

INSTITUTO UNIVERSITÁRIO DE LISBOA

Boosting Children's Reading Motivation with LLM-Generated Story Crossovers

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Master in Computer Engineering

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Department of Information Science and Technology

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Gostaria de expressar a minha gratidão à minha mãe, que sempre me encorajou e me deu todo o seu apoio incondicionável em todo o meu trabalho e educação.

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Resumo

É amplamente reconhecido que a leitura é essencial para a educação das crianças. No entanto, as horas que as crianças deveriam passar a ler estão a ser cada vez mais substituídas por horas em frente de *tablets*, telemóveis ou ecrãs de computador. Para contrariar esta tendência, no âmbito desta dissertação foi desenvolvida pelo autor uma ferramenta digital que permite aos educadores criar histórias que combinam os interesses das crianças com clássicos da literatura. O objetivo é motivar a leitura indiretamente, utilizando as capacidades generativas do ChatGPT, para criar histórias cativantes que unem os clássicos da literatura com os interesses das crianças. A ferramenta simula um livro digital num *tablet*, com conteúdo textual e visual, tendo sido desenvolvida sob o paradigma do design participativo. Um estudo realizado em Lisboa, Portugal, com 20 crianças, mostra uma experiência positiva com a ferramenta e um aumento da motivação para ler os clássicos após a sua utilização. Esta dissertação apresenta a conceção, o desenvolvimento e a avaliação da ferramenta.

PALAVRAS CHAVE: Motivação para a Leitura, Large Language Models (LLMs), Aplicação Móvel Educativa, Desenvolvimento e Design da Ferramenta

Abstract

It is widely recognised that reading is essential for children's education. Nevertheless, the hours children should spend reading are increasingly being replaced by hours in front of tablets, phones, or computer screens. To counter this trend, in the context of this dissertation, a digital tool was developed by the author that allows educators to create stories that combine children's interests with literary classics. The goal is to motivate reading indirectly by using ChatGPT's generative capabilities to create engaging stories that combine literary classics with children's interests. The tool simulates a digital book on a tablet, with textual and visual content, and was developed under the participatory design paradigm. A user study conducted in Lisbon, Portugal with 20 children shows a positive experience with the tool and an increase in motivation to read the classics after using it. This dissertation presents the design, development, and evaluation of the tool.

KEYWORDS: Reading Motivation, Large Language Models (LLMs), Educational Mobile Tool, Tool Design and Development

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List of Acronyms

- **AI:** Artificial Intelligence
- **LLMs:** Large Language Models
- **SLR:** Systematic Literature Review
- **SUS:** System Usability Score
- **PIRLS:** Progress in International Reading Literacy Study
- **SDT:** Self-Determination Theory
- **HCI:** Human Computer Interaction
- **HLE:** Home Literacy Environment

CHAPTER 1

Introduction

1.1. Context

Reading is a fundamental skill that promotes intellectual and emotional growth, and is essential for children's education [1]. Even so, reading does not only concern serious topics, as it is also a form of play that expands the imagination [2]. For children to continue to develop their reading skills into their adult years, it is important that they enjoy reading and are motivated to continue reading during their younger years [3]. Reading enjoyment is even seen as more important for children's educational success than their family's socio-economic status [2]. Compared to reading for only educational purposes, reading for pleasure still benefits text-comprehension, vocabulary acquisition, writing ability, and reading attainment [2].

Children aged 8 to 10 transition from learning how to read, to reading for various reasons, such as enjoyment and learning, and start exploring different genres [4]. However, at around 9 years old there's often a decrease in reading frequency, enjoyment, and the perceived importance of reading. This decline makes it much harder to rebuild consistent reading habits once they fall off. As reading shifts from "learning to read" to "reading to learn" during this period, establishing and maintaining a reading habit becomes essential for developing their independent reading preferences [5].

However, technology has vastly altered young people's reading habits. Recent years have seen the appearance of Generation Z that is inseparable from computers, tablets and the internet [6], and whose number of hours spent in front of a screen is increasing, while reading hours is decreasing. They are expected to spend on average 6 hours per day on their mobile phone, while only picking up books once or twice a month. Young people are just not as interested in reading compared to the fast entertainment they can obtain through new media [7].

