and hints to help the learner progress. (Boller & Kapp 2017.)

6.1 Game Loop Breakdown

Hello World() is at its core to be a tower defense game. However, different mechanics were incorporated into the genre to reflect on the cognitive domain associated verbs of Bloom's taxonomy as listed in Table 1. Even though tower defense did not appear in the list of games discussed in section 5.3, the choice fits into the factors discussed above, especially regarding time for development.

The genre of tower defense on its own, with its basic mechanics, naturally converges to the Evaluating in Bloom's taxonomy presented in Table 1. Evaluating is attached to the verb Defend and to the game activities Strategy. In a tower defense, players will defend a path or base with their strategy.

Another feature commonly used in tower defenses is to "program" what the towers will primarily target while attacking. The options are normally limited with the position of the enemies and/or strength of enemies. In Figure 10 the option is highlighted from the game *Bloons TD 6* (2018) in which is possible to select First enemy, Last enemy, Strongest enemy, or Weakest enemy.

Figure 10. Screenshot of the target selection for towers in Bloons TD 6 (Bloons TD 6 2018)

Hello World() expands on this feature allowing the player to “program” the tower behavior as “programming” a simplified line of code (the feature is illustrated in Figure 11). The player can combine resources to cast powerful spells against the enemies. Allocating resources appears in Table 1 attached to Analyzing taxonomy.

Figure 11. *Hello World()* tower's programming wireframe (Moreira Kares 2021)

There are four primary resources in *Hello World()*. One of the resources is the basic currency of the game to build and upgrade towers. The other resources, called *Nature*, *Fire*, and *Ice*, have a similar relation to *Rock-Paper-Scissor*[5]. *Nature* is strong against *Fire*, *Fire* is strong against *Ice*, and *Ice* is strong against *Nature*. The dynamic is applied in enemies, as enemy types, to enhance the strategy of the game, as when programming the spells, the player needs to consider the type of spell and type of enemies.

[5] Rock-Paper-Scissor is an ancient hand game with Chinese origins. Players compete against each other, normally 2, using their hands to gesture their choice among the three that give the game name. Rock loses for Paper; Paper loses for Scissors; Scissors loses for Rock.

When the resources were introduced in the design that created a need for designing a way to collect/generate more resources. The design iterates on the idea to have a moving tower that can be programmed to collect resources instead of attacking enemies. This tower, called Collector in *Hello World()*, can be programmed to walk in the virtual world in the four directions (left, right, up/north, down/south) and to collect the resources available on the map (illustrated in Figure 12). The feature reflects on the taxonomy called Remembering, with the associated game activity Collecting.

Figure 12. *Hello World()* collector wireframe (Moreira Kares 2021)

Note that the nomenclature *tower* refers to the mechanic, not to a building. As a matter of fact, in *Hello World()*, towers are characters as in Figure 12. The decision was done reflecting the fantasy and story importance discussed in section 3.4. The character with personalities enhances the storytelling and consequently enhances the fantasy.

Finally, the Creating taxonomy (game activity Building; verb attached Create/Construct) is partially covered in the core of tower defenses as well. The player has options in what tower to build and freedom when placing the tower.

The taxonomy Applying, regarding Role playing, can be correlated with fantasy. In addition, three attached verbs of Applying (Solve, Execute, and Implement) are correlated with the agency in the game. The core loop of the game can be defined as:

I. to Examine (verb attached to Analyzing)
II. to Plan and Create (verbs attached to Creating)
III. to Implement (verb attached to Applying)
IV. to Evaluate (verb attached to Evaluating)
V. to Interpret (verb attached to Understanding)
VI. to Repeat (verb attached to Remembering)

With the core loop defined, smaller features were design to enhance and support the experience. Two of those designed features are worth highlighting. First, *Hello World()* uses breadcrumbs in a similar way discussed while benchmarking Hello Ruby (Liukas 2015). Some of the *Hello World()* breadcrumbs are:

I. The name *Hello World()* itself comes from the first line of code which is normally taught for novice programmers.
II. Titles of levels and screens, such as Settings, end with “()” as a reference to Functions/Methods in programming.
III. In the Settings screen, the type of Variable is left on the side of the controls as shown in Figure 13.

