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Storytelling and Minecraft in Education: Creating a World and Measuring its Impact on the Learning Process

João Miguel Matos Monteiro

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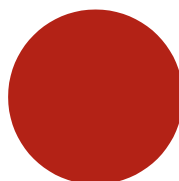
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João Miguel Matos Monteiro

Master in Multimedia @ University of Porto

Supervisor: Nuno Alexandre Meneses Bastos Moutinho (Professor @ Faculty of Economics and Management of the University of Porto)

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Master in Multimedia @ University of Porto

Approved in public trial by the Jury:

Chairman: Jorge Manuel Gomes Barbosa (Associated Professor @ Faculty of Engineering of the University of Porto)

External Examiner: Diana Machado Carvalho (Assistant Professor @ University of Trás-os-Montes e Alto Douro)

Supervisor: Nuno Alexandre Meneses Bastos Moutinho (Assistant Professor @ Faculty of Economics and Management of the University of Porto)

Abstract

Ever since its full release in 2011, Minecraft has asserted itself as one of the most popular games with children around the world. Its sandbox features possibilities have not gone unnoticed by educators, with Minecraft Education Edition's release in 2016 and its over 600 available public lessons proving its value.

Proceeding from Rinja and van der Jagt's assertion from 2004 that people tend to pay much more attention to what is told when the information is put into an interesting and exciting story, this research proposed a case study conducted with 10 classes from 3rd to 6th grades to analyse the utilization of Minecraft to assist the learning process, and measure the impact of incorporating storytelling and other game-based elements in it.

Instead of employing a pre-built world as the object for the case study with the students, a new world was projected and constructed, in association with Visionarium and incorporating the Safer Internet Day 2022 project, resulting in an engaging adventure through a Minecraft world capable of teaching children about internet safety.

The results of this case study reassert the idea that Minecraft can be utilized in the classroom with great success at captivating children and, not negating the values that the sandbox features of the game provide, also introduce the idea that adding storytelling and other game-based elements to Minecraft can further motivate and assist the learning process.

Keywords: Minecraft; Education; Storytelling; Game-based Learning; Learning Process

Resumo

Desde o seu lançamento em 2011, o Minecraft afirmou-se como um dos jogos mais populares entre crianças por todo o mundo. As possibilidades das suas características de *sandbox* não passaram despercebidas pelos educadores, com o lançamento do Minecraft Education Edition em 2016 e as suas mais de 600 aulas disponíveis comprovando o seu valor.

Partindo da afirmação de Rinja e van der Jagt de 2004 de que as pessoas tendem a prestar muito mais atenção ao que é dito quando a informação é partilhada através de uma história interessante e emocionante, este trabalho propôs um estudo de caso realizado com 10 turmas do 3º ao 6º ano para analisar a utilização do Minecraft no auxílio ao processo de aprendizagem, e medir o impacto da incorporação de *storytelling* e outros elementos de jogo.

Em vez de utilizar um mundo pré-construído como objeto para o estudo de caso com os alunos, um novo mundo foi projetado e construído, em associação com a Visionarium e incorporando o projeto Safer Internet Day 2022, resultando numa aventura interativa através de um mundo Minecraft capaz de ensinar as crianças sobre segurança na Internet.

Os resultados deste estudo reafirmam a ideia de que a utilização do Minecraft em salas de aula traduz-se num grande sucesso em cativar as crianças e, não negando os valores que os recursos de *sandbox* do jogo proporcionam, também introduzem a ideia de que adicionar histórias e outros elementos de jogo no Minecraft pode motivar e auxiliar ainda mais o processo de aprendizagem.

Palavras-chave: Minecraft; Educação; *Storytelling*; *Game-based Learning*; Processo de Aprendizagem

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Abbreviations

SID	Safer Internet Day
MSID22	Microsoft Safer Internet Day 2022
NPC	Non-Playable Character
STEAM	Science, Technologies, Engineering, Arts and Mathematics
PTSIC	Portuguese Safer Internet Centre

1. Introduction

Minecraft is today one of the most popular games in the world, particularly with children. Back in 2013, just 2 years after its full release, Zedda-Sampson identifies Minecraft as the most popular computer related activity among kids aged 8-10, and its popularity has only increased since. By the end of 2020, Minecraft registered over 200 million copies sold (Clement, 2021), over 131 million active monthly users (Vincent, 2020) and over 200 billion views on YouTube on “Minecraft content” (Bloom, 2020).

As identified by multiple studies, like the ones by Ekaputra et al. in 2013 and Petrov in 2014, Minecraft can bring many advantages when used correctly in the classroom or at home as an assisting tool to the learning process. That was further highlighted when, in 2016, Microsoft released Minecraft Education Edition, an adapted version introducing several new features to promote and facilitate its use in the classroom¹.

Another concept whose benefits to the learning process are well documented is storytelling. Van Gils (2005), McLellan (2006), and Robin (2008) all propose that incorporating conducting narratives into the classroom can promote interest and excitement, with students keener to solve problems and engage in activities when part of an overarching story with compelling characters.

With all this in mind, in association with Visionarium, a project with the mission of bringing educational activities in the STEAM fields to schools and the general public², and with Escolaglobal, a private teaching group with the mission of giving quality service in the areas of education and complementary services³, this project was envisioned, aiming to combine Minecraft and storytelling in education.

¹ Retrieved from <https://education.minecraft.net/discover/what-is-minecraft>

² Retrieved from <https://visionarium.pt>

³ Retrieved from <https://escolaglobal.org>

The objectives of this dissertation are to understand how Minecraft can be employed to assist the learning process, and if the addition of storytelling and other game design elements improves its effects. The research questions are then established as follows:

- RQ1: How to employ Minecraft in education?
- RQ2: Does Minecraft assist the learning process?
- RQ3: Does the addition of storytelling and other game design elements improve the effect of Minecraft on education?

To find the answers to these questions, after a thorough review of the available literature in the employment of Minecraft in education, using primary data collected through quantitative methods I employed an experimental research methodology as I conducted various tests with young students, with each controlled group being exposed to differently manipulated variables.

A Minecraft world was built from scratch from which 2 different adaptations were readapted to be used as the test objects in direct tests with 183 students from Escolaglobal, to compare the utilization of Minecraft *vs* traditional exposition as an education tool, and the success of inserting storytelling and game design elements into Minecraft. To properly compare the utilization of the game against traditional exposition, a visual presentation regarding the same subject was also assembled.

The data was collected through enquiries to the pupils, and then subjected to a thorough statistical analysis. These enquiries happened after sessions with 10 different classes from the 3rd to the 6th grades, where the students were exposed to new educational content through different methods, each with a different set of controlled variables. These sessions served as the basis to investigate how the following methods assist the learning process:

- Traditional *vs* Minecraft – Some classes were exposed to the new information through traditional exposition aided by a visual presentation, while the other classes were exposed through an interactive experience through a sequence of activities inside a Minecraft world.
- Minecraft with added storytelling and other game design elements *vs* Minecraft without added storytelling and other game design elements – Both groups were exposed to an interactive experience through a Minecraft World, with some classes navigating a sequence of activities designed with the help of a conducting narrative and other game design elements like a system of rewards for positive interactions, while the other classes were presented with a simplified version of the same world, where the pupils were exposed to the exact same sequence of activities in Minecraft, but without those added elements.

The Minecraft world created for these sessions was developed in association with Visionarium, inserted into one of their ongoing projects. This project, the Microsoft Safer Internet Day 2022 Park, was developed between December of 2021 and February of 2022 for

the 2022 edition of the Safer Internet Day, and consisted in designing and building an engaging adventure through a Minecraft world capable of teaching children about safety measures that must be conducted to protect their devices when online.

After this introductory chapter, this dissertation contains 6 more chapters. Chapter 2 contains the literature review and presents related works. Chapter 3 describes the construction of the Minecraft world used in the tests, and the project it was inserted in. Chapter 4 explains the testing process. In chapter 5 the results are discussed. Chapter 6 presents the conclusions and suggests future work to be done. Chapter 7 lists all the references consulted through the development of this dissertation. Finally, the Appendices can be found at the end of the document, including a technological review on Minecraft in **Appendix A**.

2. Literature Review

This chapter presents a literature review into the main topics explored in this research - game-based learning and the uses of Minecraft and storytelling in education - and mentions other relevant and similar works on these topics.

This serves as the theoretical basis of this research and highlights the opening for its contributions and its relevance in the field.

2.1 Game-Based Learning

According to Kim (2013) and Trybus (2015), game-based learning is a term referring to the application of game-thinking and game-design dynamics, the things that make games fun, to real life and non-game situations as a way to engage users.

As we advance into the 21st century game-based learning and gamification are terms more and more common, a trend already implemented, according to Pho & Dinscore (2015), in various sectors including workplace training, social media and, more relevant for this dissertation, education. This, also according to these authors, relates not exclusively to the development of games for students, but designing activities that incrementally introduce concepts and guide users towards an end goal, incorporating systems like competition, points, rewards, incentives, and feedback loops, as a motivational psychology allows students to engage with educational materials in a playful and dynamic way.

Plass et al. (2016) propose that “playfulness is orthogonal to learning theory”, with application of game design assisting the learning process by promoting engagement with the subject at matter through tenting to the learners’ cognitive, behavioural, affective, and sociocultural perspectives. Pivec et al. (2003), on the premise that “learning by experience is often more efficient than learning by studying”, state that by implementing game-based concepts in education and having students explore different roles, they “learn and obtain both basic knowledge and practical experience and soft skills that are needed for the organizations of the modern industrial manufactures”.

Persico et al. (2019) state that many fields like science, mathematics and language teaching already employ digital games, at various levels, to promote problem solving skills. Altiner (2018) also presents a study concluding that incorporating spatial games in elementary education, in the way of activities involving visual puzzles, helps students gaining proficiency in areas like mathematics and geometry. In their 2020 publication, Sabirli & Çoklar report a study conducted with 90 students in a public primary school where the effect of educational digital games on education is assessed through the gamification of an English assignment, and establish an increase in access and motivation from the students towards the lesson.

Kim (2013) shares a similar opinion to Pho and Dinscore, stating that “games encourage us to improve our performance by providing immediate and detailed feedback and systematically guiding us with all the necessary information for progress”, so the implementation of game-thinking into educational tasks can work extremely well to engage students when they're introduced to new contents. This idea was also explored by Annetta et al. (2006), who demonstrate that students exposed to virtual game-based learning environments show very positive attitudes toward the delivery method and the interactions within it. Similarly, in a study focused specifically on primary level education, Ramos & Melo (2019) conclude that the use of digital games in elementary school significantly improves the students' attention and motivation.

Games in the classroom, however, are not a replacement for good teaching, as suggested by some like Prensky (2004) and Bushnell (2009). Annetta (2008) and Pivec (2009) both argue as well that they should be viewed as supplements that engage students in the contents and provide an avenue for them to be introduced to new information and learn in a comfortable environment.

Another relevant aspect of the use of games and game-thinking in education is the frequent limitations. Pivec (2009) and Petrov (2014) both highlight some of the more common barriers in its implementation. School board approval for alternative teaching methods is a frequent obstacle, as is the lack of computer availability in schools that completely impossibilities the use of digital games and platforms, as well as the common (although diminishing) lack of knowledge by teachers on games.

Tobias et al. (2013) assimilate these gaps in their publication “Game-Based Learning”, where they assert that “people do learn from games”, but make a call for the “development of tools and technology for integrating the motivating aspects of games with good instructional design”, as effective design processes are still missing to “ensure that learners acquire the specific knowledge and skills the games are intended to impart”.

2.2 Minecraft in Education

On a following note, the effectiveness of Minecraft when used in schools to support teaching and learning has been well documented by several studies. From its initial publication Minecraft has been identified as a powerful tool to be used in education. Very shortly after its full release, *MinecraftEdu*, an early modification of Minecraft that can be considered the predecessor for Minecraft Education Edition, could already be found in various schools around the world (Good, 2016). This trend is maintained to this day, with Minecraft Education Edition's benefits and spread utilization in classrooms around the world explored in the 2020 publication by Bar-El & Ringland "Crafting Game-Based Learning: An Analysis of Lessons for Minecraft Education Edition", where the authors provide an analysis into the activities uploaded to the Minecraft Education Edition website available as of March 2020, highlighting the 627 lessons available from 237 unique authors.

With Minecraft's main selling feature being its sandbox environment, it's natural that was the main aspect being explored. Just 2 years following Minecraft's full release, Ekaputra et al. (2013) explore how the free exploration of the natural features of Minecraft can be used to assist the teaching of several subjects. While the study understands that the implementation of some modifications can improve its effect as a learning tool (referencing already *MinecraftEdu*), it focuses on how the original features can easily be connected to relevant topics and subjects. It highlights how Minecraft's biomes can be used to educate about ecology, how its redstone mechanics can be used to teach about electrical wiring, engineering and computer science, how cultural architecture and dimension orientation can be taught with the fundamental mechanics of breaking and placing blocks, and how the multiplayer features can be used for social learning. In the conclusions one can read that a "Minecraft world can be fabricated at will to fulfil an environment which has positive effects to students learning process". More support for this idea comes from Cosh (2015), who mentions several ways that Minecraft's sandbox can aid the learning process, like receiving the task of replicating something they have read can aid reading comprehension, motivating children to build and construct instead of destroying to teach social etiquette and digital citizenship, or even using the games crafting features to introduce children to concepts like Boolean logic and binary numbers.

Cipollone et al. (2014) also explore Minecraft's sandbox environment, highlighting the possibility of displaying creativity and understanding new concepts in a far easier way than if they were explored in the real world. Conducting a case study in a high-school literature class in the USA (which itself highlights the versatility of Minecraft, also being effective with older students) where student groups were tasked with creating films made within a game world, the authors point out that Minecraft's essential constructionism offers a different style of instruction widely different from the USA's traditional system, allowing an easy way for students to express their creativity.

Another study further exploring the use of the sandbox functionalities of Minecraft in education was conducted by Pusey & Pusey (2015). In this research the authors make use of the *MinecraftEdu* software of the time to engage students in learning Biology and Geology. This study highlights the success of Minecraft in increasing the interest of students in science. While only 45% of the participating students affirmed to frequently playing computer games, 84% reported enjoying using *MinecraftEdu* and 94% of the students wanting to use Minecraft in the classroom again. The most notable trend depicted in the data collected during this study is, according to the authors, the notable increase in interest in science. After being exposed to *MinecraftEdu*, the number of students who identified as being interested in science increased from 47% to 62%. Another interesting point this study makes is that strong backgrounds in technology and videogames facilitate and improve the results of the use of such resources in the classroom.

Callaghan (2016) conducts a multiple case research study also exploring the ways in which Minecraft can be used to contribute in learning environments. 168 participating students from years 7 to 10 answered online questionnaires about their experience after contacting with custom made Minecraft worlds. Of these, 72% believe that there are educational benefits to using Minecraft in class. Students also show a natural willingness to collaborate on their tasks and adapting their process to fit their group goals. One singular aspect of this research is how the author identifies that having the teacher present in the same online environment as the students contributes to the engagement and motivation of the students, when compared to scenarios where the teacher is not present in the same virtual world. The teacher's presence led to students showing significant "eagerness" in showing the teacher their constructions and would often ask the teacher to follow them and see their progress.

Torquato & Torquato (2017) document the use of Minecraft to teach History in elementary school in Brazil. This study, conducted with students from the 6th grade, proposes that having students directly interact with the materials they were learning about (by using Minecraft's creative mode to build scaled versions of medieval buildings) to create a visual relation facilitates the understanding of the taught concepts. Students worked in groups to investigate about specific real-life constructions (like the Castle of Liechtenstein), design a work plan, and collaborate in its construction within Minecraft. This study reports an increase in interest from the students to learn more about the constructions, as they were deeply motivated to accurately depict each building.

Šajben et al. (2020) explore the use of Minecraft Education Edition in the Slovakian school system, also highlighting how Minecraft can be successfully used in student-centred education, rather than the previously dominant teacher-centred education. The authors propose that Minecraft can bring the best out of a student-centred model, focusing on what the student learns instead of what the teacher teaches, and featuring teachers as facilitators of learning rather than authoritative figures. With group work also a focus of this model, Minecraft blends itself as a great tool to assist the learning process, as this research concludes after developing and testing

activities within Minecraft in several fields like Biology, English, Informatics, Math, Chemistry and Literature.