In Portugal, Progress in International Reading Literacy Study (PIRLS) 2021 has reported a decrease in reading skills compared to 2016, with only 6% of students being able to reach the most advanced reading level and the same percentage not being able to reach even the most basic reading levels. The decrease in reading ability in this year can also be influenced by the recent COVID-19 pandemic. Portugal ranks in the lower half on reading comprehension results out of the 43 countries that participated in the study [8].

One of the problems children face when trying to develop their literacy skills is identity, both as a reader and finding connections to the literature they read [9]. In addition, reading motivation increases when there is enjoyment in reading [10]. Based on Self Determination Theory's notion of intrinsic motivation, which consists on the inherent enjoyment of doing a certain action without pressures from external sources [11], children might feel more motivated if their own interests are involved. This addition of familiarity and relatability to otherwise boring stories in their perspective, may increase their interest in books that previously did not interest them, which consist of mostly books suggested by the government's reading plan [2].

Nonetheless, even with screen time increasing, young people are not yet used to digital reading and only a small percentage does so [7]. Hence, given the motivation children exhibit towards digital content, a reading tool on an electronic device with engaging stories is likely to help to combine these two areas. Additionally, Artificial Intelligence (AI) enhanced tools have been on the rise and their potential is yet to be fully explored. In fact, Artificial Intelligence in Education (AIED) has been a relevant and much researched topic in recent years, and it is predicted to only grow over time [12]. Creating stories using AI, more specifically Large Language Models (LLMs), around the children's interests might have a big impact on their reading motivation.

1.2. Research Questions

From the points presented in the context, this dissertation aims to address three research questions:

- (1) What reading habits most contribute to children's reading motivation?
- (2) Can the addition of relatability and familiarity to literary classics increase children's reading motivation?
- (3) Can LLMs create engaging stories based on children's perceived interests and literary classics?

Bearing this in mind, a tool has been developed by the author in the context of this dissertation, in which children can read stories that combine their interests with characters from literary classics and which are created by their educators using LLMs in a clear and straightforward way. The tool's design was iteratively modified with contributions from children's education professionals and the stories created by the LLM were also critiqued by them, ensuring their quality. Additionally, an experiment was conducted to understand children's reading habits and reading motivation pre and post exploration of the tool.

1.3. Objectives

The core goal of this dissertation is to boost children's reading motivation in literary classics. To achieve this, the tool developed in the context of this dissertation aims to engage children's intrinsic motivation by adding familiarity to the classics, by creating stories that combine the children's perceived interests with the literary classics. Thus, a set of three goals must first be accomplished.

The first goal of this dissertation is to review the previous work performed on the areas of children's reading motivation and gamification in reading. The second goal is to create engaging stories that combine the children's interests with literary classics using LLMs. This involves the exploration of LLMs' creative text generation, by analysing different prompt developing techniques.

Another goal is to develop a tool that aggregates the created stories, that make it possible for children to read them and for their educators to easily create more stories with any interest or literary classic. This means that it has two target users: children's education professionals and the children. As such, its design and user experience must be appropriate for both. The results obtained from the children's exploration of the tool are analyzed in order to assess if their motivation was affected.

1.4. Dissertation Structure

This section offers an overview of all chapters included in this dissertation.

Chapter 2 presents a brief explanation of the conducted systematic literature review, as well as the findings of the related works relevant to the dissertation's objectives. This section is divided into subsections, each containing the findings of previously performed work about children's reading, motivation theories, e-book's user experience, and the usage of LLMs in education. The chapter concludes with the dissertation's contribution.

Chapter 3 presents the tool development process, from its conceptualization to its implementation, along with the different iterations on the tool's design by conducting usability tests with education professionals. Additionally, it describes the crossover stories' text and image creation process using LLMs.

Chapter 4 presents the tool's evaluation, which details the experiment's design undertaken with children and the surveys developed, the description of the results gathered from the surveys and from the children's exploration of the tool, and their analysis.

Finally, Chapter 5 draws conclusions from the conducted work and presents its limitations and future research directions.

1.5. Dissemination

An 8 page paper based on this dissertation with the same title has been submitted and accepted for publication to the ICGI - International Conference on Computer Graphics and Interaction 2024 [13]. The conference papers will appear in the ICGI 2024 digital proceedings and will be submitted for publication on IEEE Xplore Digital Library [14].