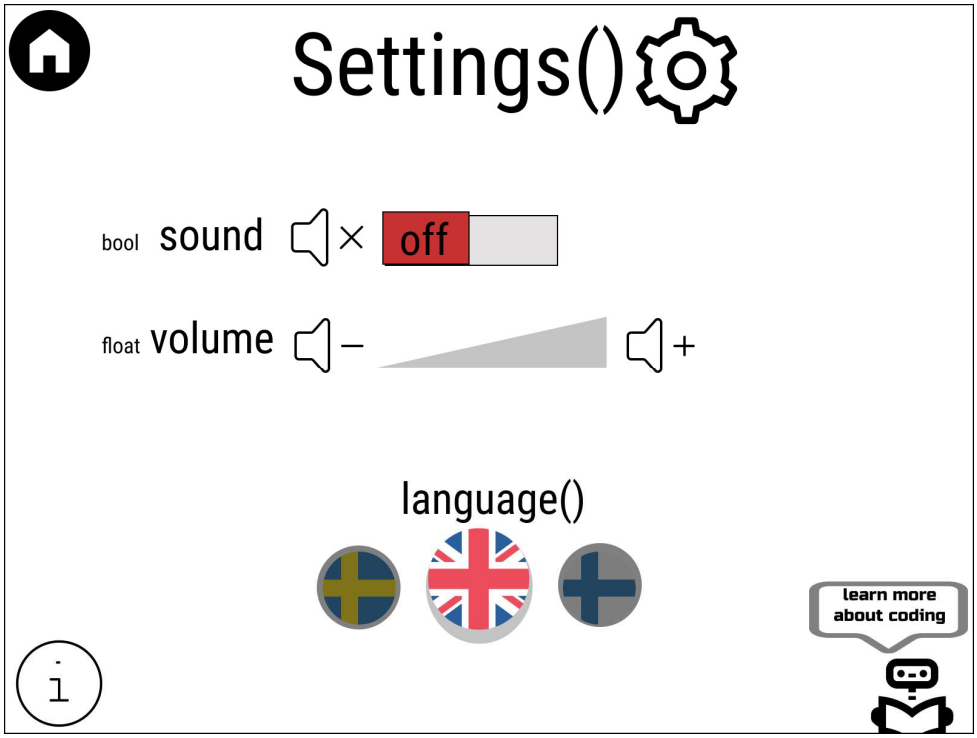


Figure 13. *Hello World()* settings wireframe (Moreira Kares 2021*)*

The last feature – metagame – became a system on its own and will be discussed in the following section.

6.2 Meta Game: *Hello Universe*()

If initially Hello World should accommodate the different levels of learners, the same should apply to the different levels of players. Some questions appeared while designing regarding non-gamers. *What about a learner that does not like games? How would this learner interact with Hello World()? How to make the experience pleasant for non-gamers?* A non-gamer enters in the negative space of motivation/players profile mentioned by Yee (2016) and should not be ignored.

When designing a solution for non-gamers, the team considered a previous concept given by the commissioner where the students of Langinkosken Koulu would draw characters and art assets for the project. At first, this concept was perceived as unachievable as for the team to manage over 200 drawn with different style would be a hard task, therefore, would complicate the design

process substantially. However, iterating on the idea, a viable solution was found and incorporated into *Hello World()* as a metagame called *Hello Universe()*.

The concept of *Hello Universe()* is to expand the story of *Hello World()* together with the players and community. Monthly, a challenge will be released for players to draw a future asset for the game. The instructions for drawing are presented as a piece of code (Figure 14).