Carrión (2018) conducts a study into the use of Minecraft to foster creativity and collaboration. Presenting students with a set of activities to be completed, initially masked only as entertainment, consistently showed added interest and motivation to complete the activities. The author also proposes that employing Minecraft in the classroom can foster creativity and discovery, and “contributes to interactive advantages such as using English, Maths and Physics among other disciplines in tasks like creating command blocks”.

Hébert & Jenson (2021) explore the utilization of Minecraft sandbox properties to teach problem solving and collaboration, promoting a workshop to help teachers design their own activities within Minecraft. While participating teachers identify that teaching with digital games requires a re-imagining of their role, shifting from pure deliverers of contents to participants in collaborative learning environments, the study shows that Minecraft provides an “exploratory platform for teachers to support their students in experimentation, creativity, collaboration and other 21st century skills”. Petrov (2014) also thoroughly explores the use of Minecraft in education, highlighting that despite the significant initial investment to offer every student the means to freely use and play the game, Minecraft can be successfully adapted to different types of teaching styles and classroom designs, with even parents showing very positive responses to using Minecraft, as their kids are finally excited about their school experience.

Another viable option in the utilization of Minecraft in an educational setting is the creation of custom mods. The term “mod” is usually identified as a custom modified package of Minecraft, introducing new features that are not available in the “vanilla” version. An example of this is the research by Al-Washmi et al. (2014), where they explore the creation of a math learning game within Minecraft. The authors develop a Minecraft mod introducing several new items like numbers, operators and calculators, that the players make use of for solving different problems, while working in groups through a predesigned map. After testing the mod with children aged 7-11, while the collaborative nature created some problems due to varying levels of experience with the game within the same group, and players who had played more extensively before began using their experience to disrupt the gameplay, they identify that most children enjoyed the experience of solving math problems while playing with Minecraft. More extensive testing is proposed, but the results already show promise to the development of educational experiences inside Minecraft.

Nebel et al. (2015) conduct a literature review on the use of Minecraft in education and experimental research, discussing the already mentioned multiple benefits it brings, and emphasizing examples that already stretched the technical and methodical boundaries of the time, highlighting its inevitable role in the future of education. Similarly, the 2021 publication by Alawajee et al. “Minecraft in Education Benefits Learning and Social Engagement” that reviews 42 peer-reviewed scientific publications on the utilization of Minecraft in educational

contexts, also concludes on the multiple benefits of the game. This research highlights points such as increased motivation, language development, academic learning in subjects like science and history, as well as the development of social skills, such as communication, collaboration, and leadership.

A recurring conclusion through all these studies, among others, is the success of using Minecraft to motivate students, increase their interest in school subjects, and facilitating the understanding of new concepts. However, all of them focus their research on the sandbox properties of Minecraft and, while a few introduce other game-design elements, the addition of conducting storylines has not yet been properly explored.

2.3 Storytelling in Gaming and Education

People tend to pay much more attention to what is told when the information is put into an interesting and exciting story (Rinja & van der Jagt, 2004). Because of this important factor, storytelling has been present throughout the entirety of human history.

Today, as an ever-growing market, one of the bigger promoters of stories and storytelling are videogames, with the narratives an indisputably huge part of gaming.

According to Annetta (2008), a vast majority of popular commercial videogames follow a rigid storyline and, because of the richness of the storylines, “videos games easily lend themselves to established instructional practices such as problem-based learning”. However, taking from van Gils (2005), even games without a rigid storyline can gain immense popularity, like Sims and World of Warcraft, as people create their own stories to consummate their experience. To this assessment, looking at the recent history of videogames, I throw in the same group games as Football Manager, League of Legends and, even more relevantly, Minecraft. These videogames, despite not having a structured predefined storyline, invite players to create their own stories through their gameplay.

With educators understanding the growth of technology and its importance for the new generations, Alismail (2015) identifies how digital storytelling can be an effective tool for both teachers and students. The author proposes that applying digital storytelling in the classroom gives students the opportunity to participate and interact, significantly increasing their motivation and supporting the learning process. Similarly, Dudacek (2015) also discusses how alternative styles of teaching like implementing transmedia storytelling in education, through interrelated characters and their stories, can be more effective and achieve higher levels of engagement from students.

A great example on how to engage children with storytelling to educate them, as identified and explained by Madej (2003), is Sesame Street. For decades, Sesame Street, an extremely popular children TV show, incorporated storytelling to transmit messages to children all around the world.

In a very relevant study for this dissertation, van Gils (2005) proposes that storytelling could be employed in elementary school to promote interest and excitement from the students, as a student would be much more interested in solving something like a math problem if asked them in a way that would assist a character along an adventure. In similar studies, both McLellan (2006) and Robin (2008), find that the use of storytelling in teaching helps students retain new information as well as aiding in the comprehension of new material, functioning as an effective bridge between existing knowledge and new material, with Sadik (2008) also identifying great benefits in asking students to create their own stories within the studied subjects.

2.4 Conclusions

While the uses of Minecraft in an educational context have been well explored and documented, one of the more relevant points that is possible to identify is the fact that almost all studies and experiments conducted explore only the sandbox features of the game and miss the opportunity of adding over it.

As the sandbox features of Minecraft are usually associated with freedom to be creative, and its value is well identified, exploring solely this mode loses other degrees and does not offer the advantages of certain aspects of storytelling and game-based learning. With Minecraft lacking a rigid storyline but offering a platform with the potential to explore numerous different narratives, this project proposes that incorporating conductive storylines to educational activities within Minecraft can successfully assist the learning process in elementary education.

Let's take the example of designing an activity in Minecraft for a History class, that would have students build a medieval castle. This activity could be delivered through two different approaches:

- Approach A would have the teacher instruct the students to build a castle in creative mode, with access to all the resources, to learn about medieval castles and how they were made.
- Approach B would have the children spawn in-game in a medieval looking palace, in front of an NPC named "King George". King George would tell the players that the neighbouring Kingdom is threatening to attack his house because of their relative abundance of resources, and so he needed a new castle to defend his people and food. He would then "hire" the player to build him a castle in a location that would allow them to defend their position, with the resources available to them: they can mine in a restricted area of the kingdom to extract stone and wood in very high quantity, but limited iron and coal. Whichever resources they mine

but don't use would be used to forge their armour and weapons, which would then be used by the players to defend the castle from attacking mobs.

While it's possible to identify several studies similar to Approach A (like Torquato & Torquato's 2017 publication) - and the data published and reviewed undoubtedly suggests that students would be excited just by building a castle in Minecraft as a way to learn - there is a significant opportunity of contribution by testing the success of Approach B. Despite there being relevant literature on both Minecraft and storytelling providing success in assisting the learning process, the marriage of these 2 areas has not been properly explored. An example like this could combine the documented success of employing Minecraft in the classroom with the documented benefits of incorporating storytelling in education, proposing that the same Minecraft activity could be presented with an overarching narrative capable of motivating the students even further, as they would then not only explore new content, but actively engage in a story with tangible fun rewards for a task well performed.

Gaming is today understood as a constantly expanding world and business. The values of game-based learning are well identified. Storytelling is also identified as a valuable tool in elementary education. The average age of gamers is now at 30 years old and rising (Johnson et al., 2014), relevant for the growing familiarity of the educators with gaming and game-thinking. With all this points in mind, complemented with Minecraft ever-growing popularity (Clement, 2021), I see a relevant opportunity to contribute to all these fields exploring the application of concepts of game-based learning to Minecraft through the addition of new elements from game design, and the creation and implementation of conductive narratives to further spark the students' motivation, looking to improve its success as a tool for assisting the learning process.

3. Microsoft Safer Internet Day 2022 Park

To find the answers to the proposed research questions, it was decided to conduct tests with young students regarding their interest in utilizing Minecraft as a tool to assist the learning process. Instead of employing an already built world as the test object, it was decided to build a new Minecraft world from scratch. With that goal asserted, inserted in the project Safer Internet Day 2022 and in association with Visionarium, a Minecraft world was built following this thesis' methodological principles through December of 2021 to February of 2022.

3.1 Safer Internet Day

Today a landmark event in online safety, the Safer Internet Day started as an initiative of an EU project named SafeBorders in 2004. It was taken up by Insafe, a European network of awareness centres, as one of its earliest actions in 2005, and since then has grown to now be celebrated in close to 200 countries around the world.⁴

As one of the countries participating in the event, in Portugal the date is commemorated with visits to schools to educate students about internet safety.

In the past year, in a partnership with Microsoft, GNR (Guarda Nacional Republicana – Portugal's statal military security force) "visited" schools around the country (through online meetings because of the limitations imposed by the government relating to the pandemic context of the world at the time) in sessions with students from 1st to 12th grades, where an officer talked with the students about the risks of carelessly navigating the internet and the security measures one must take to ensure they are safe and protected from those threats, assisted by a slide presentation. The 2021 sessions featured three distinct versions of this presentation, one for 1st through 4th grades, one for 5th and 6th grades, and one for 7th through 12th grades. The differences in support material derived from the also distinct topics discussed with each school level. While

⁴ Retrieved from <https://www.saferinternetday.org/>

the sessions with elementary level students touched on subjects like playing online games and the importance of passwords, sessions with older students focused on matters like social networks, phishing, and fake news. The topic distribution from the 2021 sessions can be found below in Table 1.

Table 1 - Topic distribution from SID 2021 sessions in Portugal

Topic	1 st – 4 th grades	5 th – 6 th grades	7 th – 9 th grades
Piracy	X		
Digital Footprint	X		
Phishing	X	X	
Cyberbullying and Welfare	X	X	X
Password Security	X	X	X
Data Sharing and Protection	X	X	X
Digital Footprint	X	X	X
Fake News		X	X
Security Updates		X	X
Intellectual Property			X
Social Networks			X

Ultimately, no matter how interesting the topic may be, having an officer talking in an online meeting supported only by a visual presentation is not the best way to captivate children. Looking to change that point, Visionarium was inserted into this project and invited to develop a virtual Minecraft world to incorporate and reinvigorate the 2022 sessions. The goal was to record an adventure through this virtual world and create a new interactive presentation incorporating those images to better captivate the students' attention and increase their interest, capable of inviting the students to interact and decide the main character's path through the world. After those presentations, this adventure would also be made available to the students to fully explore the world at home. To this end, the Microsoft Safer Internet Day 2022 Park was designed and constructed, presenting an adventure through a sequence of rooms and buildings featuring new and unique activities, each teaching about one of more topics on internet safety.

3.2 The World

Aiming to captivate children’s attention and attempting to convey important information on a seemingly uninteresting topic through a fun vehicle, this world was built and designed based around a theme park. It also embraced an ecological concept, with lots of vegetation and green spaces, incorporating many gardens and flora as decorations, trying to promote an environmental-friendly message. Most of the building feature gardens on their rooftops.

The final structure and layout underwent several modifications throughout the few months of its construction. Various tests were conducted with children (independent to the study detailed ahead), where each building and activity would be assessed and improved upon, as well as frequent consultations with experienced people in the fields of gamification, education, and internet security.

In its final version, the MSID22 Park is composed by 7 different main buildings, each with distinct activities (some buildings feature multiple activities), with each building associated to the following Internet Safety topics:

1. Antivirus & Firewalls
2. Password Security & Phishing
3. Software Updates
4. Fake News
5. Intellectual Property & Piracy
6. Data Protection
7. Cyber Bullying



Figure 1 - Snapshot from Minecraft Safer Internet Day 2022 Park

In addition to these buildings, there is also an Entrance, where the player is introduced to the world and some of the characters, the Adventurer's Cabin where players receive their rewards after navigating through the 7 buildings, and the Final Maze, a short section consisting of, as the name suggests, a quick maze leading to the end of the adventure that helps immerse the player into the final task of reaching the end of their adventure, and adding a further sense of accomplishment for the players when they do. Upon reaching the end of the Final Maze, players can see a progress report, with a structure that indicates how many of the puzzles were correctly navigated and completed, and the player is given the opportunity of further exploring the map by gaining access to the rest of the world without being confined to the linear path taken so far. Outside of this path are still many secrets and easter eggs that the player may search for. These elements were added purely as a post-game bonus, completely separate and unrelated to the topic of Internet Safety and the adventure and, therefore, not listed nor explored in this document. One of the areas accessible after the completion of the game is a corridor located underground leading to a control room of each building. These rooms, containing dozens of automated command blocks, were constructed to allow a quick reset of every building and activity, and provided major assistance throughout the construction process of the MSID22 Park.

After each building, the player may be transported back to its entrance. This is done interacting with a button present in a small blue structure from the park's service named *TuboBus*. This allows players to restart each puzzle, should they want, or explore any part of the building that they may have previously skipped.

This world welcomes players in adventure mode to allow for the spawn of mobs relevant to various puzzles, but that brings the undesired (for this specific adventure) mechanism of hunger. For that, treasure chests filled with various foods are also available next to every *TuboBus* entrance to ensure the player's adventure is never limited because of the character's hunger.

Snapshots from the world and all the buildings and structures, as well as link to a video showcasing the entire world, can be found in **Appendix B**.

3.3 Adapting the World for testing

The complete navigation through this world, excluding post-completion of the main storyline exploration, clocks at around 2 hours. However, with this world being constructed as the test object for a case study with students from 3rd to 6th grades, a lengthy completion time would complicate its application in future tests with schools as it would not fit the usual timeframe of classes for the 1st and 2nd cycles, usually maxing out at between 1 and 1 and a half hours. This demanded that an adapted version of this world was redeveloped, to shorten the adventure so that could be completed within 1 hour.

The first step in development of this adaptation was cropping the number of buildings. SID presentations from previous years were consulted to identify a set of topics common to both the 1st and 2nd cycles, but both the subjects in question and the puzzles of each building were taken into consideration during this step, with the buildings picked to remain in this adapted version aiming to maximize both the relevance of topics and interest in the activities.

After a careful revision, while maintaining all the buildings and areas in the visible world, the accessible path was cropped to feature solely the following buildings:

1. Entrance
2. Antivirus & Firewalls
3. Password Security & Phishing
4. Intellectual Property & Piracy
5. Adventurer's Cabin

Ahead you can find a description of each building and the activities inside.

3.3.1 Entrance

As with every theme park, the first step of any visit is going through the entrance. The player spawns in a small room with an NPC Marvin welcoming them to the world, where they can climb inside a minecart and travel down a colourful corridor to the main area of the building. The exit of the building is at first blocked by a fence block, but the player can interact with several NPCs Guests, an NPC Technician that gives the first hint towards the overarching narrative of the adventure, a second Marvin that directs the player to the front desk, where they can interact with an NPC to show their ticket and gain entrance to the Park.



Figure 2 - Entrance building

3.3.2 Antivirus & Firewalls

In this building, whose design is inspired by a museum, the player can find 2 distinct showcases protected by a glass pane exploring the 2 topics that name this building, Antivirus and Firewalls.

In the first section of the building, the player is invited to interact with a button that spawns a Zombie within the showcase. On the floor inside the showcase area, several pressure plates activate an automated system that fires arrows inside the showcase when a mob is detected (through the weight-activated pressure plates). To advance through to the next room, the player must interact with this exhibit's button, with a fence blocking the path until they do.

When the player advances to the second room of the building they are forced to walk over a set of pressure plates, that cause a Skeleton to spawn within the second showcase. Talking to the NPC Guide in front the player discovers that those skeletons represent intruders that put another NPC in harm's way, because the Firewall is deactivated. The player must then complete a quick puzzle to save the NPC in Trouble. However, they are free not to, and can advance through the exit door of this room whether they complete the puzzle or not.



Figure 3 - Antivirus & Firewalls building

3.3.3 Password Security & Phishing

In the second building, the player is tasked with logging in to the Park's website.

Outside the building an NPC Marvin informs the player of their task and offers some security tips. In a board next to it is displayed the password necessary for logging in

(represented through a specific sequence of 4 different coloured wool blocks) that the player must memorize.