CHAPTER 2

Literature Review

The first goal of this dissertation consists on conducting a Literature Review to identify gaps in research on children's reading motivation using LLMs, and to assess how to implement the tool. Thus, a Systematic Literature Review (SLR) was performed to guide the research. The subsequent sections present the literature obtained through the SLR, as well as works manually collected. The final section presents the dissertation's contribution.

2.1. Systematic Literature Review

A SLR follows a defined protocol and allows for a comprehensive and transparent search of the existing work. The SLR for this study was conducted based on steps proposed by Silva and Neiva [1] and aimed to explore the significance of reading in children's development, the methodologies used to motivate them, the influence of gamification on storytelling, and the various motivational techniques and approaches that could be implemented in the tool.

As such, the keywords used to carry on this SLR were the following: "libraries", "children", "gamification", "serious games", "reading", "engagement", "motivation", "LLM", and "chatGPT". With them, the initial search string was produced:

Search string: ("librar*" OR "reading") AND ("children") AND ("engagement" OR "motivation") AND ("gamification" OR "serious game*") AND ("LLM" OR "Large Language Models" OR "chatGPT").

In order to gather the most important information from the area of Computer Science, the SLR was aimed on the following six repositories:

- IEEE Xplore Digital Library (www.ieeexplore.com);
- Scopus (www.scopus.com);
- ScienceDirect (www.sciencedirect.com);
- SpringerLink (https://link.springer.com);
- ACM Digital Library (https://dl.acm.org).

Initially, no date limit was restricted to verify the scope of the papers. The search string was adapted to each repositories' search engine and the search was executed on all metadata. Table 2.1 shows the quantity of articles obtained on the different repositories.

For the first filter, it was defined that only papers in Portuguese and English would be allowed. It is important to note that both ACM and ScienceDirect did not have that filtering option. A second filter was tried, which applied the search string to only titles, abstracts or keywords, when possible. The Springer repository did not allow for that

Database	No Filter	First Filter	Second Filter
IEEE	0	0	0
Scopus	33	32	0
ScienceDirect	10	10	0
SpringerLink	9399	9368	-
ACM	95	95	0

TABLE 2.1. Number of articles obtained across repositories with no filter, the first filter and the second filter.

filtering option. However, in doing that, no paper was found throughout all repositories, excluding SpringerLink. As such, another search string without ("LLM" OR "Large Language Models" OR "chatGPT") was tried with the same filters applied to the previous search string. The number of papers on SpringerLink was disregarded since it did not contain the filtering option. The search results are shown on Table 2.2.

TABLE 2.2.	Number	of	$\operatorname{articles}$	obtained	across	$\operatorname{repositories}$	on	new	search	string.

Database	Filters on new search string
IEEE	6
Scopus	46
ScienceDirect	1
ACM	1

The number of articles obtained with the new search string shows a lack of research done in regards to children's reading motivation using LLMs specifically. This might be due to LLMs recent evolution since, when combining the other keywords, a vast search result is obtained. When researching the keywords separately, numerous studies surface detailing children's preferences in e-books, story's elements and their reading motivation. A manual search with the keywords was thus conducted on the repositories to search for the more pertinent related work to the dissertation's objectives. The following section will describe the findings of the works obtained with the systematic literature review, as well as the ones obtained manually.

2.2. Children's Reading Engagement and Motivation

The significance of reading for children's cognitive and emotional development is clear. It positively influences their vocabulary acquisition, critical thinking abilities, and overall cognitive growth [15]. Additionally, reading fosters emotional and psychological well-being by enhancing empathy [16].

When a child is first developing their reading habits and ability, reading turns into a social activity. Reading becomes a parent telling them a story in their home, a teacher or librarian enacting a story, and afterwards, discussing it with their friends who also experienced it [17]. Thus, their reading engagement and enjoyment is connected to their environment. Children who visit libraries with their families, where they are surrounded by books and encouraged to read, experience a positive impact on their reading behavior 6

[17]. The children's school environment and their peers' influence, who in turn have been influenced by their own parents, are also important for fostering reading habits. In addition, their home environment, in particular the number of books they have at home, influences their reading achievement [18].