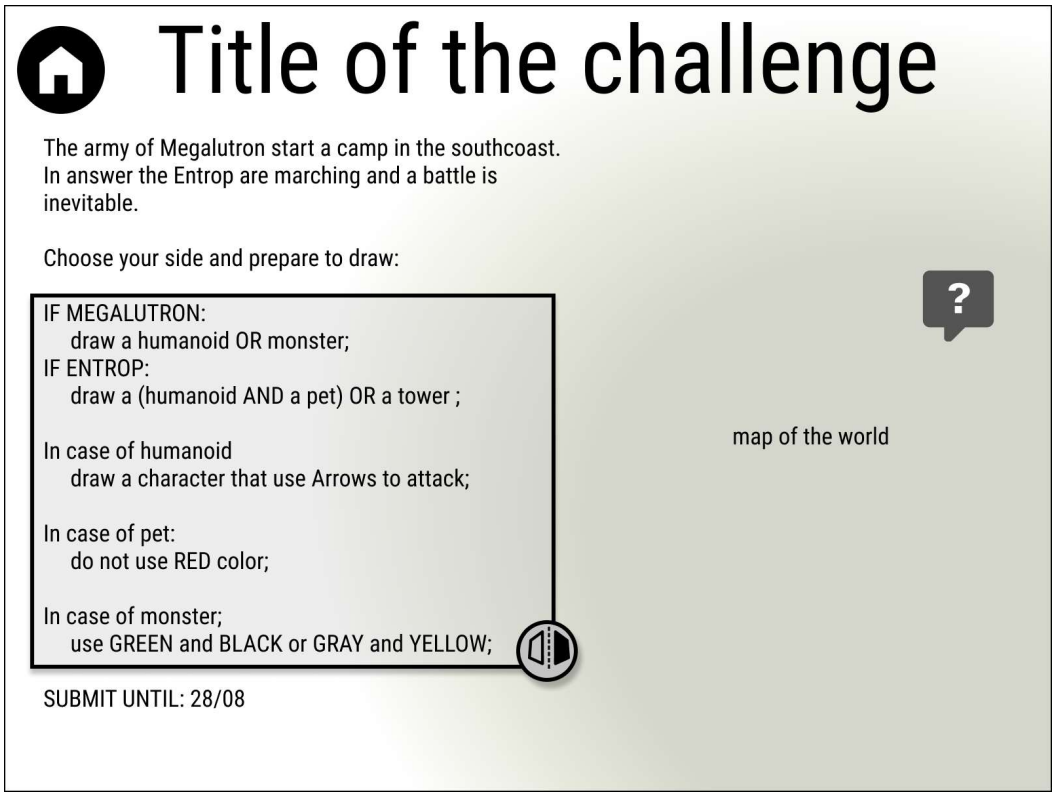


Figure 14. *Hello Universe()* challenge instructions wireframe (Moreira Kares 2021)

Players can submit their drawing for the contest. Students and players will vote, and the winner of the contest will have the drawing given to the artist from the development team to be adapted for a future asset. Note that the design also iterates on the idea of *Hello World()* becoming a lifelong product where future XAMK interns will maintain it. The *Hello Universe()* also brings one last component missing in *Hello World()* which is the social aspect. Additionally, *Hello Universe()* will avoid direct conflict between contestants and will favor concepts generated in groups. These measures aim to lower the competition aspects

reflecting on the competition and extrinsic motivations problems discussed in section 4.3.

6.3 Questionnaire

Once *Hello World()* core was well structured in a prototype, a playtesting with one class of the school was organized. In order to have a base metric for comparison, a questionnaire was prepared to be answered before the testing session (Appendix 4). This second questionnaire consisted of 16 questions of which nine consisted open-ended. The questionnaire aimed also to validate the previous data for the personas (Appendix 3) having six of the questions similar to the first questionnaire. Respondents were asked again about video games of their preference and to open their thoughts to explain their choice. The follow-up question asked students about fun games. The idea was to compare favorite versus funniest and correlate them to explore in deep the concept of fun for the students.

A total of 13 students were present in the class and were able to answer the questionnaire. The first question asked three of their favorite games, and there were 28 unique answers. From this new list of games, only two were new compared with the before list from the commissioner.

When asked about fun games and the reasons behind them, sandbox games appeared in 12 out of 13 answers. The word freedom appeared seven times in total. The word story appeared only one time in the answers.

The 13 students were from the class Robotics and Coding. Possible contamination of the results will be discussed in section 7. As expected, when asking the interested in coding, the answers had a mean value of 2.54 and a modal value of 3. Nonetheless, at the end of the questionnaire, the students were asked if they feel engaged in learning, and the mean value drop to 2.23 and a modal value of 2.

Two videos from different games were shown during the questionnaire. The official trailer for *Baba is You* (2019) and for *While True: Learn()* (2018) were selected as they have already a PEGI rating of 7+ and would present no harm for the students. The students were asked to open their thoughts about the games and their interest in playing them. For *Baba is You* (2019) 11 out of 13 answers are classifying the game as either fun or interesting. For *While True: Learn()* (2018) it dropped significantly to only 3 answers. As a matter of fact, for *While True: Learn()* (2018) the most common answers are using “confusing” to describe the game, appearing 8 times. These findings can be explained by the core of the games, while *Baba is You* (2019) uses basic concepts of programming, *While True: Learn()* (2018) is made with pure and complex concepts of machine learning.

Finally, one last finding was regarding previous experience with learning games. All the 13 students had played before a learning game. When it comes to rating their experience, the mean value stands at 1.3 with a modal value of 1, on a scale of 1 to 3. Additionally, when asked to mention the name of the game, 9 of the students answered: “I don’t remember the name”. The learning games did not deliver a memorable experience.

6.4 Playtesting and Test results

After answering the questionnaire, the students had access to the prototype of *Hello World()*. The very same 13 students played the game for 20 minutes. At the beginning of the play session, a member of the development team explained the concept to the students, afterwards they had the freedom to explore the game with the development team ready to answer possible questions but without interfering directly with the student’s experience. The author of this study stayed in the room as an observer. Additionally, the commissioner provided an interpreter/translator due to the lack of confidence of the author in his Finnish skill.

In general, while playing the students seemed to enjoy the game. They were communicative among themselves, comparing their strategies and helping each other when facing something confusing. While observing, one of the students (student A) seemed stressed when opened the game. The author kept observing student A while he was looking at the screen without taking any action. Student B approached Student A and explained the basic mechanics of the game. Suddenly student A shout: “This is awesome!” with Student B answering: “Yes, I never seemed anything like this” – free translation done by the interpreter.

The excitement reflected in the feedback form answered after the playtesting. When asked how interesting the game is, the mean value stands at 2.3, on a scale of 1 to 3, and the modal value stands at 2. The interest is not so ever converted into motivation. The mean value when asking their motivation of studying coding after playing the game stands at 2.15, decreasing in a total of 0.07 when compared with motivation before playing the game. Nonetheless, this can be considered insignificant as the rating system is from 1 to 3 only and the population is too little (13).