In the entrance of the building there are 2 different doors leading to 2 different rooms, each representing a different website where the player can introduce their password. The 2 rooms feature very different designs, with the entrance to each reflecting that. The room on the right represents the Park's legitimate website, and so is depicted with a clean and attractive design, in shades of purple and white, but nothing over the top. The left room on the other side features an extremely extravagant look, with vibrant colours, solid gold and emerald blocks, and a roller coaster. This overly decorated aesthetic aims to captivate the player as this room represents a fraudulent website, attempting to trick users into forfeiting their passwords.

At the end of each room an NPC Guide gives the player 4 blocks of coloured wood that the player must place in the correct order in a designated place, simulating the process of inputting the password to log in to the website. The puzzle of this building is set on choosing the correct area to reveal the password. While the left room appears much more captivating, even featuring a roller coaster that the players are invited to ride, and promises of diamonds, gold ingots and emeralds for inputting the password there, as it represents a phishing scheme if the player advances through this area they lose all their supposed rewards and have their password revealed in an elevated screen outside the building, visible after exiting. An NPC Security Guard then explains that they may have been victims of a phishing scheme. On the other hand, if the player inputs their password in the correct room, they unlock a reward.

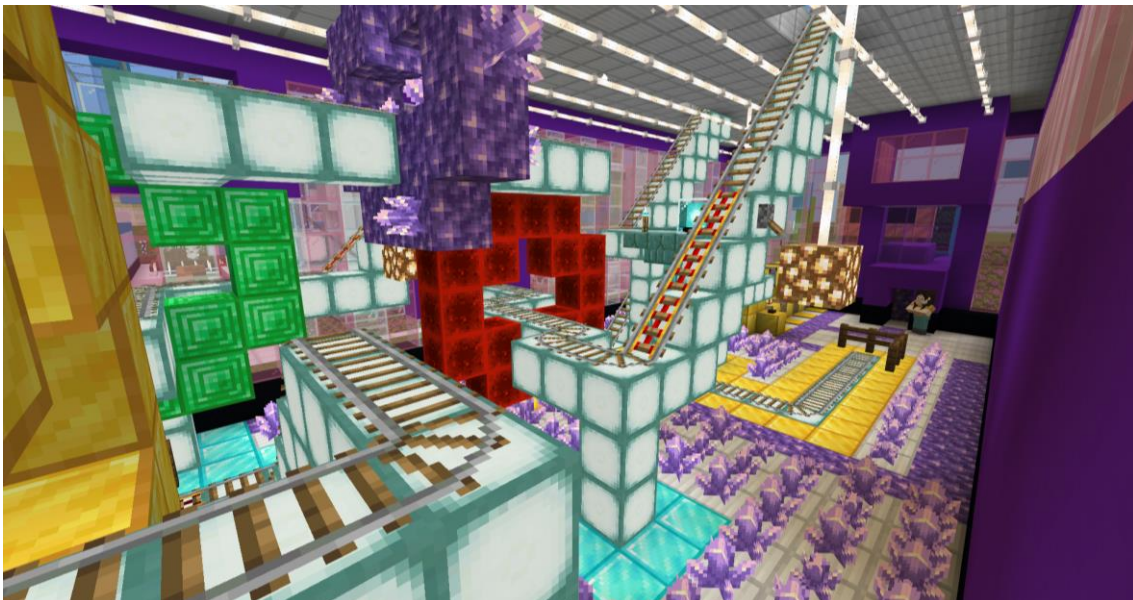


Figure 4 - Password Security & Phishing building

3.3.4 Intellectual Property & Piracy

This building touches on two different topics through 2 different activities.

An NPC Marvin welcomes the player and directs them to the NPC Guide near it. A set of iron doors block the player from immediately skipping through, instead being forced to interact with the Guide that, apart from allowing the player to advance further, introduces him to the first activity of this building. The Guide gives the player multiple blocks of coloured wood and invites the player to arrange them in a unique pattern of their choice, with a designated space for it right next to them. After the player creates their pattern and advances through the previously blocked iron doors, a second NPC Guide informs them that their design was stolen, and copies are being sold without the player's permission. In the following room the player finds 3 NPCs Sellers "selling" a copy of their pattern. A fourth NPC User also displays the same pattern but, upon interacting with them, reveals that they were not looking to sell a copy, were merely displaying a copy because they enjoyed the pattern and did not know it was wrong to do so without permission, and so remove the pattern from the display.



Figure 5 - Intellectual Property & Piracy building

In the following section, the player is tasked with obtaining a new operative system. To this end, they are then confronted with 2 different paths: the left room features a store where the player may buy the operative system, while the right room represents a website where NPCs promise the player the operative system for free. While the player never actually needs to obtain any representation of an operative system, it's the choice of the path the player advances through that impacts the puzzle and the possible unlocking of the final piece of armour.

Should the player choose the correct path and enter the store to purchase the operative system legally, he may interact with several other NPCs inside. Some of these NPCs will ask the player questions about cyberpiracy and internet safety and, should the player answer all 4

questions correctly, the third and final reward is unlocked. If the player instead attempts to obtain the operative system for free by visiting the website, they will find themselves navigating through spider webs and finding nothing but an NPC that was also tricked into visiting the website and lost their parents' credit card number as a result.

3.3.5 Adventurer's Cabin

The final building, the Adventurer's Cabin is where the player gains access to the rewards unlocked through their visit. For each puzzle completed, a treasure chest with a piece of armour is present inside.

In this room it also possible for the player to backtrack to the beginning of each building, should the player want to retry any puzzle that they may not have been able to complete. After collecting their rewards and restocking on food (an extra treasure chest filled with food is also present inside), the player may advance through to the Final Maze, where they can find a review of their success through the park's puzzles after reaching the end. In this adaptation of the world the player does not gain access to the rest of the park upon completion.



Figure 6 - Adventurer's Cabin

3.3.6 Minecraft without added Storytelling elements

To compare the addition of storytelling and gamification elements to Minecraft, from the adapted version described above, another adaptation had to be produced. For this second version several character, elements, and interactions were removed from the world. The selected rooms and topics remained the same, but some activities were modified and two major elements were

removed: the overarching storyline, and the reward system for successfully completing each activity (subsequently, the Adventurer's Cabin was also removed for it fulfilled no purpose without the rewards, with players advancing directly to the Final Maze after the Intellectual Property & Piracy building).

In this version, players spawn in the same building, navigate through the entrance just the same, but do not have the interaction that starts the overarching storyline.

The antivirus showcase remains the same, but the task that demands players to fix the firewall showcase is removed. Similarly to the antivirus exhibit, players now only have to press a button to spawn the skeletons representing intruders, and switch on or off the already present lever to activate or deactivate the firewall. There is no longer the possibility to interact with the NPC in Trouble.

The building that explores the topics of Password Security & Phishing remains mostly the same, with only the reward for choosing the correct path being removed.

Finally, the Intellectual Property & Piracy room also remains objectively identical, with only the reward for correctly answering all the questions removed.

As mentioned earlier, without the reward system, the Adventurer's Cabin is removed from this version of the world as it now fulfils no purpose. After leaving the Intellectual Property & Piracy room players are instead transported to the entrance of the Labyrinth. At the end of the Labyrinth players no longer find the progress bar, with the present characters only congratulating the player for reaching the end.

3.4 The Story

To test the impact of adding storytelling to Minecraft in educative contexts, the MSID22 Park was constructed with an overarching narrative. This story, told through interactions with several characters throughout the adventure (some mandatory to continue the adventure, some purely optional), focuses on a cyberattack on the MSID22 Park, and the player must correctly complete several activities to reactive different components of the Park's defences, as well as unlock special items that will help protect them from threats (represented within the game by diamond armour pieces).

In the Park Entrance, an NPC Technician is the first to mention that there is something wrong with the Park's mainframe. Advancing through the Park's Entrance, before entering the first building, the player is forced to interact with an NPC Agent that exposes the premise of this narrative to the player: the Park's mainframe is under attack and the player must advance through the buildings to reactive the Park's defences and unlock a special armour.

In the Antivirus & Firewall building, the player must save the NPC in Trouble from the intruders (Skeletons) by completing the puzzle and reactivating the Park's Firewall. If the player

manages to do so, they may then interact with the NPC in Trouble that unlocks the first piece of armour.

In the Password Security & Phishing building, the player is asked to simulate within the game a login into the Park's website to reactivate its automated defence mechanisms. An NPC Marvin shows the player the password, who must then choose the correct login area to insert it. Choosing the correct path reactivates the Park's defences and unlocks the second piece of armour.

In the Intellectual Property & Piracy building, should the player once again choose the correct path, several NPCs will ask the player questions regarding internet security. These characters are revealed to be security agents looking for possible threats within the park. Should the player answer all the questions correctly, the store is deemed as safe from the cyberattack and the third and final piece of the armour is unlocked.

The player can then receive these rewards in the Adventurer's Cabin, before navigating (ideally well armoured) through the Final Maze.

3.5 The Characters

Throughout this world several NPCs fulfil important roles in the adventure, the experience, and the narrative. These characters will not only help teaching the players about internet security while guiding them through the puzzles, but also fulfil the important role of conveying the narrative to the players.

There are 2 types of main recurring NPCs, introduced ahead. These characters carry the most important roles not only in the story but also in the park itself. Several iterations can be found throughout the adventure, and so for quick association and easy identification these characters always carry the same skin, shown below in Figure 2.



Figure 7 - Marvin & Guide

Marvins: Immediately as the adventure begins, players are confronted with the first iteration of one of the most important characters, a Marvin. Marvins are robots stationed throughout the park that provide important information to the players and offer reflection points on the discussed internet safety topics.

Guides: Guides can be found in every building. These NPCs represent most of the Park's staff and help the player navigate through the rooms and puzzles.

While not featured as many times throughout the adventure, there are several other characters that fulfil important roles in more punctual situations, presented below:

Visitors: Scattered throughout the whole park, the player can find and interact with other visitors. These characters help immerse the player into the world, as any park would receive several guests, and some of them give the player tips about internet security.

Agent: This NPC fulfils the extremely important role of exposing the player to the cyberattack narrative and asking for their cooperation.

Technicians: These NPCs help transmit the narrative that the cyberattack is causing problems in the park by highlighting the damage they are trying to repair.

Engineer: An employee of the MSID22 Park, this NPC helps the player solve the puzzle in the Antivirus & Firewall building.

NPC in Trouble: An NPC that is under immediate threat due to the Park's antivirus being disabled, and the player must solve the first puzzle to save. If the player is successful, they will then unlock the first reward.

Security Guard: Stationed outside the Password Security & Phishing building, this NPC teaches the player about Phishing and the consequences of not being careful with one's passwords.

Salesmen: Found in the Intellectual Property & Piracy building, Salesmen are ill-intended NPCs trying to conn the player by selling or promising things that were illegally acquired.

Users: Also found in the Intellectual Property & Piracy building, Users are NPCs whose unawareness led them to participate in bad internet safety practices. Interacting with them may help them understand the correct path of action.

Clients & Store Owner: Undercover security agents, they can be found in the Store portion of the Intellectual Property & Piracy room. Assessing threats inside the park, they ask the player questions about good internet safety practices.

4. Empirical Work

With the test object's construction complete, it was possible to advance to the main task of this research: conduct tests with students to understand the impact of storytelling and Minecraft in the learning process.

These tests were conducted thanks to the support from Escolaglobal, a private school established in Santa Maria da Feira, that opened their doors to this project across several days in March and April of 2022. Sessions were held with 10 different classes: 2 classes from the 3rd grade, 2 classes from the 4th grade, 3 classes from the 5th grade, and 3 classes from the 6th grade.

To compare the impact of the various variables (Minecraft and storytelling), 3 types of sessions were prepared:

1. Minecraft with storytelling and game-design elements
2. Minecraft without added elements
3. Traditional presentations

To understand the impact of Minecraft in the learning process, it was necessary to have a term of comparison for these activities. For that end, in 3 of the 10 sessions, instead of exploring a Minecraft World, students were exposed to a traditional presentation where I, supported by a Microsoft Power Point presentation, talked with the students about Internet Safety. Further information on these sessions can be found ahead in section 4.1.

3 classes participated in sessions with Minecraft with storytelling, 4 classes in sessions with Minecraft without added Storytelling elements, and 3 classes in sessions with Traditional presentations. The distribution of classes through the session was done as Table 2 below presents:

Table 2 - Class distribution for each session

Session	3 rd grade	4 th grade	5 th grade	6 th grade
Minecraft with storytelling	1		1	1
Minecraft without added storytelling	1	1	1	1
Traditional presentation		1	1	1

This distribution was made with the goal of maximizing the diversity of sessions within each grade. The classes that participated in the different sessions within each year were randomly selected when possible, with the exception of grouping the smaller classes into the same session (randomly selected to be Minecraft without added storytelling) to approximate the number of participants in each session. Coincidentally, the session presented to 4 classes ended up accumulating the fewest individual participants.

The sessions with Minecraft began with a short introduction to the topic of internet safety and the study. Students were then given access to the adapted versions of the MSIS22 Park and invited to explore it. I was present in the room and available for answering questions and assisting the students throughout.

Each session with Minecraft lasted around 1 hour and 20 minutes, while the sessions with traditional presentations lasted around 1 hour. At the end of each session, all students answered an enquiry about their experience, thoroughly explained ahead in section 4.2.

4.1 Traditional Presentations

As explained in section 3.1, in the Safer Internet Day activities from previous years, Power Point presentations we used to support the speakers during their sessions, that the first part of this project aimed to add to. Therefore, these already constructed presentations offered the perfect basis for a control session, truly comparing the success of using Minecraft over the method previously in use for this exact scenario.

For this project, I made slight alterations to the two presentations for 1st through 6th grades and arrived at the two final versions that were showed in these “control” sessions. These presentations were prepared to touch on roughly the same topics present in the Minecraft worlds made available in the other sessions. However, given the opportunity of discussing with children such relevant issues of the modern days, some extra points that the Minecraft world did not touch on were also discussed during these sessions. This also brought some adjustments to the original distribution of topics, namely the insertion of Social Networks in the discussion with students of the 5th and 6th grades, a specific topic I found to be extremely relevant with children joining them earlier and earlier, and I believed proved to be fortuitous with most of the children present already familiar with them but not so much the threats and dangers they may pose. The issue distribution can be found ahead in Table 3.

Table 3 - Topic distribution in sessions with traditional presentations

Topics	4 th grade	5 th – 6 th grades
Data Sharing & Protection	X	X
Antivirus & Firewall	X	X
Phishing	X	X
Cyberbullying & Welfare	X	X
Piracy	X	X
Digital Footprint	X	X
Social Networks		X
Fake News		X

The adapted presentations can be found in **Appendix C** of this document.

4.2 Enquiries

Before any session could be held however, the enquiries had to be constructed. As the main method of collecting tangible data directly from the students, these represented an extremely important step in this research.

With the knowledge that each student of Escolaglobal would be given access to a laptop to utilize during these sessions, it made sense to reap the benefits of their ease of accessibility to computers and compose digital-based questionnaires in the shape of Microsoft Forms. At the end of each session, all students were given access to a web address where they could find this online questionnaire about their experience.

For each type of session a different questionnaire was composed, but all 3 aimed to collect information on the same topics. Each featured similar questions, merely with the linguistics adapted to fit the type of session.

When constructing the questionnaires, there were 2 main points that had to be taken into consideration:

1. The goal was to gather data on the students' interest and motivation, and therefore transform subjective opinions into quantitative data.
2. The people answering these questionnaires would be children, and so they should be constructed for easy understanding and simple answers.

While identifying the best method of gathering answers, recognizing the work by Chandel et al. (2015) highlighting the importance of cognitive symmetry in answer scales to give the respondent a fair and balanced scale of options, and considering the work by Tsang (2012) accentuating the benefits of having a midpoint option in educational to avoid forcing the respondents to choose a certain direction when they may not want to, combined with Chambers & Johnston's (2002) findings identifying that applying 3-point instead of 5-point scales with children in an attempt to simplify the options does not produce more accurate results, as well as Lissitz & Green's (1975) showing that having more than 5 points in response scales provides negligible amounts of extra utility, the conclusion came to base the questionnaire on symmetric 5-point Likert scales (Likert, 1932). Likert scales offer the enquired a sequence of choices, in this case symmetrical, frequently used to assess one's subjective feelings like interest, liking and motivation, and facilitating comparisons. An example of the employment of a 5-point symmetrical Likert scale in a questionnaire can be found in Figure 8 below.