Home Literacy Environment (HLE), a broad concept that encompasses a range of child-parent activities related to literacy, has a big impact on children's language and literacy skills [19]. Georgiou et al. [20] analyzed how reading comprehension activities can predict children's reading skills, and it found them to play a key role in predicting reading skills from Grade 1 onward. It additionally showed child-rated reading interest was only predicted by earlier reading skills and that having access to literary resources was "predictive of emergent literacy skills".

Miniscalco et al. [21] verified that posing story related questions may be a good strategy to better children's narrative comprehension who have Attention Deficit Hyperactivity Disorder (ADHD) or Autism Spectrum Disorder (ASD). Furthermore, it was found that for less-proficient readers (fourth graders in the study) answering questions during reading negatively affects comprehension outcomes compared to after reading [22]. Additionally, Davey's study [23], which focused on autistic children and their special interests, found that these children enjoyed having another person taking interest in their interest and that these interests can be useful to provide opportunities to learn.

Children's motivation to read can also be influenced by their perception of its importance and value. Some may not recognise it beyond independent reading skill acquisition [10] and it is suggested that e-books with a better reading experience might motivate reluctant readers more [24]. Reading for pleasure, according to Clark and Rumbold [2], is defined as reading that one does purely out of their own free will "anticipating the satisfaction that [they] will get from the act of reading" and normally involves the individual's interests. Reading motivation is thus defined as "the individual's personal goals, values and beliefs with regard to the topics, processes, and outcomes of reading" [25]. It is a complex concept that encompasses reading goals, social factors that drive engagement in reading, both intrinsic and extrinsic motivation, and self-efficacy [25]. A study conducted by Wang and Guthrie [26] reported that both types of motivation had different effects on text comprehension. While intrinsic motivation was positively related to it, extrinsic motivation was negatively associated with text comprehension. The following section will delve into the literature pertaining to different motivation theories.

2.3. Motivation Theories

One of the most influential motivation theories according to Brühlmann [27] is the Self-Determination Theory (SDT), first proposed by Ryan and Deci [11]. This theory, which follows basic psychological needs and Maslow's hierarchy of human needs, states that "every human being tries to gain as much autonomy over its own actions and desires as possible" [27].

The theory distinguishes between different types of motivation. Intrinsic motivation is based on the inherent enjoyment of doing a certain action and it can result in high quality learning and creativity. Being intrinsically motivated consists in acting without pressures from external sources, while extrinsic motivation comes from the need to act because it leads to a separable outcome [11]. For example, a student is being extrinsically motivated when studying for a test in order to get a good grade. SDT adds a third aspect, amotivation, where there exists no motivation. This theory thus considers all these aspects of motivation necessary in order to reach intrinsic development.

The theory also focuses on three basic psychological needs: autonomy, competence and relatedness. Autonomy refers to an individual's inclination to carry out activities independently and by choice. Competence pertains to a person's capacity to successfully perform a task. Relatedness can be described as a type of social influence, representing the desire to connect and engage with others. SDT states that intrinsic motivation will enhance only when these three needs are accompanied by each other.

An extensive literature review conducted by Tyack and Mekler [28] showed that SDT has become very popular in Human Computer Interaction (HCI) research, and its concepts of need satisfaction and intrinsic motivation have been widely applied to analyze the player experience and inform game design.

Another important motivation theory is the Flow Theory, formulated by Csikszentmihaily in 1990. The theory presents the existence of a state between anxiety and boredom where the player feels total focus and concentration on the task one is performing, to the point where the immersion is so great the person may disregard their basic needs [29]. It is most connected with the concept of intrinsic motivation in SDT.

In order to feel flow, there are a set conditions that have to be met, including actionawareness merging, having clear goals and unambiguous feedback, concentration on task, and sense of control [6]. One of the most important conditions is that the individual's perception of the challenge of the situation and their perception of their own skill in order to complete it, both need to be at an individually high level [30]. Figure 2.1 shows the flow channel, where if one's skill cannot meet the challenge, anxiety is likely to occur. Conversely, if the challenge is too easy to the individual's perception of skill, one might feel boredom.

These motivation theories explain why adding gamification into less interesting tasks can increase an individual's motivation. The game-like elements motivate the person by immersing and adding fun to the task.