Although, two out of the 13 answers, scaled the interest and motivation in 1 out of 3. These students described the game as confusing and “buggy”. One member of the development team during the testing reported that one student found 3 bugs in the prototype, which perhaps reflected in their experience. All other 11 answers were positive descriptions such as good, fun, and nice.

When asking specifically about the least favorite part of the game, the resource collector is pointed as confusing or “tricky” in six of the answers. The lack of a tutorial was also mentioned often during the play session. Is very likely that the resource collector is not a feature that can be understood without any explanation as the rest of the game. Opposingly, for the best feature of the game, there is no consensus. The towers are mentioned twice, and towers upgrades are mentioned once. The majority of the answers, five in total, points to the relation enemy type and resources as fun and interesting mechanics.

Finally, the metagame *Hello Universe()* was not explored nor mentioned in the feedback form. This is an unexpected outcome. However, this can be explained by the short time of the play session (20 minutes). In addition, the feature is mainly designed for non-gamers and/or students with no interest in coding as discussed in section 6.2. This is not the case when the 13 students reported playing videogames weekly. Alongside, the class was Robotics and Coding, therefore, they were motivated somehow in learning to code.

7 RELIABILITY OF RESEARCH

This thesis is a commissioned project, and the author was directly involved with the development of *Hello World()* therefore the conclusion might be biased. However, this thesis relies strongly on literature review as a pillar for the whole research. All the sources were meticulously selected, through the author's or book's name, based on their own reliability in the gaming industry. Additionally, all the studies mentioned and used were taken from the primary source, except for the learning pyramid (illustrated in Figure 3). The learning pyramid, as discussed in section 3, has no empirical evidence. Although, the model is widely used for educators and yet holds its value for the system. Nonetheless, the author of the thesis yet might be biased with previous experiences teaching coding and developing games.

Regarding the testing session, it was done only with the Robotics and Coding fall class from Langinkosken Koulu, therefore, the students were already motivated in learning to code. Alongside, during the questionnaire, the question about their level of motivation is asked to rate on a scale from 1 to 3. The scale is too small and could have had impacted the results if the motivation was perceived with a bigger variation. Finally, even though the questionnaire was answered anonymously, the presence of the author in the room of the playtesting could have contaminated the answers. However, the author does not speak Finnish, and the level of direct interaction with the participants were zero to null.

8 CONCLUSIONS AND DISCUSSION

This study aimed to understand how to consider players' motivation during the design process of a learning game. A substantial amount of important information was found during the research, helping to shape *Hello World()* design, and answering partially the primary question *How to design a learning game to motivate children aged 8 to 12 in the learning process?.*

Regarding *Hello World()*, the project can be considered, in part, successful. The prototype appeared to generate interest in the children, motivating them to learn. During the playtesting the players were excited about the game, asking questions and discussing in groups about the game mechanics. Although, the questionnaire after testing could not support such observation as expected prior. As discussed before, the scale for rating is short (1 to 3), consequently any slight variation seemed insignificant. In summary, even though the motivation mean value decreased 0.07, the children's behavior and comments while playing supports the success. To answer the primary question, the understanding of the difference between extrinsic and intrinsic motivation, and how that affects the behavior was crucial for *Hello World()* development.

In addition, two topics attracted attention during the research to finally drive a construction of a hypothesis. For a successful learning game, the hypothesis lays on fantasy and feedback. Fantasy should be considered as a metaphor meaningful for the learner (proposed term *contextual fantasy*). For example, instead of teaching the concept of variables for programming, a game should use a strong metaphor as creating a space in order to use a skill. *Magic:The Gathering*[6] (1993) for example, where you need mana to play a card, calling mana as variable and card as function is potentially an engaging metaphor for teaching programming in the author's opinion.

[6] Magic: The Gathering (1993) is a collectible card game. There are different card types, such as creatures and mana. In order to use a non-mana card, players need to spend their mana to do it.

Additionally, Feedback is crucial in the flow (Csíkszentmihály 1990) and for motivation (Kapp et all. 2014; Hodent 2018), therefore crucial for learning. Feedback is what videogames excel on, with sound effects, visual particles, score, and level for example. Although, in learning games, the feedback seems to be centered towards the learning outcome and not towards the player. The feedback is what one has learned, which is hard to measure, therefore, hard to see progress. This hypothesis is briefly touched by Järvilehto (2014; 2021), especially during the interview, where Järvilehto (2021) opens up about an archived idea of his own using *Hearthstone* (2014)[7] mechanics in a game to teach about chemical elements.

The feature *Hello Universe(),* however, designed specifically for generating motivation considering different player types, did not seem relevant during the playtesting. Although, it is important to emphasize that the time limits and classroom (Robotics and Coding) might have influenced this outcome.