Q: How much do you like chocolate?

- 1 - I dislike it a lot
- 2 - I slightly dislike it
- 3 - I don't like nor dislike it
- 4 - I slightly like it
- 5 - I like it a lot

Figure 8 - Example of a 5-point symmetrical Likert scale

The example shown in Figure 8 shows a symmetrical scale of options for the enquired to choose from, where option number 3 represents the centre of the scale, not pending to either side, and corresponding options diverge equally in meaning from the centre.

The final enquiry was constructed according to the principles suggested by Malhotra (2006) and Beglar & Nemoto (2014) on designing and developing Likert-scales and questionnaires, like how to choose the questions' wording and order.

The questionnaires were composed by 10 to 11 questions (the versions answered after sessions with Minecraft had 11 questions, while the traditional presentation version only had 10), that can be divided into 2 different sections (at the end of the questionnaire students also had an extra space to leave additional comments). Section 1 is common to all 3 versions and had the goal of understanding the students' familiarity with Minecraft and its use in the classroom, by asking the following questions:

1. How old are you?
2. Have you ever played Minecraft before?
3. Have you ever played Minecraft as part of a class or to learn something new?
4. Do you watch Minecraft videos during your free time?

5. Do you agree that Minecraft can be used in class to learn new things?

This would allow for the results to measure overall familiarity, interest in the game, and the pre-existing disposition to participate in educational activities through this platform.

The second section asked questions specific to the session they participated in, but that followed the same pattern (the enquiry after the traditional presentation only featured questions 6 through 10 of this section):

6. How interesting did you find this activity?

7. How much did you learn about internet safety in this activity?

8. If instead of this presentation/Minecraft you'd have participated in a Minecraft activity/presentation, do you think you would have learned more or less?

9. If instead of this presentation/Minecraft you'd have participated in a Minecraft activity/presentation, do you think it would have been more or less interesting?

10. Having a story to follow in a Minecraft adventure (would have) made it more or less interesting to follow?

11. Unlocking rewards for completing the activities (would have) made you more or less motivated to complete them?

These questions provided the main results this research aimed to collect: measuring the variance in interest from students regarding the utilization of Minecraft vs tradition presentation and, within Minecraft, the addition of storytelling and game-based elements.

The enquiries totalled 183 answers, all valid, with each enquiry registering between 56 and 66 answers. The questionnaires can be found in **Appendix D** as they were distributed (in Portuguese).

5. Results & Discussion

In this chapter the data collected through the enquiries detailed in the previous chapter is presented and analysed.

After understanding the overall interest and familiarity with Minecraft of the enquired students in the first section, the second section of the enquiries is what collects the main data for this research. It focused on collecting information in the topics of student interest and each method's success in assisting the learning process, to compare between 3 different groups, with the variable between the groups being the means of transmitting the information. Exploring student's age as a variable was also considered, but the sample was concluded to be too small to extract significant results.

As explored in section 4.2, to facilitate these comparisons, answers were collected through 5-point symmetrical Likert Scales. All of the questions from this second section (as well as the final question of the first section) featured these scales, all with the same sequence of meanings, with the top option being the extreme negative opinion towards the question, the middle option being a neutral opinion, and the bottom option the positive extreme. These scales were then translated into numbers, with the top option translated into 1 and the bottom option translated into 5, to facilitate the analysis. Frequency tables for all question are found ahead, and after each table the possible answers and respective keys are shown. This process of translating the Likert scales into integers allows the study of the responses through the mean values, and understand which method produces the better results.

Likert variables with five or more categories can be used as continuous without any harm to the statistical analysis (Johnson & Creech, 1983; Norman, 2010; Sullivan & Artino, 2013; Zumbo & Zimmerman, 1993). Nevertheless, with Likert data, the intervals between the scale values are not equal and this is the reason why only nonparametric statistics should be used (Jamieson, 2004). Therefore, to verify the relevance of the information collected through the enquiries, based on the work by Hall et al. (2006), instead of the parametric traditional ANOVA, it was decided to employ the Kruskal-Wallis H test to test mean ranks, "a rank-based nonparametric test that can be used to determine if there are statistically significant differences between two or more groups of an independent variable on a continuous or ordinal dependent

variable” (Laerd Statistics, 2018). This test, analysing the mean of the answers from each group, allowed us to understand if the differences in answers between the students that participated in the different types of sessions are statistically significant.

To correctly employ the Kruskal-Wallis H test, it’s important that the data being analysed fulfils the necessary prerequisites, these being, per Laerd Statistics (2018):

1. The dependant variable being measured on a continuous level.
2. The independent variable consisting of 2 or more categorical, independent group.
3. Independence of observation.

Prerequisite 1 is fulfilled as the answers were collected through Likert scales, an ordinal approximation of a continuous variable with the five or more categories rule applied (Johnson & Creech, 1983; Norman, 2010; Sullivan & Artino, 2013; Zumbo & Zimmerman, 1993). Prerequisite number 2 is also fulfilled, as there are 3 independent groups being compared, with the type of session each student participated in being the independent variable distinguishing them. Prerequisite 3 is also fulfilled, as there are no relationships between each group, with different participants in each group, and no participant being in more than one group.

It is important however to understand that the Kruskal-Wallis H test is an *omnibus* test statistic, meaning that it does not identify which group is statistically significantly different from the others, it only tells that at least 2 groups are different. To discuss which groups are indeed different, the mean of the responses from each group was also assessed separately, allowing an easy identification of the differences in answers.

To facilitate identification during the statistical test, each group was assigned an ID number. Tables 9 through 28 ahead use these IDs to distinct between the groups. Group 1 corresponds to the students that participated in the sessions with traditional presentations, group 2 corresponds to the students that participated in the sessions with Minecraft without added storytelling elements, and group 3 corresponds to the students that participated in the sessions with added storytelling and game-based elements.

The full tables of the statistical analysis conducted can be found in **Appendix E**.

5.1 Understanding the enquired

As mentioned above, the first section of the enquiries, identical in all 3 versions, served the purpose of understanding the overall familiarity and interest in Minecraft of the students. Ahead you can find tables 4 through 8 showing the frequency tables of the answers to these first 5 question.

Table 4 - Question 1 frequency table

1. How old are you?			
Answer	Frequency	Percentage	Cumulative Percentage
8	18	9.8	9.8
9	51	27.9	37.7
10	43	23.5	61.2
11	53	29.0	90.2
12	18	9.8	100.0
Total	183	100.0	

Table 5 - Question 2 frequency table

2. Have you ever played Minecraft before?			
Answer	Frequency	Percentage	Cumulative Percentage
No	3	1.6	1.6
Yes	180	98.4	100.0
Total	183	100.0	

Table 6 - Question 3 frequency table

3. Have you ever played Minecraft as part of a class or to learn something new?			
Answer	Frequency	Percentage	Cumulative Percentage
No	11	6.0	6.0
Yes	172	94.0	100.0
Total	183	100.0	

Table 7 - Question 4 frequency table

4. Do you watch Minecraft videos during your free time?			
Answer	Frequency	Percentage	Cumulative Percentage
No	93	50.8	5.8
Yes	90	49.2	100.0
Total	183	100.0	

Table 8 - Question 5 frequency table

5. Do you agree that Minecraft can be used in class to learn new things?			
Answer	Frequency	Percentage	Cumulative Percentage
1	9	4.9	4.9
2	6	3.3	8.2
3	15	8.2	16.4
4	39	21.3	37.7
5	114	62.3	100.0
Total	183	100.0	

Question 5 collected answers through a Likert Scale, translated into integers through the following key:

- 1 – Completely disagree
- 2 – Slightly disagree
- 3 – Don't agree nor disagree
- 4 – Slightly agree
- 5 – Completely agree

Through these initial questions, it was possible to understand that almost the entirety of the enquired students had significant experience with Minecraft, with 98.4% of them having played Minecraft before at least once, further accentuated by the fact that almost 50% of the enquired students consume more Minecraft content in their free time outside of playing it.

It's also impossible to dispute the idea that students understand Minecraft's potential uses in education, with 83.6% of the enquired either "slightly agreeing" or "completely agreeing" and an overall average answer of 4.33 in the above shown scale (placing the mean between "Slightly agree" and "Completely agree") when confronted with the idea that Minecraft can be used successfully in classrooms. However, it must be taken into account the fact that 94% of the students had already been exposed to educational activities within Minecraft.

These initial results seem to translate that most children have familiarity with Minecraft, which would facilitate its implementation as a standard tool in the classroom, but it's also important to understand the students these tests were conducted with had an added layer of familiarity, granted by Escolaglobal already employing the game as a platform in some classes, that may have eased their experience in this activity, and may not be representative of all students around the country.

5.2 Interest in the activity

Focusing now on the second section of the enquiries, the first topic assessed and compared between the 3 different groups was the students' interest in the activity, to try to identify differences in interest between traditional presentations and Minecraft activities.

First, each student was inquired in their interest in the activity they participated in. The frequency table for this question can be found below in Table 9, and the mean of each group in Table 10.

Table 9 - Question 6 frequency table

6. How interesting did you find this activity?			
Answer	Frequency	Percentage	Cumulative Percentage
1	4	2.2	2.2
2	2	1.1	3.3
3	9	4.9	8.2
4	50	27.3	35.5
5	118	64.5	100.0
Total	183	100.0	

Question 6 collected answers through a Likert Scale, translated into integers through the following key:

- 1 – Not interesting at all
- 2 – Not very interesting
- 3 – Somewhat interesting
- 4 – Quite interesting
- 5 – Very interesting

Table 10 - Question 6 means

ID	6. How interesting did you find this activity?		Value
1	Mean		4.43
	95% Confidence Interval	Inferior Limit	4.21
		Upper Limit	4.62
	Trimmed Mean		
2	Mean		4.59
	95% Confidence Interval	Inferior Limit	4.38
		Upper Limit	4.80
	Trimmed Mean		
3	Mean		4.52
	95% Confidence Interval	Inferior Limit	4.30
		Upper Limit	4.73
	Trimmed Mean		

Looking at the answers from each group, the mean value for all groups is significantly high. And while group 1 present a very slightly lower mean, all 3 groups present very similar results. As explained earlier, to assess the significance of this slight variation, the Kruskal-Wallis test was employed. Table 11 ahead present the test's statistics.

Table 11 - Question 6 Kruskal-Wallis test statistics

Test Statistics ^{a,b}	
	6. How interesting did you find this activity?
Kruskal-Wallis H	2.951
df	2
Significance	.229

a. Kruskal-Wallis test

b. Grouping Variable: ID

As explained earlier, The Kruskal-Wallis test analyses and ranks the mean values of the answers from each group to identify if there is statistically significant variance between the groups. That can be done by interpreting the value returned by the test identified as Significance. If the returned significance is lower than .05, the differences in results can be considered statistically significant.

The Kruskal-Wallis test applied to the answers of question 6 returned a significance of .229, well above the threshold of .05, and so the differences in the answers of this question do not present themselves as statistically relevant. Therefore, conclusions should not be extracted from it. Students in general showed great enthusiasm for all activities, with 91.8% of them classifying the activity as “quite” or “very interesting”. Throughout the tests, the students’ present educators all agreed that just from being a different session to what they were used, plus with a different person taking over the class, was enough to make them extremely interested and motivated. However, a second question regarding their interest was present in the enquiries.

Question 9 asked students how they think the other type of session compares to the one they participated in (students from group 1 that participated in sessions with traditional presentations were asked if they thought a Minecraft session would have been more or less interesting, and students from group 2 and 3 that participated in Minecraft sessions were asked about a session with a traditional presentation). Frequency tables of the answers for this question are shown ahead in Tables 12 and 13, and the mean of the answers of each group in Table 14.

Table 12 - Question 9 frequency table

9. If instead of this presentation/Minecraft you'd have participated in a Minecraft activity/presentation, do you think it would have been more or less interesting?			
Answer	Frequency	Percentage	Cumulative Percentage
1	39	21.3	21.3
2	50	27.3	48.6
3	40	21.9	70.5
4	22	12.0	82.5
5	32	17.5	100.0
Total	183	100.0	

Question 9 collected answers through a Likert Scale, translated into integers through the following key:

- 1 – A lot less interesting
- 2 – Less interesting
- 3 – Equally interesting
- 4 – More interesting
- 5 – A lot more interesting

Table 13 - Question 9 frequency table by ID

9. If instead of this presentation/Minecraft you'd have participated in a Minecraft activity/presentation, do you think it would have been more or less interesting?				
ID	Answer	Frequency	Percentage	Cumulative Percentage
1	1	4	6.5	6.5
	2	5	8.2	14.7
	3	22	36.1	50.8
	4	15	24.6	75.4
	5	15	24.6	100.0
	Total	61	100.0	
2	1	16	28.6	28.6
	2	25	44.6	73.2
	3	7	12.5	85.7
	4	2	3.6	89.3
	5	6	10.7	100.0
	Total	56	100.0	
3	1	19	28.8	28.8
	2	20	30.3	59.1
	3	11	16.7	75.8
	4	5	7.5	83.3
	5	11	16.7	100.0
	Total	66	100.0	

Table 14 - Question 9 means

ID	9. If instead of this presentation/Minecraft you'd have participated in a Minecraft activity/presentation, do you think it would have been more or less interesting?	Value	
1	Mean	3.52	
	95% Confidence Interval	Inferior Limit	3.23
		Upper Limit	3.82
	5% Trimmed Mean	3.58	
2	Mean	2.23	
	95% Confidence Interval	Inferior Limit	1.91
		Upper Limit	2.56
	5% Trimmed Mean	2.15	
3	Mean	2.53	
	95% Confidence Interval	Inferior Limit	2.18
		Upper Limit	2.88
	5% Trimmed Mean	2.48	

Looking at the mean values for the answers of each group, a significant difference between group 1 and groups 2 and 3 immediately jumps out. Answers from group 1 averaged at 3.52 (Between “Equally interesting” and “More interesting”), while answers from groups 2 and 3 averaged at 2.23 and 2.53 respectively (between “Less interesting” and “Equally interesting”), with the trimmed means also tending more towards the extremes than the centre of the scale. 49.2% of the students exposed to the traditional presentations agree a Minecraft activity on the same topic would have been “more” or “a lot more interesting”, while 36.1% of them agreed it would have been equally interesting, and only 14.7% believe it would have been less interesting. 65.6% of the students that participated in a session with Minecraft (from both groups 2 and 3) also agreed that a traditional presentation would have been “less” or “a lot less interesting”.

A full integer of difference between the mean values should be significant, something verified by the Kruskal-Wallis test. The results from the test can be found ahead in Table 15.

Table 15 - Question 9 Kruskal-Wallis test statistics

Test Statistics ^{a,b}	
	9. If instead of this presentation/Minecraft you'd have participated in a Minecraft activity/presentation, do you think it would have been more or less interesting?
Kruskal-Wallis H	31.821
df	2
Significance	<.001

a. Kruskal-Wallis test

b. Grouping Variable: ID

The same way students that participated in a Minecraft session generally tended to agree that a session with a traditional presentation would be less interesting, students that participated in a session with a traditional presentation tended to agree that a session with Minecraft would be more interesting.

5.3 Assisting the learning process

The following pair of questions focused on assessing if the activities helped the students learn more about the topic.

Question 7 asked the students how much they understood to have learned in the session they participated in. Similarly to the previous topic, students were also asked in question 8 how much they believed they would have learned had they participated in a different kind of activity (group 1 if they took part in Minecraft session, and groups 2 and 3 if they took part in sessions with traditional presentations).

The frequency table of the answers to question 7 can be found ahead in Table 16, and the means of each group in Table 17.