2.4. Gamification in Education

Gamification has been a popular concept utilized in recent years. Although there is no single accepted definition, gamification uses game-based mechanics, design elements and game-thinking in nogame-contexts in order to engage people, motivate action, promote learning, and solve problems [31]. Besides its recent definition, the use of game-like 8



FIGURE 2.1. Graphic of the Flow State, adapted from Brühlmann's study [27].

elements to enhance engagement in a non-game task and to combine work with play, dates back much further [32].

In a literature review of gamification in education conducted by Nah et al. [33], gamification elements such as points, levels/stages, badges, leaderboards, prizes and rewards, progress bars, storyline and feedback, were reported to have been used extensively to gamify education with high levels of success in enhancing student's learning engagement, but varying success in their learning outcomes [33]. In a gamified learning tool used in an online course [34], the number of experience points earned correlated with assignment scores; however, the highest scores were obtained by students who did not have the most experience points. Chapman and Rich [35] developed a survey on student's perceptions to investigate the effect of gamified course on student's motivation. The study showed that students, no matter their age, gender or student status, felt much more motivated with it than a traditional learning course.

Anthony et al. [36] describe their findings on designing study protocols for children aged 5 to 7 in order to enhance engagement and motivation. They developed a two-part laboratory study, where they added gamification elements to its second part. Their completion rates rose from 73% to 97%, showing that gamification helped with children's motivation to complete the task.

Bartle [37] defined four different types of players with different motivational styles: Explorers, Killers, Achievers, Socializers. Explorers enjoy exploring the game environment, while Killers focus on the competitive aspect of the game, wanting to impose on the other player types. Achievers set their own goals and focus on their completion. Finally, Socializers want to interact with all kinds of players. Özhan and Kocadere [38] studied the effect of different game-based elements on these different player types. More specifically,

they studied the effect of "Leader Board and Points for Killers; Leader Board, Points, Content Unlocking, Levels, Achievements for Achievers; Achievement, Badge, Narrative for Explorers; Badge, Team and Gifting for Socializers." Although the study did not assert any results regarding how the selected components influence the different types of players, it showed an important perspective on catering to each player type.

Some studies have also been conducted on the effect of gamification to aid the development of children's reading skills. Ronimus et al. [39] examined the effectiveness of the digital game GraphoLearn (GL) in assisting second-grade students who struggle with developing accurate and fluent reading skills. They found that the children's reading development benefitted more rapidly with the intervention of GL, especially if they showed high cognitive engagement. However, children with high emotional engagement played the game for longer, but had no larger gains in reading. Van de Ven et al. [40] studied the effects of an adventure-based game in 8 year old children with mild learning disabilities and showed enhancement of children's pseudoword and text-reading fluency, both in the short and long term, but did not affect their self-reported reading motivation.

Furthermore, the addition of gamification elements in reading has been put much into practice since the appearance of digital books and reading applications.

2.5. E-books

Books in digital formal, best known as e-books, are more easily accessible than physical books. From their usual audio narration feature, allowing for younger readers to read independently, to their portability and instant access to new stories, e-books give children more opportunity to develop their reading interests independently and create their own personal portable library [41]. According to the National Literacy Trust [42], e-books have the ability to boost student's reading motivation and increase reading attainment, compared to other types of reading materials. Moreover, it is more likely for the child to identify themselves as a reader, have a favorite book and have an overall better reading enjoyment if they read across a multitude of reading formats [43].

Numerous studies have explored children's reading experiences with e-books. Kobayashi et al. [44] studied different paragraph layouts on a reading device to facilitate reading comprehension. Xu et al.'s research stated several challenges children face on the simple swipe motion to turn the page of an e-book [45]. Additionally, another study [46] explored children's reading engagement with digital books and found that children find it appealing to quickly and spontaneously scroll through the pages, having thus control of their reading pace. Moreover, it stated six facets for reading engagement: affective, creative, interactive, shared, sustained, and personalized reading.

Well-designed e-books that contain interactive story-telling elements can have a positive effect on story comprehension and learning achievement. The addition of audio, images and animations, create a new reading experience different from what children can get with printed books [47]. Smeets and Bus [48] found children gained the most vocabulary after reading interactive animated e-books. However, designers should carefully choose which features to add. Features like an added dictionary can lead to a positive effect on children's vocabulary learning, however, they may harm meaning-making [47].