The second for this study, *How do players perceive learning games*, could be answered. In the questionnaire, when asking about prior experience with learning games the mean value is significantly low (1.3). When asking about the game the most common answer is “I don’t remember”, which drives the conclusion and answer for the second question as players perceive learning games as a “not interesting” game. Assuming their perception is very likely that their expectation towards *Hello World()* was low. In this specific case, it drove their surprise shown through Student A and Student B short dialogue: ”This is awesome!”; “Yes, I never seemed anything like this”. The hypothesis is the students were resistant about their experience, but the feeling could be converted into fun, exactly as illustrated before in Figure 6.

To answer the final question, *How can this perception influence the Fun factor in the game?*, the player perception, when negative, can be used to surprise the

[7] Hearthstone (2014) is a digital collectible card game. Cards have keywords with powers and can be combined with each other in a deck of 30 cards. Decks lean in having a synergy towards specific keywords.

player. Surprise is the second gear to convert fear into fun (Figure 6). As none of the students rated their experience with maximum score, most of their experience can be considered neutral to negative, therefore, the third question could be answered only with such perspective.

The thesis unfolded the learning process and intrinsic motivations in order to better understand the audience and improve the experience of *Hello World()* from the game design point of view. However, during the research, the author understood that motivation is not an aspect that can be isolated by itself. There are other aspects equally relevant and connected to motivation that could be explored in future studies, such as the role of emotions and the role of feedback. The same is valid for the learning process, which can be extended to the cognitive process as a whole. Additionally, it is important to mention that topics as accessibility, especially accessibility for neural disorders, could not be discussed due the time constraints. However, this research provides a short guide to better understand learning games, and it is considered a success in the author's opinion.

REFERENCES

Anderson, S. P. 2011. Seductive Interaction Design: Creating Playful, Fun, and Effective User Experiences. Ebook. California: Poet Painter.

Angry Birds, 2009. Videogame. Rovio.

Baba is You. 2019. Videogame. Hempuli.

Bloons TD 6. 2018. Videogame. Ninja Kiwi.

Boller, S.; Kapp, K. 2017. Play to Learn: Everything You Need to Know About Designing Effective Learning Games. Virginia: ATD Press.

Choi, B. & Baek, Y. 2013. Rethinking Fantasy as a Contributor to Intrinsic Motivation in Digital Gameplay. In Baek, Y. (ed.) Psychology of Gaming. New York: Nova Publishers.

Csíkszentmihály, M. 1990. Flow: The Psychology of Happiness. Ebook. New York: Harper Collins.

Dale, E. 1969. Audio-Visual Methods in Teaching. 3ed. New York: Dryden Press.

Dance Dance Revolution. 2009. Videogame. Konami.

Dirksen, J. 2012. Design for How People Learn. California: New Riders.

Dragon Box Algebra. 2013. Videogame. Kahoot DragonBox AS.

Fisher, C. 2015. Designing games for Children: Developmental, Usability, and Design Considerations for Making Games for Kids. New York: New Riders.

Gee, J. P. 2003. What video games have to teach us about learning and literacy. New York: Palgrave Macmillan.

Harris, J. S. 1961. New Product Profile Chart. Chemical and Engineering News, 17 April, 39(16), pp.110-118.

Hearthstone. 2014. Videogame. Blizzard.

Hirsh-Pasek, K. & Golinkoff, R. M. & Berk, L. E. & Singer, D. 2009. A Mandate for Playful Learning in Preschool: Presenting the Evidence. Oxford University Press.

Hodent, C. 2018. The Gamer's Brain: How Neuroscience and UX Can Impact. New York: CRC Press.

Hoffman, E. 2015. Precision of Emotion: A New Kind of “Fun” Approach in Educational Games. Video online. Available at:

https://www.youtube.com/watch?v=FP-LNRtwpb8&ab_channel=GDC [Accessed 3rd August 2021].

Interactive Software Federation of Europe. 2020. Key facts about Europe's video games sector. WWW document. Available at: https://www.isfe.eu/data-key-facts/key-facts-about-europe-s-video-games-sector/1 [Accessed 27 August 2021].

Järvilehto, L. 2014. Learning as Fun. Rovio visions.

Järvilehto, L. 2021. Professor of Practice. Interview on 14.10.2021. Aalto University.

Jin, P., & Low, R. 2011. Implications of game use for explicit instruction. In S. Tobias & J. D. Fletcher (Eds.), Computer games and instruction. Charlotte, NC: Information Age

Kapp, K. M. & Blair, L. & Mesch, R. 2014. The Gamification of Learning and Instruction Fieldbook. California: Wiley.

Kellinger, J. J. 2017. A Guide to Designing Curricular Games: Advances in Game-Based Learning. Boston: Springer.

Koster, R. 2005. A Theory of Fun for Game Design. Arizona: Paraglyph Press.