Table 16 - Question 7 frequency table

7. How much did you learn about internet safety in this activity?			
Answer	Frequency	Percentage	Cumulative Percentage
1	5	2.7	2.7
2	8	4.4	7.1
3	30	16.4	23.5
4	43	23.5	47.0
5	97	53.0	100.0
Total	183	100.0	

Question 7 collected answers through a Likert Scale, translated into integers through the following key:

- 1 – I learned nothing
- 2 – I learned little
- 3 – I learned some things
- 4 – I learned quite a bit
- 5 – I learned a lot

Table 17 - Question 7 means

ID	7. How much did you learn about internet safety in this activity?	Value	
1	Mean	4.02	
	95% Confidence Interval	Inferior Limit	3.74
		Upper Limit	4.29
	5% Trimmed Mean		4.11
2	Mean	4.41	
	95% Confidence Interval	Inferior Limit	4.13
		Upper Limit	4.69
	5% Trimmed Mean		4.55
3	Mean	4.18	
	95% Confidence Interval	Inferior Limit	3.95
		Upper Limit	4.42
	5% Trimmed Mean		4.27

Looking at the mean values of the answers from each group, group 2 presents a higher average answer of 4.41, compared to averages of 4.18 from group 3 and 4.02 from group 1, and with all 3 groups' trimmed means being closer to the extreme than the centre of the scale. The students that believed to have learned less were the ones participating in sessions with a traditional presentation, while students participating in the session with Minecraft without added storytelling elements were the ones believing to have learned the most in comparison. The Kruskal-Wallis test was also employed to confirm the statistical relevance of this variance, with the values from this test available ahead in Table 18.

Table 18 - Question 7 Kruskal-Wallis test statistics

Test Statistics ^{a,b}	
	7. How much did you learn about internet safety in this activity?
Kruskal-Wallis H	6.690
df	2
Significance	.035

a. Kruskal-Wallis test

b. Grouping Variable: ID

It is however extremely important to understand that this question did not assess how much the students actually learned, only their own perception of how much they learned.

As mentioned earlier, students were also asked to answer a question on how much they believed they could have learned had they took part in a different session. Ahead in Tables 19 through 21 are the frequency tables and mean analysis on the answers to this question.

Table 19 - Question 8 frequency table

8. If instead of this presentation/Minecraft you'd have participated in a Minecraft activity/presentation, do you think you would have learned more or less?			
Answer	Frequency	Percentage	Cumulative Percentage
1	20	10.9	10.9
2	58	31.7	42.6
3	55	30.1	72.7
4	26	14.2	86.9
5	24	13.1	100.0
Total	183	100.0	

Question 8 collected answers through a Likert Scale, translated into integers through the following key:

1 – I would have learned a lot less

2 – I would have learned less

3 – I would have learned the same

4 – I would have learned more

5 – I would have learned a lot more

Table 20 - Question 8 frequency table by ID

8. If instead of this presentation/Minecraft you'd have participated in a Minecraft activity/presentation, do you think you would have learned more or less?				
ID	Answer	Frequency	Percentage	Cumulative Percentage
1	1	2	3.3	3.3
	2	18	29.5	32.8
	3	21	34.4	67.2
	4	9	14.8	82.0
	5	11	18.0	100.0
	Total	61	100.0	
2	1	12	21.4	21.4
	2	16	28.6	50
	3	18	32.2	82.2
	4	5	8.9	91.1
	5	5	8.9	100.0
	Total	56	100.0	
3	1	6	9.1	9.1
	2	24	36.4	45.5
	3	16	24.2	69.7
	4	12	18.2	87.9
	5	8	12.1	100.0
	Total	66	100.0	

Table 21 - Question 8 means

ID	8. If instead of this presentation/Minecraft you'd have participated in a Minecraft activity/presentation, do you think you would have learned more or less?	Value	
1	Mean	3.15	
	95% Confidence Interval	Inferior Limit	2.86
		Upper Limit	3.44
	5% Trimmed Mean	3.14	
2	Mean	2.55	
	95% Confidence Interval	Inferior Limit	2.23
		Upper Limit	2.87
	5% Trimmed Mean	2.50	
3	Mean	2.88	
	95% Confidence Interval	Inferior Limit	2.59
		Upper Limit	3.17
	5% Trimmed Mean	2.87	

Looking at the responses from groups 2 and 3, students that participated in sessions with Minecraft tend to agree that they would have learned less had they been exposed to a traditional presentation instead, with students from group 2 slightly more convinced of this fact, with a mean response of 2.55 against group 3's 2.88 (but both between "I would have learned less" and "I would have learned the same"). Group 1 however, presents some interesting results. While the mean response of 3.15 says that the students exposed to a traditional presentation tend to believe that they would have learned more had they participated in an activity in Minecraft instead, the percentage of students from this group that believe they "would have learned less" or "a lot less" is 32.8%, the same 32.8% that believe they "would have learned more" or "a lot more". The mean value tending over 3 results from a seemingly stronger conviction of the students that believe they would learn more a different setting, with 11 believing they "would have learned a lot more", compared to only 2 students believing they "would have learned a lot less".

With group 1, that generally responded to having learned the least (in comparison to groups 2 and 3), being the only group with a mean of responses above 3 and thus being the only group seemingly tending to believe they would have learned more in an opposing session,

suggests all 3 groups tend to believe they would learn more in a Minecraft activity than with a traditional presentation.

As with all other comparisons, the Kruskal-Wallis test was employed to verify the statistical relevance in variation, with a significance of .030, past the threshold of .05. The results are present in Table 22 below.

Table 22 - Question 8 Kruskal-Wallis test statistics

Test Statistics ^{a,b}	
	8. If instead of this presentation/Minecraft you'd have participated in a Minecraft activity/presentation, do you think you would have learned more or less?
Kruskal-Wallis H	7.029
df	2
Significance	.030

a. Kruskal-Wallis test

b. Grouping Variable: ID

It is again important to accentuate that this question did not assess how much the students actually learned, it was only an assessment on their perception of how much they would have.

5.4 Overarching narrative

As mentioned in section 2.1 of this dissertation, Rinja & van der Jagt (2004) propose that people pay more attention to what is told when the information is put into an interesting and exciting story. Sharing a similar opinion, Dudacek (2015) proposes that employing storytelling in educational activities can significantly improve students' engagement towards the lessons.

Following the above-mentioned ideas, the enquiries also aimed to gather students' opinions on the addition of storytelling elements to Minecraft. To do so, the same question was made to the 3 groups, although through different ways.

Group 1, having participated in a session with a traditional presentation, were asked if, had they participated in a Minecraft activity, they believed a story to follow would have made such activity more interesting. Group 2, having participated in an activity with Minecraft but without the added storytelling elements, were asked if they believed that having those elements added would have made their experience more interesting. Group 3, having just participated in a

session with Minecraft with those added storytelling elements, were asked if it made the activity more interesting (these elements were explained in the question, being the overarching narrative of the cyberattack on the park told through the characters). So overall all 3 groups were asked on how they believed having a story to follow impacted a Minecraft adventure.

The frequency table and the analysis through the mean of the responses are available below in Tables 23 and 24.

Table 23 - Question 10 frequency table

10. Having a story to follow in a Minecraft adventure (would have) made it more or less interesting to follow?			
Answer	Frequency	Percentage	Cumulative Percentage
1	2	1.1	1.1
2	9	4.9	6.0
3	35	19.1	25.1
4	53	29.0	54.1
5	84	45.9	100.0
Total	183	100.0	

Question 10 collected answers through a Likert Scale, translated into integers through the following key:

- 1 – It (would have) made it a lot less interesting
- 2 – It (would have) made it less interesting
- 3 – It (would have) made it equally interesting
- 4 – It (would have) made it more interesting
- 5 – It (would have) made it a lot more interesting

Table 24 - Question 10 means

ID	10. Having a story to follow in a Minecraft adventure (would have) made it more or less interesting to follow?	Value	
1	Mean	3.82	
	95% Confidence Interval	Inferior Limit	3.57
		Upper Limit	4.07
	5% Trimmed Mean	3.89	
2	Mean	4.11	
	95% Confidence Interval	Inferior Limit	3.85
		Upper Limit	4.36
	5% Trimmed Mean	4.17	
3	Mean	4.45	
	95% Confidence Interval	Inferior Limit	4.24
		Upper Limit	4.67
	5% Trimmed Mean	4.56	

Regarding the addition of an overarching narrative, with 137 out of 183 students answering either “It (would have) made it more interesting” or “It (would have) made it a lot more interesting”, 74.9% of the enquired students believed the inclusion of an overarching narrative would increase their interest in the Minecraft adventure. Group 1 presented an average response of 3.82 (close to “It would have made it more interesting”), group 2 gave an average response of 4.11 (also close to “It would have made it more interesting” but tending instead to “It would have made it a lot more interesting”), and group 3 responded with an average of 4.45 (between “It would have made it more interesting” and “It would have made it a lot more interesting”). All 3 groups tended to agree that the addition of an overarching story made a Minecraft adventure more interesting, although not with the same convictions. The group that indeed experienced an overarching story were the most enthusiasts about it, while group 1, not having participated in any Minecraft session shared the same opinion, but seemingly not with as much conviction. Therefore, the Kruskal-Wallis test was also employed, to verify these apparent differences. The results are shown in Table 25 ahead.

Table 25 - Question 10 Kruskal-Wallis test statistics

Test Statistics ^{a,b}	
	10. Having a story to follow in a Minecraft adventure (would have) made it more or less interesting to follow?
Kruskal-Wallis H	17.114
df	2
Significance	<.001

a. Kruskal-Wallis test

b. Grouping Variable: ID

All groups tended to agree that the addition of storytelling elements can improve students' interest in the activity, as proposed by Dudacek (2015). Being exposed to those elements also fortified that idea, but with the Kruskal-Wallis test revealing a significance lower than .001 (and thus also lower than the threshold of 0.05), these differences in ideas between the groups, while seemingly small at first glance, are statistically relevant, confirming that students exposed to an overarching narrative further identify an increase in motivation from it.

5.5 Reward system

Finally, the incorporation of game-based features in a Minecraft journey was appraised in the enquiries, through the reward system existing in the version that group 3 was exposed to. Question 11 - the question asking students about their changes in motivation by having (or not) rewards for completing the proposed tasks correctly - was only present in the enquiries given to students from groups 2 and 3, those that indeed participated in sessions with Minecraft. This choice was due to the question being directly connected to the activities that the students in these groups were tasked to complete. While it was considered to be fruitful to ask group 1 about their ideas on the addition of an overarching story, where it was believed relevant answers could be gathered nonetheless, on this specific topic it was understood it would be fruitless to ask them about something that was believed to be essential to have experienced first-hand. For this reason, question 11 collected only 122 answers, as opposed to the 183 from the other questions.

The frequency table for the answers to this question and their means for groups 2 and 3 are shown ahead in Tables 26 and 27.

Table 26 - Question 11 frequency table

11. Unlocking rewards for completing the activities (would have) made you more or less motivated to complete them?			
Answer	Frequency	Percentage	Cumulative Percentage
1	2	1.6	1.6
2	5	4.1	5.7
3	13	10.7	16.4
4	33	27.0	43.4
5	69	56.6	100.0
Total	122	100.0	

Question 11 collected answers through a Likert Scale, translated into integers through the following key:

- 1 – It (would have) made me a lot less motivated
- 2 – It (would have) made me less motivated
- 3 – It (would have) made me equally motivated
- 4 – It (would have) made me more motivated
- 5 – It (would have) made me a lot more motivated

Table 27 - Question 11 means

ID	11. Unlocking rewards for completing the activities (would have) made you more or less motivated to complete them?		Value
2	Mean		4.32
	95% Confidence Interval	Inferior Limit	4.07
		Upper Limit	4.58
	5% Trimmed Mean		4.43
3	Mean		4.33
	95% Confidence Interval	Inferior Limit	4.10
		Upper Limit	4.56
	5% Trimmed Mean		4.44

83.6% of the enquired students agree that knowing they could receive rewards for correctly completing activities would increase their motivation to do so (selecting either “It (would have) made me more motivated” or “It (would have) made me a lot more motivated”), with the answers from both groups being extremely similar. The mean of the answers from group 2 is 4.32 (between “It would have made me more motivated” and “It would have made me a lot more motivated”), while for group 3 is 4.33 (similarly between “It made me more motivated” and “It made me a lot more motivated”). The trimmed means presented the same .01 difference. Nonetheless, the Kruskal-Wallis test was employed to verify the similarity. Results from the test are shown below in Table 28.

Table 28 - Question 11 Kruskal-Wallis test statistics

Test Statistics ^{a,b}	
	11. Unlocking rewards for completing the activities (would have) made you more or less motivated to complete them?
Kruskal-Wallis H	.007
df	1
Significance	.934

a. Kruskal-Wallis test

b. Grouping Variable: ID

As expected, the Kruskal-Wallis test presented a significance of .934, and therefore the difference between groups can be ignored. It’s fair to assess that both groups, whether they were exposed to the reward system for correctly completing the tasks or not, agree that knowing that correctly completing them would bring rewards in the game significantly motivated them.

5.6 Other Observations

As mentioned in chapter 4.1 in the detailing of the construction of the enquiries, at the end of the questions explored above, students had an extra space where they could leave comments and other remarks, discussed here.

Frequent comments included things like wishes for the world to be longer and having more puzzles, features available in the full version of the world but that had to be reduced to fit the available timeframes.

A recurring comment from students from group 3 was the idea that a final “boss battle”, where players can utilize the rewards they unlocked through the adventure and face off against the invaders would bring a sense of completion to the narrative and the adventure. This hypothesis was indeed considered during the world creation but ended up being scratched as to not promote violence. The goal of the narrative was set more as “Reactivating the Park’s defences”, than as “Defeating the invaders”. It is however a thought to consider in the future, because despite possibly transmitting a slightly different message, boss fights are indeed a big part of a large portion of games and would undoubtedly represent a stronger climax to the overarching narrative.

Other comment that more than one student placed referred to the lack of weight felt from choosing the wrong path in some of the puzzles. Despite the world trying to transmit some sort of sanction for choosing the unsafe route, several students felt that these wrong options did not express the true impact that such choice would convey in real life.

Several students called for a multiplayer version of the adventure instead of a solo adventure. With the significant popularity of multiplayer games, it could certainly help to further increase interest from the students, but how much it could assist the learning process versus generating possible distractions is a topic that would need additional investigation.

Finally, a significant problem to the overall experience was observed time and time again. Despite most students affirming to be fans of the storytelling elements, a significant portion of them was not very inclined to follow the instructions and interact with the NPCs, especially in students from the 5th and 6th grades. Before starting, all students were recommended to interact with every NPC they found, in particular Marvins and Guides. However, throughout the sessions a student would repeatedly call for help because they did not understand what they had to do next, a situation that was always solved by interacting with a nearby character. After each of these calls for help all students would be reminded that interacting with the NPCs would answer almost any doubt, and yet it wouldn’t take longer than 5 minutes for another student to find themselves “stuck”.

Another frequent similar occurrence was students interacting with NPCs but not paying attention to the dialogue, leading students to miss on portions of the story or activities altogether. In the entrance of the Intellectual Property & Piracy Building players have the activity of designing their own pattern, an important task to the understanding of the second room of this building. However, even though the room was designed in a way that players were forced to interact with the NPC Guide explaining the activity before they could advance, players would interact only so the door would open, not pay attention to the dialogue, and dart through to the next room, thus missing an important part of the activity.

With interactions with NPCs not coming as naturally as expected during the construction of the MSID22 Park, the way of conveying the narrative may have to be rethought.

6. Conclusions & Future Work

From its conception, this project aimed to understand how Minecraft can be best applied to assist the learning process, and the impact of incorporating storytelling into Minecraft in educational contexts.

To achieve these goals, after understanding how it has been used to assist the learning process by conducting a thorough literature review on the applications of Minecraft in education, a case test was conducted with 10 classes from the 3rd to the 6th grades from Escolaglobal. For this, in association with Visionarium, a Minecraft world was developed from scratch, the Microsoft Safer Internet Day 2022 Park, promoting an adventure through a theme park with the goal of teaching players about internet safety. 4 classes explored an adaptation of this world, featuring an overarching narrative and other game-based elements like a reward system for correctly completing several puzzles throughout the adventure. 3 classes explored a different adaptation of the same world, without the storytelling and game-based elements. A traditional presentation regarding the same internet safety topics was also assembled and presented to the remaining 3 classes, instead of participating in a session with Minecraft.