Rubegni et al.'s study focused on finding the elements that make a story on a tablet engaging for children. The reading application developed, called "Fiabot!", was designed to support the creation of multimedia stories with videos, audio and images. These elements were the triggers of conversation amongst children and it was remarked that the tablet itself contributed to the children's enjoyment of the stories [49]. Moreover, the study found that the selection of stories by the children was mainly driven by social influence.

Although the importance of the support of an adult in children's reading is undeniable, Korat et al. [50] showed that e-books with expansions through visual and audio channels in the story's content can assist children's story comprehension independently. Additionally, Wallace at al. suggested that one font size does not fit all and e-books should allow readers to change it according to their needs [51]. When it comes to the analysis of elementary school student's reading behaviors, Umarji et al. [52] showed how useful user-logs can be to better understand them.

Therefore, digital books have been shown to enhance children's reading abilities. As technology evolves, education continues to benefit from its advancements. The impact of recent innovations, including AI and Large Language Models (LLMs), on education is explored in the subsequent section.

2.6. LLMs in Education

Artificial Intelligence (AI) has become an unavoidable aspect of our daily lives, and its adoption in the education field has been on the rise [12]. Its use has shown to increase student motivation and engagement, especially due to its personalized learning experiences [53].

ChatGPT, an AI chatbot based on the GPT (Generative Pre-training Transformer) language model, has already been shown to have great potential in supporting teachers and their students. Murgia et al. [54] explored ChatGPT's adaptability to online inquiries to different literacy levels. Their analysis of feedback from 9 and 10 year old children supported its capability to create texts comprehensible to fourth graders. However, the authors state that there still exists the need to have teachers give contextualization to the texts and to improve the right level of readability. Furthermore, the authors from the previous study conducted a preliminary exploration of ChatGPT's support of children's information discovery [55]. When prompting it for advice for a fourth grader's presentation, it "offered scaffolding on how to approach information discovery", taking in the behavior of a potential educational agent. Nonetheless, it was argued that due to its unpredictability as a generative model, there should be more studies conducted on Chat-GPT's capability to cater to a younger audience. Additionally, the study also compared fourth grader's reading ease of ChatGPT's responses in Italian and English. It found that ChatGPT is more likely to produce simpler texts in english, its self-preferred language. ChatGPT's potential and adaptability in generating questions to evaluate the reading comprehension skills of children has been confirmed, and its questions were well tailored for the target demographic's cognitive abilities [56]. A framework developed by Topsakal [57] for teaching children a foreign language used ChatGPT to create adequate and simple dialogues, such as introducing oneself, in both languages.

2.7. Contribution

Throughout the presented literature review, a gap was found regarding the impact of stories with the children's interests on their reading motivation for books that do not appeal to them. Moreover, ChatGPT's capability to create text and questions adequate for children has been confirmed, but the literature asks for more studies. This dissertation pretends to further the exploration of its text generative capability by creating captivating children appropriate stories with their own interests. In fact, there is a lack of existing literature concerning the use of ChatGPT for generating such stories based on children's specific preferences.

This dissertation presents a tool designed to evaluate its effect by analyzing elementary school children's motivation to read with LLM-generated story crossovers. This is done by combining children's interests and literary classics, adequate to these children's age group. LLM-generated questions related to the stories are also created, in order to analyze children's comprehension of them.

CHAPTER 3

Tool Design and Development

To close the gap identified in the Literature Review (see Chapter 2), a tool was developed in the context of this dissertation in which children can read stories based on their interests and different literary classics. These stories are generated by LLMs and created by the children's education professionals. The tool's conceptualization contributed with the education professional's insights, and its design was iteratively modified with their suggestions.

This chapter presents the complete design and development process of the tool. Section 3.1 describes the tool's conceptualization with education professional's feedback. Section 3.2 presents the final design of the tool, with an emphasis on the developed interface and interaction processes that shape the user experience. Section 3.3 shows the different iterations of the tool's prototypes, thus justifying the final design's choices based on the education professional's feedback. Finally, Section 3.4 describes the tool's Tablet-based implementation details; the database implemented to run alongside the tool, and the creation process of the crossover stories using ChatGPT.