Leedy, P. D. 2020. Practical Research: Planning and Design. 12th edition. Colorado: Pearson.

Letrud, K. & Hernes, S. 2018 Excavating the Origins of Learning Pyramid Myths. Online Article. Tailor & Francis Online. Available at: https://www.tandfonline.com/doi/full/10.1080/2331186X.2018.1518638 [Accessed 6th November 2021].

Liukas, L. 2015. Hello Ruby: Adventures in Coding. New York: Feiwel and Friends.

Lopes, M. P. R. 2021. CEO. Interview on 28.09.2021. Gaz Games Artes.

Magic:The Gathering. 1993. Card game. Wizards of The Coast.

Martens, A. & Müller, W. 2017. Gamification. In Nakatsu, R. & Rauterberg, M. & Ciancarini, P. (Eds.) Handbook of Digital Games and Entertainment Technologies. Singapore: Springer.

Minecraft. 2011. Videogame. Mojang Studios.

Pallaskalio, K. 2019. Coding in Finnish curriculum. Codeschool.fi. Available at: https://www.codeschool.fi/2019/04/finnish-curriculum/ [Accessed 5th September 2021].

Pink, D. H. 2009. Drive: The Surprising Truth About What Motivates Us. New York: River Head Books.

Piaget, J. 1951. Play, dreams, and imitation in childhood. New York: Norton.

Ryan, R. M. & Deci, E. L. 2000. Self-Determination Theory and the Facilitation of Intrinsic Motivation, Social Development, and Well-Being.

Snyder, H. 2019. Literature review as a research methodology: An overview and guidelines. In Journal of Business and Research, 104.

Tang, S. & Hannegban, M. & El Rhalibbi, A. 2009. Introduction to Games-Based Learning. In Connolly, T. & Stansfield, M. & Boyle, L. (Eds.) Games-Based Learning Advancements for Muli-Sensory Human Computer Interfaces: Techniques and Effective Practices. New York: IGI Global.

Torrent, J. & del Blanco, A. & Moreno-Ger, P. & Martínez-Ortiz, I. & Fernández-Manjón, B. 2014. Accessible Games and Education: Accessibility Experiences with eAdventure. In Mangiron, C. & Orero, P. & O'Hagan, M. (Eds.) Fun for All: Translation and Accessibility Practices in Video Games. Bern: Peter Lang AG, International Academic Publishers.

Scratch. 2007. Software. MIT.

While True: Learn(). 2018. Videogame. Nival Interactive.

Yee, N. 2016. The Gamer Motivation Profile: Model and Findings. Video online. Available at: https://youtu.be/gDvaBpfsl1A [Accessed 12th October 2021].

Yee, N. 2019. A Deep Dive into the 12 Motivations: Findings from 400,00+ Gamers. Video online. Available at: https://youtu.be/gxJUPfKtg_Q [Accessed 13th October 2021].

LIST OF FIGURES AND TABLES

Harris profile of the learning material for benchmark

Hello Ruby	--	-	+	++
Interactivity				
Content				
Accessibility				
Availability				
Uniqueness				
Story				
Gameplay				
Extra activitities				
Relevance				

Dragon Box Algebra	--	-	+	++
Interactivity				
Content				
Accessibility				
Availability				
Uniqueness				
Story				
Gameplay				
Extra activitities				
Relevance				

Baba is You	--	-	+	++
Interactivity				
Content				
Accessibility				
Availability				
Uniqueness				
Story				
Gameplay				
Extra activitities				
Relevance				

while: True Learn()	--	-	+	++
Interactivity				
Content				
Accessibility				
Availability				
Uniqueness				
Story				
Gameplay				
Extra activitities				
Relevance				

Scratch	--	-	+	++
Interactivity				
Content				
Accessibility				
Availability				
Uniqueness				
Story				
Gameplay				
Extra activitities				
Relevance				

Edited screenshots of the first questionnaire (in Finnish only)

Auta meitä määrittelemään tulevaisuus

Hei! Olemme 15 hengen ryhmä ja meillä on tärkeä tehtävä. Teemme hauskaa peliä sinulle! Tarvitsemme apuasi, sillä emme tunne sinua! Vastaamalla tähän kyselyyn, olet suureksi avuksi! Oletko valmis?

Aloitetaan puhumalla videopeleistä!

Mitkä ovat lempipelejäsi? (listaa kolme) *

Long answer text

Miksi juuri nämä pelit? Mistä pidät eniten niissä? *

Long answer text

Koetko oppineesi jotain näistä peleistä?

- ◯ Kyllä
- ◯ Hmm.. En oikeastaan

Mitä opit? *

Long answer text

Rehellisesti sanottuna, en pelaa pelejä ihan kauheasti ja siksi tarvitsen apuasi. Haluan löytää hauskimman pelin pelata!