Following each session, students responded to an online survey built with Likert scales that yielded a total of 183 valid responses, enabling comparisons of student interest and motivation between the groups that took part in the various sessions. From the information extracted from these enquiries, an activity presented in a Minecraft world, constructed from scratch for this purpose and incorporating an overarching narrative and game-based elements like reward systems, is concluded to be the most successful way to employ Minecraft in education.

The statistical methodologies applied in this study conclude that students strongly agree that an activity presented through Minecraft instead of through a traditional presentation positively impacts their interest and motivation. The statistical analysis also concludes that Minecraft can positively impact the learning process, with the enquired students tending to identify Minecraft as the better tool to assist their learning process. However, it's important to understand this study did not measure how much students actually learned, only their own perception of how much they learned or could have, and future works may look to assess this limitation. One potential approach would have students answer to a test before being exposed to

the novel contents, and another one after the activities, to properly measure each method's impact in the learning process. Unfortunately, due to the complexity and time requirements of the task, this study was forced to drift away from this methodology.

The incorporation of storytelling elements also proved to be vehemently beneficial to students' motivation. Nonetheless, further analysis on the best way to convey the overarching narrative is necessary. Using only interactions with NPCs can frequently lead to students missing important chunks of the story or information, as not all of them are inclined to frequently interact with the NPCs. The narrative structure is another aspect that future studies should focus on, with students recurringly asking for a stronger climax to the story, as well as an increase in the weight of the choices they were confronted with throughout the adventure. And while Minecraft's main selling point will continue being its sandbox features, the incorporation of certain game-based elements in educational activities proves to register positive results in the students, with participating students firmly agreeing that knowing they can receive in-game rewards for correctly completing each given task would make them more motivated to do so.

To continue exploring the incorporation of storytelling elements and Minecraft's impact in education, additional tests with more classes should be conducted, where students may participate in distinct types of sessions to maximize the number of methods each student is exposed to. It may also be interesting to benefit from Minecraft's documented versatility to explore other subjects, ideally applying contents from the national educative program, which could provide a more tangible benefit to Minecraft's application in education. Future works with larger sample fields may also look to operate with age as a variable, to explore possible distinctions in its success with certain ages. Finally, with students participating in this research frequently expressing how they wished they could have partaken in this adventure with their friends, the possibility of adding multiplayer features to similar activities is another idea that further studies may explore, supported by Callaghan's (2016) and Torquato & Torquato's (2017) reports of success with multiplayer activities within Minecraft.

After projecting and constructing a brand-new Minecraft world, implementing it in a rigorous set of tests with 183 students and conducting a thorough statistical analysis to the information collected, this study accentuates the successful impact of employing Minecraft in Education, highlighting the incorporation of storytelling and new game-based elements into the game to further assist the students of today with their learning process.

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Appendices

Appendix A - Minecraft

This chapter presents a quick review into Minecraft, the software that serves as the platform for the research for this dissertation.

The best-selling video game of all time⁵, Minecraft is a sandbox video game available on multiple platforms. Developed by Mojang Studios, it was fully released in 2011 after originally being made available for testing in 2009. In 2014, Microsoft purchased Mojang Studios and took ownership over Minecraft intellectual property, with Mojang being maintained as a subsidiary company. While the game continues to be developed and updated by Mojang, several expansions and spin-offs have since been released, like Minecraft Dungeons and the one that is explored further ahead, Minecraft Education Edition.

In Minecraft, the player can explore virtually infinite digital block-based worlds, while exploring the three fundamental actions the gameplay is based around:

- Mining – breaking block to collect raw materials and items.
- Crafting – combining collected materials to create new blocks, tools, and items.
- Building – placing blocks to create structures.

It offers the players two main playing modes:

- Survival – An adventure style mode where players must find, mine and craft resources to maintain their health and survive, while being faced with the challenges of hunger and hostile mobs.
- Creative – A sandbox mode, where players have unlimited resources and can freely explore the limits of their creativity.

While the original version was developed in Java, after development to make Minecraft accessible on multiple platforms, including those that do not support Java, a separate version was rewritten in C++, a version that is now commonly known as the Bedrock Edition. Both versions are available, with the Java version (available only for Windows, Mac, and Linux) being known for how customizable it is, despite a steeper learning curve in terms of

⁵ Per the Minecraft Franchise Fact Sheet published by Xbox Game Studios in April 2021

customization, while the Bedrock edition (available for all platforms) offers more restricted customization, but through an official content store called Minecraft Marketplace.

Minecraft Education Edition

With the growing recognition for Minecraft's utility in an educational environment, and its popularity rising within the teaching community, in 2016 Mojang Studios announced the release of an adapted version introducing several new features designed to facilitate its use in the classroom. Thus Minecraft Education Edition was born. This version, available for free to any student with an Office 365 Education account, introduced a significant number of new mechanics to the original version of the game, the most relevant being the following:

- Easy Classroom Collaboration – Any teacher or student can set up a world directly from their device, allowing to host up to 30 students without the need of a separate server setup.
- Classroom mode – A utility tool for teachers that gives them the capability of monitoring the entire world, the location of every student, the ability to teleport them, and a chat window to communicate.
- Code Builder – This feature gives students and educators the possibility of exploring code writing from within the game with a simple interface and mechanics suited for learning.
- Permission blocks – New blocks for the educators to place and restrict where the students can move, place, and break blocks.
- Chemistry Resource Pack – An exclusive set of blocks and items, from chemical elements to lab tables, that allows the players to learn and explore the wonders of chemistry in a safe environment.
- Cameras and portfolios – New items that give students the possibility of taking photographs of themselves and their creations, that are then stored in a portfolio and easily exported to their computers.
- NPCs – Students and educators have the ability of creating non-playable characters and give them specific instructions, being for them to serve as instructors to students, execute tasks like giving or removing specific items or blocks, and being programmed to perform specific actions through code.
- Many lessons and worlds downloadable for free from education.minecraft.net.

In association with this project, Microsoft now offers online formations at education.minecraft.net to teachers and parents to get accustomed with the games and promote its use either at home or in the classroom as a learning assistance tool.

Appendix B - MSID22 Gallery



MSID22 Park



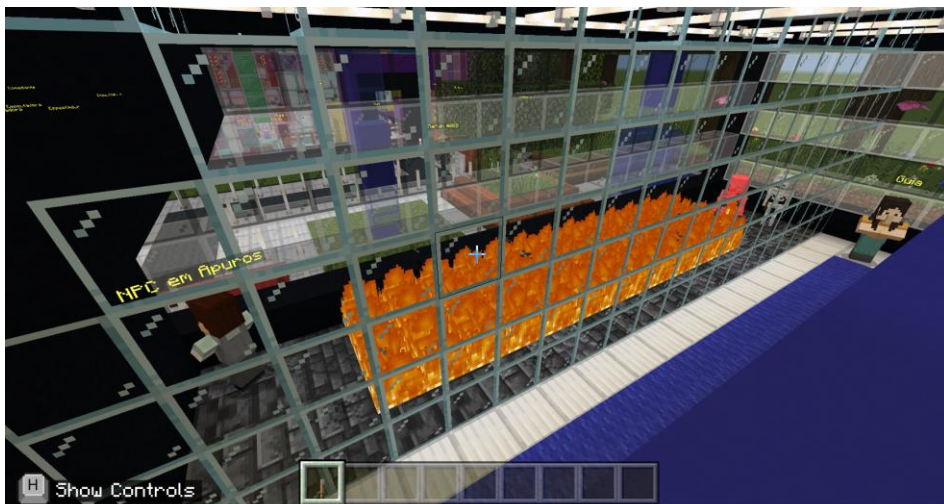
MSID22 Park



MSID22 Park



Spawn room



Firewall exhibit in Antivirus & Firewalls building



Entrance to Phishing room in Password Security & Phishing building



Safe login room in Password Security & Phishing building



Software Updates building



Entrance of Fake News building



Lab room in Fake News building



Library room in Fake News building



Piracy section in Intellectual Property & Piracy building



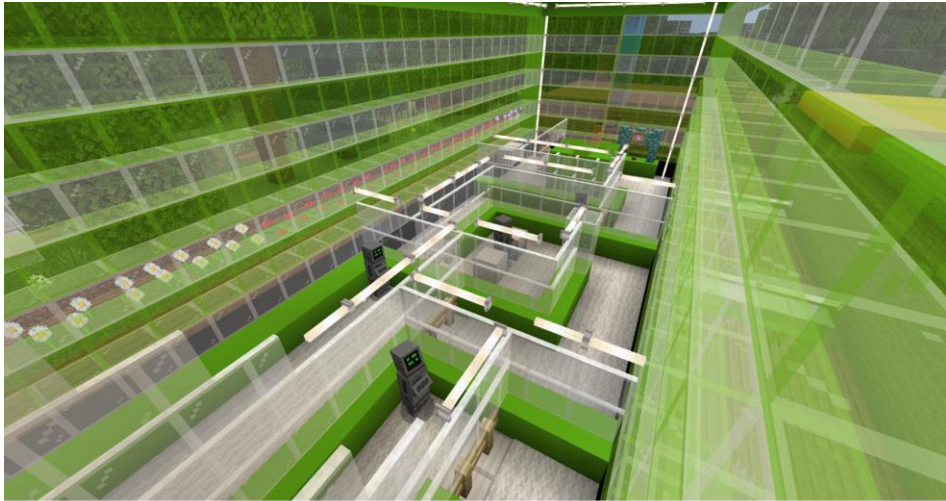
Data Protection building



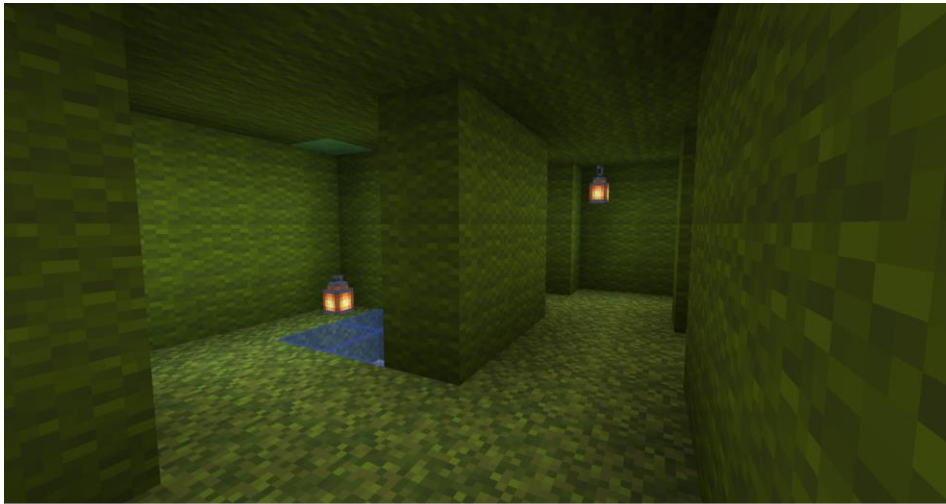
Ride in Data Protection building



Customs room in Data Protection building



Cyber Bullying building



Final Maze



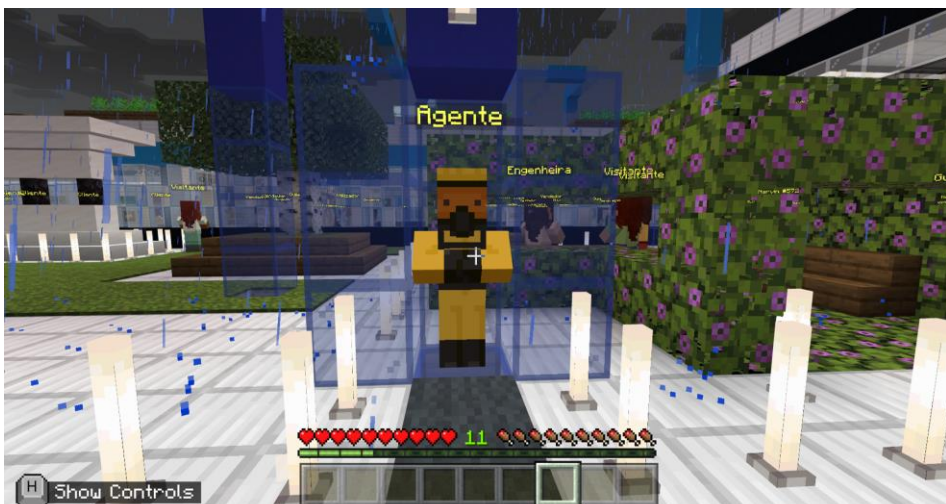
Final Maze Ending



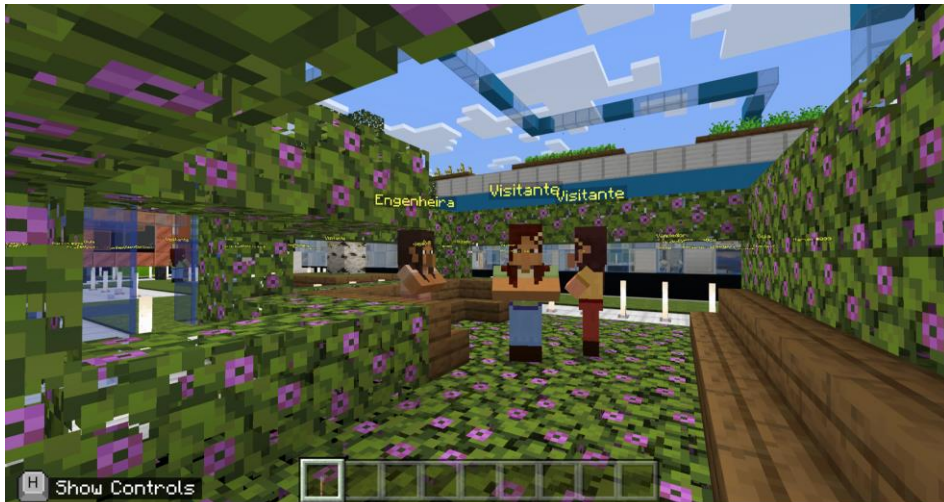
TuboBus after Password Security & Phishing building



Control rooms



NPC Agent



NPC Engineer



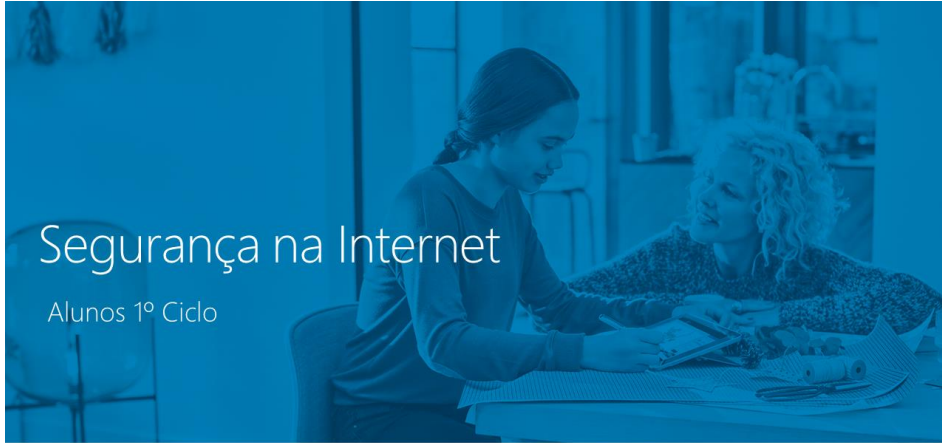
NPC Technician

MSID22 Park Video Showcase

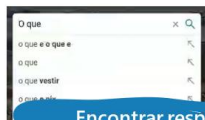
<https://youtu.be/3xokAJpAn2A>

Appendix C - Adapted SID Presentations

3rd and 4th grades



O que consegues fazer na Internet



Encontrar respostas para as tuas perguntas



Jogar



Ver vídeos



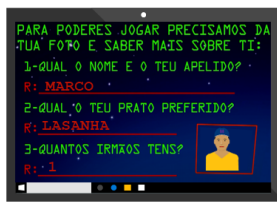
Falar com amigos

Dilema

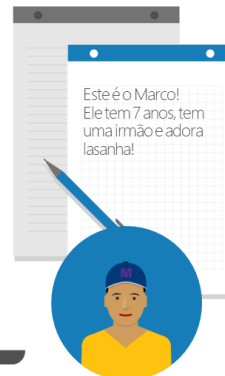
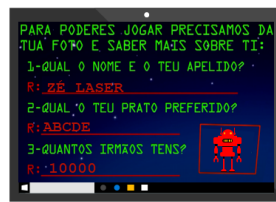
Vamos jogar?