3.1. Tool Conceptualization

The created tool, named "Crossover Stories", allows educators to create stories that combine children's interests with literary classics and simulates a digital book to encourage the children to read them. Therefore, it has two target users. One includes third and fourth grade children, which roughly correspond from ages 8 to 10 years old, as it is the age where they start developing their autonomous reading ability [8]. The other target user entails children's education professionals that would create new stories with quality for them. Thus, this tool has two phases: the authoring of the stories and their reading.

In the authoring phase, the stories' creator can add and edit the reader's interests, add literary classics they want to combine and create stories with and, automatically through the LLM-based tool, create the crossover stories and its related questions, and later edit them in order to ensure its quality for the readers. On creating the story, the education professionals can also choose the size of the story, and, although this study is only focused on children till fourth grade, the creators also have the option to choose a style that fits older children.

In the reading phase, the children can choose one of the available interests on the tool and then choose one of the crossover stories associated with it to read. Upon finishing the story, the readers would have to answer three multiple choice questions about it. However, before starting their reading, hints to answer the story's questions would appear in order to analyze whether the child paid more attention and was more motivated to read the story when aware that questions would follow.

With each correct answer, they win a star, in order to provide positive reinforcement [58]. If they get the answer wrong, the tool would jump to the paragraph where the information the child needs to be able to answer the question is, in order to give the reader the opportunity to read it again and then answer the question correctly. Since the goal is to motivate the reader without applying any pressure and to encourage their intrinsic motivation, there would be no consequences, and they would always receive three stars for answering all the questions.

Then, the children are asked whether they would want to know more about the literary classic that the crossover story they read combined. If so, they would be able to read the summary for that classic, as when selecting books for reading for leisure, children usually read its abstract and quickly flip through it [59]. Thus, when choosing this option, it indicates that their curiosity was peaked.

Seven professional educators, including librarians, psychologists and elementary teachers, played a major part in the development of the tool's concept and design through interviews and usability tests, allowing for a participatory design to be developed. Their role in the tool development consisted on getting their opinion about the concept, verifying the stories and questions' quality for the specific age range (vocabulary, complexity, logical progression) and testing the tool's design from the story's creators' point of view. They were recruited from Lisbon's elementary schools and libraries via email or in person.

All interviewed professionals reported a very positive opinion about the concept. They stated it could help in making the children more open-minded when it comes to reading if the stories had characters they already knew and if they were presented on an electronic device that they were already comfortable with. However, three of them had doubts if it would motivate them to read the literary classics, affirming that the child's already established reading enjoyment and curiosity could play a big part on their motivation. All but one participants were open about expanding children's education with technology, but, although most were comfortable with it, only three had used a LLM-based tool like ChatGPT recently, and only one of them used it often. The reasons for not using them were either a lack of knowledge and reluctance or a neutral stance towards them with low interest in frequent use. Their feedback helped not only to design the tool, but also to develop the children's reading habits survey (described in Section 4.1) and to improve the study's analysis of children's reading motivation.

3.2. Tool Final Design

The final design of the prototype was developed based on the previously mentioned concept (Section 3.1) and achieved by iterativily modifying it with suggestions from the education professionals. This section describes the tool's final design, along with its different processes and varied screens that embodies the user experience. The key elements of the 14 design iterations that culminated in this final design are later presented in Section 3.3. The text in all images was translated from Portuguese into English for this dissertation.

Initially, the user will have to login as either the creator of the stories or the reader. When logging in as the reader, the education professional has the option to choose if one wants to go with hints for the session by checking the "Hints" checkbox and an user id has to be chosen, which can consist in any number. When logging in as the creator, the user has 3 choices: interests, literary classics or crossover stories, hereafter mentioned together as items. Each choice will lead to a grid view of the items chosen (Figure 3.1).



FIGURE 3.1. Screenshots from the screens of the tool of the login (left), the creator's home screen (middle) and the interest's screen (right). If the education professional wants hints to appear on the children's session, one has to check the "Hints" checkbox in the login screen.

By clicking on the "+" (plus) button, the creator can add a new item. The steps taken to complete this action differ for each item and their processes are depicted in Figure 3.2, Figure 3.3, and Figure 3.4. The processes' diagrams are composed of initial and end states, boxes that represent an action the user must execute to go onto the next step, and diamond shapes that, when shown alongside a question, represent decision points, and, when not accompanied by a question, represent a separation of the actions that can be performed in any order, since they appear on the same screen.