Mitä peliä suosittelisit? Miksi minun pitäisi kokeilla sitä? *

Long answer text

Jos sinulla on lempihahmo jossakin pelissä, mikä se on? Mistä pelistä se on? *

Short answer text

Millä alustalla pelaat eniten? *

- PC
- Konsoli (XBox, PlayStation, Nintendo)
- Puhelin/Tabletti

Kuinka usein pelaat?

	1	2	3	
En ihan hirveästi				Tosi paljon!

Riittävästi videopeleistä. Vaikutat kiinnostavalta henkilöltä, kerro vähän itsestäsi, esimerkiksi mitä tykkäät tehdä vapaa-ajallasi.

Mitä tykkäät tehdä perheesi kanssa?

Long answer text

Entä ystäviesi kanssa?

Long answer text

Onko sinulla harrastuksia? Ja mitä tykkäät tehdä ulkona? *

Long answer text

Teetkö sitä usein?

	1	2	3	
En niin paljon, kuin haluaisin				Paljon, siis TOSI PALJON!

Minkä oppiaineen opiskelusta pidät eniten? *

- Matematiikka
- Historia
- Ympäristöoppi
- Äidinkieli
- Liikunta
- Käsityöt
- Uskonto/Elämänkatsomustieto
- Musiikki
- Kuvaamataito
- Vieraat kielet

Pidätkö siitä paljon?

	1	2	3	
Se on ihan okei	○	○	○	Rakastan sitä!

Vaikutat fiksulta ihmiseltä. Voisitko auttaa minua?

Yritän ymmärtää mitä koodaaminen on. Voitko auttaa minua? *

- Tottakai!
- Anteeksi, en oikeastaan. *Ei hätää! Autoit meitä jo paljon :)

Kiva! Voitko selittää minulle mitä koodaaminen on? *

Long answer text

Kiitos! Olemme viimein saapuneet loppuun.

Kuinka vanha olet? *

Personas Profiles

Saga Rodas, 11

"Why this is like that?"

Favorite games:
Minecraft and Fortnite

Favorite character:
Gamora

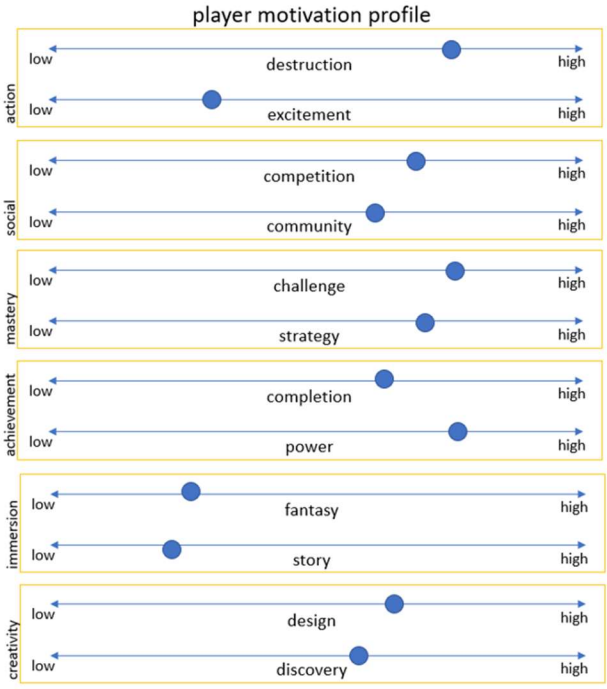
Favorite platform:
PC and Switch

Saga comes from a Swedish speaking family. She has a younger brother (5). Saga is dedicated in her studies and wants to be an engineer as her parents. She loves schools, especially extra classes like dancing, boardgame, drama and coding.

She is curious, a truth seeker and is constantly asking question to understand the surroundings.

When it comes to videogames, she loves to play with her online friends.

Saga is also very good with languages, speaking fluently Finnish, Swedish and English.



Leo Susi, 7

"I saw a dream..."

Favorite games:
Minecraft, Among Us and Pokemon Go

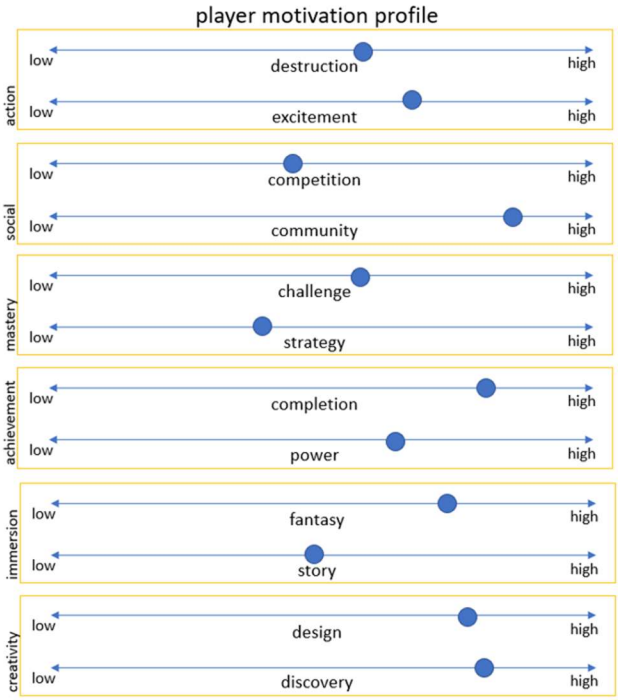
Favorite character:
Tortunator

Favorite platform:
Tablet

Even though Leo just started school, he seems to not be enjoying much apart of the art classes and his friends. He has problem to focus on the class, always dreaming while awake.