1



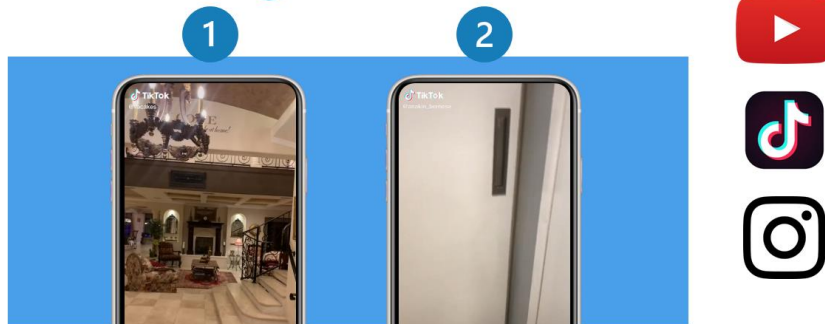
2



Dilema

Vamos jogar?

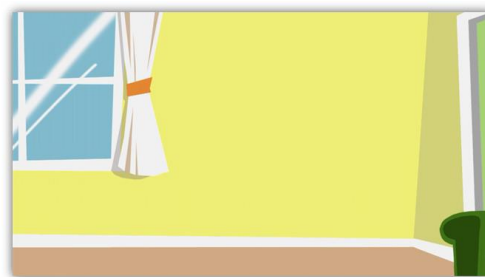
Microsoft GNR



Os teus Dados são Pessoais

Microsoft GNR

- ➔ Nunca fornecer os teus dados pessoais (nome, idade, foto, morada, ...).
- ➔ Usa nomes fictícios (inventados).
- ➔ Desconfia de quem te pede essa informação.
- ➔ Se não tiveres a opção de duplo fator para a tua autenticação, escolhe palavras difíceis de descobrir.

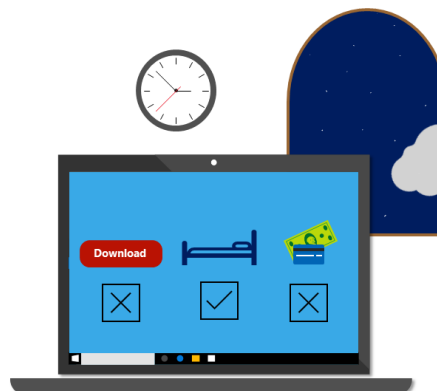


As palavras passe mais usadas em 2020: [123456](#) [123456789](#) [picture1](#) [password](#) [12345678](#) [111111](#)

Joga... Mas em segurança!

Microsoft GNR

- ➔ Muitos jogos online contêm vírus, não os descarregues para o teu computador!
- ➔ Mantém o Antivírus atualizado e a Firewall ligada.
- ➔ A dependência pode afetar a tua saúde. Reserva momentos de descanso *offline*.
- ➔ Muitos jogos estão associados a compras e a subscrição de serviços online.



Joga... Mas em segurança!

- Uma vez na Internet, para sempre na Internet.
- Se não tens a certeza se deves partilhar, não partilhes!
- Evita partilhar fotos que possam envergonhar-te a ti ou aos outros.



Fiz uma amiga na Internet! Ela compreende-me mesmo...

"Comigo tens sempre um amigo com que podes contar para te ouvir."

"Pois, eu sei que os teus pais não te compreendem e a culpa é deles."

"Se precisares de alguma coisa, diz-me e eu ajudo-te. Até nos podemos encontrar."



"Sempre que quiseres falar, podes ligar-me... Tens aqui o meu nº de telemóvel. Se quiseres, podes dar-me o teu."

Quem estará do outro lado?

- Os teus pais devem sempre saber o que fazes na Internet.
- Quem está do outro lado nem sempre é quem tu pensas.
- Desconfia de quem te pergunta onde vives ou outras informações pessoais.
- Não fales online com quem não conheces na vida real



Bullying e Cyberbullying

- Se alguém te faz mal...QUEIXA-TE!
- Esconderes-te não é a solução!
- Fica atento aos sinais dos teus colegas.
- Não respondas a desafios que achas que te podem magoar a ti ou aos outros.



Fenómenos e dinâmicas criminais que ocorrem no meio digital

- Clonagem de cartão de crédito/débito.
- Compra/venda
- MB Way
- Roubo de dados
- Internet – visita de site
- Entregas de encomendas
- Publicações da internet

Quem comete estes crimes no meio digital, faz-se por



- Outro funcionário
- Empresário
- Amigo da família
- Bancário
- Funcionário da EDP

Acima de tudo...



E aproveita as vantagens da Internet para...

- Aprender mais
- Conhecer o mundo
- Comunicar mais facilmente
- e para te divertires!

Joga, mas com cuidado

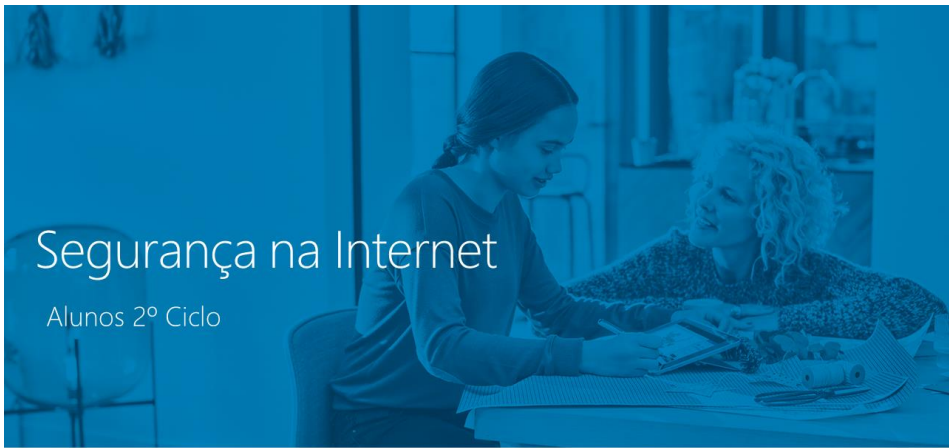
Cuidado com o que partilhas

Respeita as diferenças

Não respondas a provocações

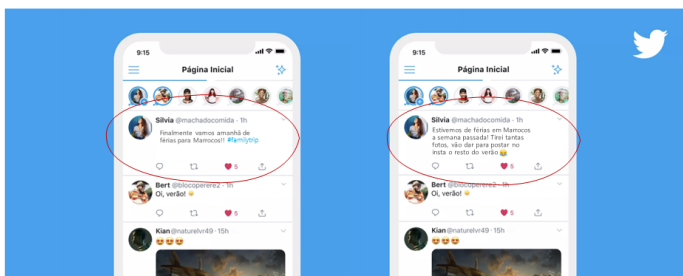


5th and 6th grades



Dilema

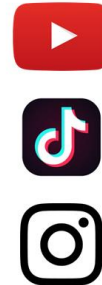
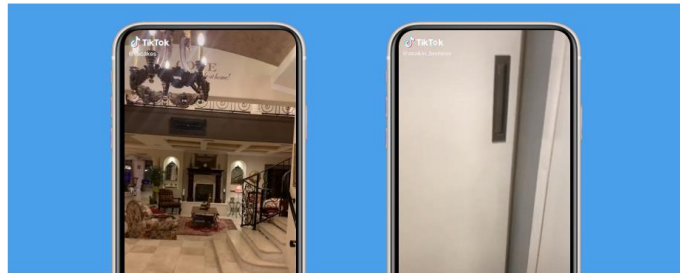
Vamos jogar?



Dilema

Vamos jogar?

Microsoft GNR



Nas Redes Sociais...

Microsoft GNR



Alguma vez te colocaram em grupos com pessoas que não conhecias?

Alguma vez publicaste vídeos que te expunham a ti ou aos teus amigos?



Alguma vez partilhaste uma notícia que não sabias se era verdadeira?

Alguma vez publicaste vídeos em que partilhavas como era a tua casa?

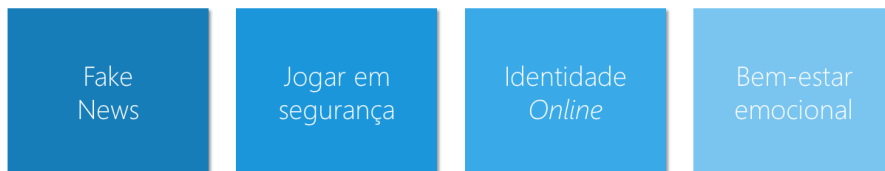


Alguma vez partilhaste detalhes sobre as tuas rotinas e sítios onde estarias?

Alguma vez publicaste stories a responder a todas as perguntas pessoais que te faziam?



Microsoft GNR



Que cuidados deves ter quando utilizas a Internet?



Bem-estar emocional



Estás demasiado tempo online? E a jogar? ↩
Presta atenção aos sinais de vício
(mudanças de humor, privação de sono, ...)

Reserva momentos offline ↩

Não publiques coisas falsas ou que
possam humilhar alguém na Internet ↩

Pede ajuda aos teus pais, amigos ou
professores. ↩

Fenómenos e dinâmicas criminais que ocorrem no meio digital



- Clonagem de cartão de crédito/débito.
- Compra/venda
- MB Way
- Roubo de dados
- Internet – visita de site
- Entregas de encomendas
- Publicações da internet

Quem comete estes crimes
no meio digital, faz-se por



Outro funcionário

Empresário

Amigo da família

Bancário

Funcionário da EDP

Acima de tudo...

Não te esqueças que fazes parte da geração mais informada de sempre.
Tens todo o conhecimento do mundo à distância de um clique!

Por isso, aproveita as vantagens
da Internet para...

- Aprender mais
- Conhecer o mundo
- Comunicar mais facilmente
- e para te divertires!



Juntos por uma Internet melhor!



Dia da Internet Mais Segura

Cria e partilha com responsabilidade:
Uma internet melhor começa contigo

1

Desfoca o plano de fundo! Nas chamadas de vídeo, garante que proteges a tua privacidade.

2

Sentes-te ameaçado ou deprimido? Não estás sozinho. Pede ajuda e ajuda os outros

3

Uma boa prática passa por garantir que carregas em "sair" quando a chamada de vídeo termina!

4

Agora, mais do que nunca, não te esqueças de reservar momentos offline.

5

Com tanta informação online, garante que esta é verdadeira antes de partilhares.

6

Não te esqueças: uma vez online, para sempre online!



Uma Parceria



Somos Solução



anespo
associação nacional de escolas profissionais

Consórcio Internet Segura



Obrigado!

Perguntas?

Juntos por uma Internet Melhor!



Appendix D - Enquiries

Group 1 – Traditional presentation

Atividade Internet Segura - AT

* Obrigatória

1. Quantos anos tens? *



2. Já jogaste Minecraft? *

Sim

Não

3. Já jogaste Minecraft na escola ou para aprender algo novo? *

Sim

Não

4. Costumas ver vídeos de Minecraft nos teus tempos livres? *

Sim

Não

5. Concordas com a ideia de que o Minecraft pode ser usado na escola para aprender matérias novas? *

- Discordo completamente
- Discordo um bocadinho
- Não concordo nem discordo
- Concordo um bocadinho
- Concordo completamente

6. Quão interessante achaste esta atividade? *

- Nada interessante
- Pouco interessante
- Algo interessante
- Bastante interessante
- Muito interessante

7. Achas que esta apresentação te ajudou a aprender mais sobre segurança na Internet? *

- Não aprendi nada
- Aprendi pouco
- Aprendi algumas coisas
- Aprendi bastante
- Aprendi imenso

8. Se em vez desta apresentação pudesses ter explorado um mundo no Minecraft sobre segurança na internet terias aprendido mais ou menos? *

- Teria aprendido muito menos
- Teria aprendido menos
- Teria aprendido o mesmo
- Teria aprendido mais
- Teria aprendido muito mais

9. Se tivesses explorado um mundo no Minecraft que te ensinasse estas mesmas coisas (como por exemplo o que é um antivírus e como deves ter cuidado com notícias falsas) em vez de assistires a esta apresentação teria sido mais ou menos interessante? *

- Muito menos interessante
- Menos interessante
- Igualmente interessante
- Mais interessante
- Muito mais interessante

10. Se tivesses uma história para seguir enquanto visitasses um mundo de Minecraft, como por exemplo se esse mundo estivesse a ser atacado e tivesses de completar várias atividades para reativar o sistema de defesa do mundo, em vez de explorares o mundo livremente, tornaria a experiência mais ou menos interessante? *

- Muito menos interessante
- Menos interessante
- Igualmente interessante
- Mais interessante
- Muito mais interessante

11. Aqui podes escrever o que achaste desta apresentação. Obrigado pela tua participação, espero que tenhas gostado! *

Group 2 – Minecraft without added storytelling

Atividade Internet Segura - MSS

* Obrigatória

1. Quantos anos tens? *

2. Já tinhas jogado Minecraft antes? *

Sim

Não

3. Já tinhas jogado Minecraft na escola ou para aprender algo novo? *

Sim

Não

4. Costumas ver vídeos de Minecraft nos teus tempos livres? *

Sim

Não

5. Concordas com a ideia de que o Minecraft pode ser usado na escola para aprender matérias novas? *

- Discordo completamente
- Discordo um bocadinho
- Não concordo nem discordo
- Concordo um bocadinho
- Concordo completamente

6. Quão interessante achaste esta atividade? *

- Nada interessante
- Pouco interessante
- Algo interessante
- Bastante interessante
- Muito interessante

7. Explorar este mundo no Minecraft ajudou-te a aprender mais sobre segurança na Internet? *

- Não aprendi nada
- Aprendi pouco
- Aprendi algumas coisas
- Aprendi bastante
- Aprendi imenso

8. Achas que com uma apresentação da tua professora, em vez desta atividade no Minecraft, terias aprendido mais sobre segurança na Internet?