He does not play much, only when his friends wants to play. When alone he rather watch videos.

Leo likes to play outside, and love sports. Basketball, football, hockey. He plays for the pleasure to play, he does not seem to care about the result.



Edited screenshots of the second questionnaire (in Finnish only)

Auta meitä määrittelemään tulevaisuus

Anna kun kerron sinulle tarinan! 15 kaverusta kokoontui yhteen tärkeän tehtävän takia: luodakseen hauskan videopelin juuri sinulle. Jep, siinä se oli, mutta tehtävä olikin hyvin, hyvin vaikea.

Se on vaikea ensinnäkin koska me emme tunne sinua. Toiseksi koska...

no... se on salaisuus. Lupaatko pitää sen jos kerron?

...sen takia koska me emme pelaa videopelejä! :(

Voisitko sinä auttaa meitä?

Aloitetaan puhumalla videopeleistä!

Mitkä ovat 3 mielestäsi parasta videopeliä? *

Long answer text

Vau, sinulla on tosi hyvä maku pelien suhteen!

Olen kuullut paljon hyvää noista peleistä :)

Mutta miksi valitsit juuri nämä kolme peliä? Mistä asioista pidät eniten niissä? *

Long answer text

Suosittelisitko mainitsemiasi pelejä minulle? Haluaisin pelata jotain todella HAUSKAA peliä

Mitä peliä suosittelisit minulle? Ja minkä takia juuri sitä?

Long answer text

Mielenkiintoista, en olekkaan ennen kuullut siitä. Mutta kiitos, aion ehdottomasti kokeilla!

Kerro lisää itsestäsi. Mitkä ovat sinun lempi aineesi koulussa? *

- [ ] Matematiikka
- [ ] Historia
- [ ] Ympäristöoppi
- [ ] Biologia
- [ ] Äidinkieli
- [ ] Urheilu
- [ ] Käsityöt
- [ ] Uskonto
- [ ] Musiikki
- [ ] Kuvataide
- [ ] Vieraat kielet
- [ ] Other...

Mikä on kevään valinnaiskurssisi

jos et muista nimeä niin kertoisitko valinnaisesta jotakin *

Short answer text

Vau! Oletpa mielenkiintoinen!

Kaverini kysyi minulta eilen koodauksesta. En oikeastaan osannut selittää sitä hänelle. Osaatko auttaa? Pystytkö sinä selittämään mitä koodauksella tarkoitetaan? Ja älä välitä jos et osaa, enhän minäkään osannut.

Long answer text

Haluaisitko opiskella koodaamaan? (Tai oppia lisää jos olet jo aloittanut?) *

	1	2	3	
Enpä oikeastaan	○	○	○	Ehdottomasti!

Hienoa!

Oletko koskaan pelannut mitään koodaukseen liittyvää peliä? *

- ○ Joo
- ○ En

Jos olet, millainen se peli oli?

Long answer text

Okei, nyt aion näyttää sinulle muutaman pelin, voisitko kertoa mielipiteesi niistä?

Mitä pidät tästä? *

Long answer text

Entäpä mitä sanot tästä? *

Long answer text

Haluaisitko pelata näitä pelejä?	1	2	3	
En oikeastaan	○	○	○	Joo ehdottomasti!

Ehkä huomasitkin jo, mutta nuo pelit liittyvät koodaamiseen. Nähtyäsi videot, innostivatko ne sinua oppimaan koodaamista? *

	1	2	3	
Eipä juuri	○	○	○	Joo ehdottomasti!

Kiitos! Olemme viimein ihan jo loppusuoralla

Lupaan että olemme jo melkein valmiit.

Kaverini Matti kutsui näyttämiämme pelejä oppimispeleiksi. Oletko koskaan pelannut oppimispelejä?

- ○ Joo
- ○ En

Piditkö niistä?	1	2	3	
En oikein	○	○	○	Tosi paljon

Voisitko kertoa pelaamasi oppimispelin nimen? Millainen se peli oli?

Short answer text

Kiitos tosi paljon!

Apusi on ollut meille korvaamatonta, kerroit tosi paljon hyviä asioita!

OLET AUTTAMISEN MESTARI! :)