*

- Teria aprendido muito menos
- Teria aprendido menos
- Teria aprendido o mesmo
- Teria aprendido mais
- Teria aprendido muito mais

9. Se a tua professora fizesse uma apresentação a explicar as mesmas coisas que aprendeste nesta atividade (como por exemplo o que é um antivírus e como deves ter cuidado com as tuas passwords) em vez de explorares este mundo no Minecraft teria sido mais ou menos interessante? *

- Muito menos interessante
- Menos interessante
- Iguamente interessante
- Mais interessante
- Muito mais interessante

10. Se tivesses tido uma história para seguir enquanto visitaste o mundo (como por exemplo se o parque estivesse a ser atacado e tivesses de completar as atividades para reativar o sistema de defesa do parque) teria tornado a experiência mais ou menos interessante? *

- Muito menos interessante
- Menos interessante
- Igualmente interessante
- Mais interessante
- Muito mais interessante

11. Se pudesses desbloquear recompensas (como armaduras especiais) por completar as atividades de cada sala ficarias mais ou menos motivado(a) para as completar corretamente? *

- Muito menos motivado(a)
- Menos motivado(a)
- Igualmente motivado(a)
- Mais motivado(a)
- Muito mais motivado(a)

12. Aqui podes escrever o que achas que pode ser melhorado neste mundo Minecraft. Obrigado pela tua participação, espero que tenhas gostado! *

Group 3 – Minecraft with added elements

Atividade Internet Segura - MCS

* Obrigatória



1. Quantos anos tens? *

2. Já tinhas jogado Minecraft antes? *

Sim

Não

3. Já tinhas jogado Minecraft na escola ou para aprender algo novo? *

Sim

Não

4. Costumas ver vídeos de Minecraft nos teus tempos livres? *

Sim

Não

5. Concordas com a ideia de que o Minecraft pode ser usado na escola para aprender matérias novas? *

- Discordo completamente
- Discordo um bocadinho
- Não concordo nem discordo
- Concordo um bocadinho
- Concordo completamente

6. Quão interessante achaste esta atividade? *

- Nada interessante
- Pouco interessante
- Algo interessante
- Bastante interessante
- Muito interessante

7. Explorar este mundo no Minecraft ajudou-te a aprender mais sobre segurança na Internet? *

- Não aprendi nada
- Aprendi pouco
- Aprendi algumas coisas
- Aprendi bastante
- Aprendi imenso

8. Achas que com uma apresentação da tua professora, em vez desta atividade no Minecraft, terias aprendido mais sobre segurança na Internet? *

- Teria aprendido muito menos
- Teria aprendido menos
- Teria aprendido o mesmo
- Teria aprendido mais
- Teria aprendido muito mais

9. Se a tua professora fizesse uma apresentação a explicar as mesmas coisas que aprendeste nesta atividade (como por exemplo o que é um antivírus e como deves ter cuidado com as tuas passwords) em vez de explorares este mundo no Minecraft teria sido mais ou menos interessante? *

- Muito menos interessante
- Menos interessante
- Igualmente interessante
- Mais interessante
- Muito mais interessante

10. Achas que teres uma história para seguir enquanto visitaste o mundo (teres de reativar o sistema de defesa do parque) tornou a experiência mais interessante? *

- Muito menos interessante
- Menos interessante
- Igualmente interessante
- Mais interessante
- Muito mais interessante

11. Poderes desbloquear recompensas por completar as atividades de cada sala deixou-te mais ou menos motivado(a) para completar as atividades corretamente? *

- Muito menos motivado(a)
- Menos motivado(a)
- Igualmente motivado(a)
- Mais motivado(a)
- Muito mais motivado(a)

12. Aqui podes escrever o que achas que pode ser melhorado neste mundo Minecraft. Obrigado pela tua participação, espero que tenhas gostado! *

Appendix E - Full Statistical Analysis

1. How old are you?				
Answer	Frequency	Percentage	Valid Percentage	Cumulative Percentage
8	18	9.8	9.8	9.8
9	51	27.9	27.9	37.7
10	43	23.5	23.5	61.2
11	53	29.0	29.0	90.2
12	18	9.8	9.8	100.0
Total	183	100.0	100.0	

2. Have you ever played Minecraft before?				
Answer	Frequency	Percentage	Valid Percentage	Cumulative Percentage
No	3	1.6	1.6	1.6
Yes	180	98.4	98.4	100.0
Total	183	100.0	100.0	

3. Have you ever played Minecraft as part of a class or to learn something new?				
Answer	Frequency	Percentage	Valid Percentage	Cumulative Percentage
No	11	6.0	6.0	6.0
Yes	172	94.0	94.0	100.0
Total	183	100.0	100.0	

4. Do you watch Minecraft videos during your free time?				
Answer	Frequency	Percentage	Valid Percentage	Cumulative Percentage
No	93	50.8	50.8	5.8
Yes	90	49.2	49.2	100.0
Total	183	100.0	100.0	

5. Do you agree that Minecraft can be used in class to learn new things?				
Answer	Frequency	Percentage	Valid Percentage	Cumulative Percentage
1	9	4.9	4.9	4.9
2	6	3.3	3.3	8.2
3	15	8.2	8.2	16.4
4	39	21.3	21.3	37.7
5	114	62.3	62.3	100.0
Total	183	100.0	100.0	

6. How interesting did you find this activity?				
Answer	Frequency	Percentage	Valid Percentage	Cumulative Percentage
1	4	2.2	2.2	2.2
2	2	1.1	1.1	3.3
3	9	4.9	4.9	8.2
4	50	27.3	27.3	35.5
5	118	64.5	64.5	100.0
Total	183	100.0	100.0	

7. How much did you learn about internet safety in this activity?				
Answer	Frequency	Percentage	Valid Percentage	Cumulative Percentage
1	5	2.7	2.7	2.7
2	8	4.4	4.4	7.1
3	30	16.4	16.4	23.5
4	43	23.5	23.5	47.0
5	97	53.0	53.0	100.0
Total	183	100.0	100.0	

8. If instead of this presentation/Minecraft you'd have participated in a Minecraft activity/presentation, do you think you would have learned more or less?				
Answer	Frequency	Percentage	Valid Percentage	Cumulative Percentage
1	20	10.9	10.9	10.9
2	58	31.7	31.7	42.6
3	55	30.1	30.1	72.7
4	26	14.2	14.2	86.9
5	24	13.1	13.1	100.0
Total	183	100.0	100.0	

9. If instead of this presentation/Minecraft you'd have participated in a Minecraft activity/presentation, do you think it would have been more or less interesting?				
Answer	Frequency	Percentage	Valid Percentage	Cumulative Percentage
1	39	21.3	21.3	21.3
2	50	27.3	27.3	48.6
3	40	21.9	21.9	70.5
4	22	12.0	12.0	82.5
5	32	17.5	17.5	100.0
Total	183	100.0	100.0	

10. Having a story to follow in a Minecraft adventure (would have) made it more or less interesting to follow?				
Answer	Frequency	Percentage	Valid Percentage	Cumulative Percentage
1	2	1.1	1.1	1.1
2	9	4.9	4.9	6.0
3	35	19.1	19.1	25.1
4	53	29.0	29.0	54.1
5	84	45.9	45.9	100.0
Total	183	100.0	100.0	

11. Unlocking rewards for completing the activities (would have) made you more or less motivated to complete them?				
Answer	Frequency	Percentage	Valid Percentage	Cumulative Percentage
1	2	1,1	1.6	1.6
2	5	2,7	4.1	5.7
3	13	7,1	10.7	16.4
4	33	18,0	27.0	43.4
5	69	37,7	56.6	100.0
Valid Total	122	66,7	100.0	
Omitted	61	33,3		
Total	183	100,0		

ID	6. How interesting did you find this activity?	Statistic	Standard Test Statistic	
1	Mean	4.43	.106	
	95% Confidence Interval	Inferior Limit	4.21	
		Upper Limit	4.64	
	5% Trimmed Mean	4.55		
	Median	5.00		
	Variance	.682		
	Standard Error	.826		
	Minimum	1		
	Maximum	5		
	Amplitude	4		
	Interquartile Range	1		
	Asymmetry	-2.419	.306	
Kurtosis	8.098	.604		
2	Mean	4.59	.104	

	95% Confidence Interval		Inferior Limit	4.38	
			Upper Limit	4.80	
	5% Trimmed Mean			4.69	
	Median			5.00	
	Variance			.610	
	Standard Error			.781	
	Minimum			1	
	Maximum			5	
	Amplitude			4	
	Interquartile Range			1	
	Asymmetry			-2.445	.319
	Kurtosis			7.397	.628
3	Mean			4.52	.106
	95% Confidence Interval		Inferior Limit	4.30	
			Upper Limit	4.73	
	5% Trimmed Mean			4.64	
	Median			5.00	
	Variance			.746	
	Standard Error			.864	
	Minimum			1	
	Maximum			5	
	Amplitude			4	
	Interquartile Range			1	
	Asymmetry			-2.117	.295
Kurtosis			4.658	.582	

ID	7. How much did you learn about internet safety in this activity?	Statistic	Standard Test Statistic	
1	Mean	4.02	.139	
	95% Confidence Interval	Inferior Limit	3.74	
		Upper Limit	4.29	
	5% Trimmed Mean	4.11		
	Median	4.00		
	Variance	1.183		
	Standard Error	1.088		
	Minimum	1		
	Maximum	5		
	Amplitude	4		
	Interquartile Range	2		
	Asymmetry	-.917	.306	
	Kurtosis	.205	.604	
2	Mean	4.41	.141	
	95% Confidence Interval	Inferior Limit	4.13	
		Upper Limit	4.69	
	5% Trimmed Mean	4.55		
	Median	5.00		
	Variance	1.119		
	Standard Error	1.058		
	Minimum	1		
	Maximum	5		
	Amplitude	4		
	Interquartile Range	1		
	Asymmetry	-1.954	.319	
	Kurtosis	3.123	.628	

3	Mean		4.18	.118
	95% Confidence Interval	Inferior Limit	3.95	
		Upper Limit	4.42	
	5% Trimmed Mean		4.27	
	Median		4.00	
	Variance		.920	
	Standard Error		.959	
	Minimum		1	
	Maximum		5	
	Amplitude		4	
	Interquartile Range		1	
	Asymmetry		-1.025	.295
	Kurtosis		.593	.582

ID	8. If instead of this presentation/Minecraft you'd have participated in a Minecraft activity/presentation, do you think you would have learned more or less?		Statistic	Standard Test Statistic
1	Mean		3.15	.146
	95% Confidence Interval	Inferior Limit	2.86	
		Upper Limit	3.44	
	5% Trimmed Mean		3.14	
	Median		3.00	
	Variance		1.295	
	Standard Error		1.138	
	Minimum		1	
	Maximum		5	
	Amplitude		4	
	Interquartile Range		2	

	Asymmetry		.333	.306
	Kurtosis		-.869	.604
2	Mean		2.55	.159
	95% Confidence Interval	Inferior Limit	2.23	
		Upper Limit	2.87	
	5% Trimmed Mean		2.50	
	Median		2.50	
	Variance		1.415	
	Standard Error		1.190	
	Minimum		1	
	Maximum		5	
	Amplitude		4	
	Interquartile Range		1	
	Asymmetry		.473	.319
	Kurtosis		-.406	.628
3	Mean		2.88	.146
	95% Confidence Interval	Inferior Limit	2.59	
		Upper Limit	3.17	
	5% Trimmed Mean		2.87	
	Median		3.00	
	Variance		1.400	
	Standard Error		1.183	
	Minimum		1	
	Maximum		5	
	Amplitude		4	
	Interquartile Range		2	
	Asymmetry		.356	.295
	Kurtosis		-.821	.582

ID	9. If instead of this presentation/Minecraft you'd have participated in a Minecraft activity/presentation, do you think it would have been more or less interesting?		Statistic	Standard Test Statistic
1	Mean		3.52	.147
	95% Confidence Interval	Inferior Limit	3.23	
		Upper Limit	3.82	
	5% Trimmed Mean		3.58	
	Median		3.00	
	Variance		1.320	
	Standard Error		1.149	
	Minimum		1	
	Maximum		5	
	Amplitude		4	
	Interquartile Range		2	
	Asymmetry		-.403	.306
	Kurtosis		-.376	.604
2	Mean		2.23	.163
	95% Confidence Interval	Inferior Limit	1.91	
		Upper Limit	2.56	
	5% Trimmed Mean		2.15	
	Median		2.00	
	Variance		1.491	
	Standard Error		1.221	
	Minimum		1	
	Maximum		5	
	Amplitude		4	
	Interquartile Range		2	

	Asymmetry		1.152	.319
	Kurtosis		.581	.628
3	Mean		2.53	.174
	95% Confidence Interval	Inferior Limit	2.18	
		Upper Limit	2.88	
	5% Trimmed Mean		2.48	
	Median		2.00	
	Variance		2.007	
	Standard Error		1.417	
	Minimum		1	
	Maximum		5	
	Amplitude		4	
	Interquartile Range		2	
	Asymmetry		.623	.295
	Kurtosis		-.886	.582

ID	10. Having a story to follow in a Minecraft adventure (would have) made it more or less interesting to follow?		Statistic	Standard Test Statistic
1	Mean		3.82	.125
	95% Confidence Interval	Inferior Limit	3.57	
		Upper Limit	4.07	
	5% Trimmed Mean		3.89	
	Median		4.00	
	Variance		.950	
	Standard Error		.975	
	Minimum		1	
	Maximum		5	
	Amplitude		4	

	Interquartile Range		2	
	Asymmetry		-.852	.306
	Kurtosis		.817	.604
2	Mean		4.11	.127
	95% Confidence Interval	Inferior Limit	3.85	
		Upper Limit	4.36	
	5% Trimmed Mean		4.17	
	Median		4.00	
	Variance		.897	
	Standard Error		.947	
	Minimum		2	
	Maximum		5	
	Amplitude		3	
	Interquartile Range		2	
	Asymmetry		-.620	.319
	Kurtosis		-.790	.628
3	Mean		4.45	.108
	95% Confidence Interval	Inferior Limit	4.24	
		Upper Limit	4.67	
	5% Trimmed Mean		4.56	
	Median		5.00	
	Variance		.775	
	Standard Error		.880	
	Minimum		2	
	Maximum		5	
	Amplitude		3	
	Interquartile Range		1	
Asymmetry		-1.463	.295	

	Kurtosis	1.046	.582
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ID	11. Unlocking rewards for completing the activities (would have) made you more or less motivated to complete them?	Statistic	Standard Test Statistic	
2	Mean	4.32	.128	
	95% Confidence Interval	Inferior Limit	4.07	
		Upper Limit	4.58	
	5% Trimmed Mean	4.43		
	Median	5.00		
	Variance	.913		
	Standard Error	.956		
	Minimum	1		
	Maximum	5		
	Amplitude	4		
	Interquartile Range	1		
	Asymmetry	-1.605	.319	
	Kurtosis	2.370	.628	
3	Mean	4.33	.115	
	95% Confidence Interval	Inferior Limit	4.10	
		Upper Limit	4.56	
	5% Trimmed Mean	4.44		
	Median	5.00		
	Variance	.872		
	Standard Error	.934		
	Minimum	1		
	Maximum	5		
	Amplitude	4		
Interquartile Range	1			

	Asymmetry	-1.425	.295
	Kurtosis	1.716	.582

Ranks			
	ID	N	Mean Rank
6. How interesting did you find this activity?	1	61	84.21
	2	56	97.71
	3	66	94.35
	Total	183	
Test Statistics ^{a,b}			
	6. How interesting did you find this activity?		
Kruskal-Wallis H	2.951		
df	2		
Significance	.229		

a. Kruskal-Wallis test

b. Grouping Variable: ID

Ranks			
	ID	N	Mean Rank
7. How much did you learn about internet safety in this activity?	1	61	82.84
	2	56	105.36
	3	66	89.13
	Total	183	
Test Statistics ^{a,b}			
	7. How much did you learn about internet safety in this activity?		
Kruskal-Wallis H	6.690		
df	2		
Significance	.035		

a. Kruskal-Wallis test

b. Grouping Variable: ID

Ranks			
	ID	N	Mean Rank
8. If instead of this presentation/Minecraft you'd have participated in a Minecraft activity/presentation, do you think you would have learned more or less?	1	61	103.98
	2	56	78.86
	3	66	92.08
	Total	183	
Test Statistics ^{a,b}			
	8. If instead of this presentation/Minecraft you'd have participated in a Minecraft activity/presentation, do you think you would have learned more or less?		
Kruskal-Wallis H	7.029		
df	2		
Significance	.030		

a. Kruskal-Wallis test

b. Grouping Variable: ID

Ranks			
	ID	N	Mean Rank
9. If instead of this presentation/Minecraft you'd have participated in a Minecraft activity/presentation, do you think it would have been more or less interesting?	1	61	121.83
	2	56	71.16
	3	66	82.11
	Total	183	
Test Statistics ^{a,b}			
	9. If instead of this presentation/Minecraft you'd		

	have participated in a Minecraft activity/presentation, do you think it would have been more or less interesting?
Kruskal-Wallis H	31.821
df	2
Significance	<.001

a. Kruskal-Wallis test

b. Grouping Variable: ID

Ranks			
	ID	N	Mean Rank
10. Having a story to follow in a Minecraft adventure (would have) made it more or less interesting to follow?	1	61	74.16
	2	56	89.83
	3	66	110.33
	Total	183	
Test Statistics ^{a,b}			
	10. Having a story to follow in a Minecraft adventure (would have) made it more or less interesting to follow?		
Kruskal-Wallis H	17.114		
df	2		
Significance	<.001		

a. Kruskal-Wallis test

b. Grouping Variable: ID

Ranks			
	ID	N	Mean Rank
11. Unlocking rewards for completing the activities (would have) made you more or less motivated to complete them?	2	56	61.24
	3	66	61.72
	Total	122	

Test Statistics ^{a,b}	
	11. Unlocking rewards for completing the activities (would have) made you more or less motivated to complete them?
Kruskal-Wallis H	.007
df	1
Significance	.934

a. Kruskal-Wallis test

b. Grouping Variable: ID