To create an interest (Figure 3.2), the user has to go into the "Interest" screen, click on the "+" (plus) button, and then write the interest itself, associate an image with it, and finish by clicking the "Add" button. To add a literary classic (Figure 3.3), the user has to go into the "Literary Classics" screen; click on the "+" (plus) button, and then input the classic's title, author, and summary, along with an associated image (Figure 3.5). The action is finalized when the user clicks the "Add" button.



FIGURE 3.2. Create new interest process.



FIGURE 3.3. Add new literary classic process.


FIGURE 3.4. Create new crossover story process.



FIGURE 3.5. Screenshots of the screens to introduce a new interest (left) and add a literary classic (right). The difference in height from the latter comes from the fact that the user would need to scroll down to see the "Add" button at the bottom, thus the extended screenshot.

To create a crossover story (Figure 3.4), the user goes into the "Crossover Stories" screen and clicks on the "+" (plus) button. This will start the creating process where six steps will have to be accomplished. Each step consists of a different screen. The first step is to choose an interest, followed by choosing a literary classic that will be the base for the crossover story. If the desired interest or literary classic do not yet exist, clicking the "+" (plus) button beside the writing field would then lead to the creating process of the desired item. Upon finishing the creating process of the requested item, it would redirect and continue the creation of the crossover story. Afterwards, the user would need to choose the age range and the size of the story (short, which corresponds to less than 5 paragraphs, or long, which corresponds to more than 5 paragraphs).

The following step consists of confirming their choices. If the user desires to modify any item, clicking on the edit button beside the item's text field will lead one to the desired screen. After confirming their choices, the user clicks on the "Generate Text" button, which is followed by a screen where the title and the text of the crossover story will appear, having been generated under the hood by ChatGPT. If the user is not satisfied, one can edit the text fields, otherwise, clicking "Generate Questions" will lead to a screen with the questions, once again having been generated under the hood by ChatGPT. To finalize the process, the user clicks on the "Create Crossover" button (Figure 3.6).



FIGURE 3.6. Non-sequential screenshots from the tool of the creation of a crossover story process.

The creators can also manipulate each item by editing or deleting them. Figures 3.7 and 3.8 depict a flow chart of both actions, respectively.

When pressing on the selected item to edit it, a menu (Figure 3.9) will appear. By clicking on the blue Pencil icon, it will lead to the selected item's edit screen where the user can freely edit it. Meanwhile, clicking the selected item will lead to the item's screen. If the requested item is a literary classic, simply pressing the blue Pencil icon will lead to the classic's edit screen. If it is an interest, the user can edit it on the screen one is lead to. Finally, if one wants to edit the text or title of the crossover story, clicking on the crossover story's menu and selecting "Edit Crossover Story" will lead to the desired screen. If it is the questions the user wants to edit, clicking on the menu's option "Edit Questions" will lead to the intended screen.

The process to delete an item is similar to the process to edit one. By pressing on the selected item, the same menu will appear and clicking on the red button with the Trash icon will delete said item. Meanwhile, clicking on a selected item will lead it to the item's screen. If the item is a literary classic, clicking the red button with the Trash icon will delete it. If it is not a classic, clicking on the menu and choosing option "Delete Item" will delete the selected interest or crossover story. Before permanently deleting the item, a popup window appears to confirm the action.



FIGURE 3.7. Edit item process.



FIGURE 3.8. Delete item process.



FIGURE 3.9. Appearance of the menu when pressing and thus selecting an item.

Both the creator and the reader can read the crossover stories. When the creator gets to the end of the story, one is redirected to the generated questions. When logging in as the reader, the user can choose one of the available interests on the tool, which will then lead to a screen that shows crossover stories with that specific interest. Only interests with associated crossover stories will appear. After choosing a story to read, another screen would appear with the hints for the story's questions, if the hints variable had been chosen before logging in (Figure 3.10). As in common reading tools (see Section 3.3.1), there are several ways to navigate the story: by scrolling on the seekbar, by clicking on the arrow buttons on either side of the seekbar, and by touching the sides of the screen.

A page turning sound plays whenever the user turns a page in the crossover story and a "sparkling" sound plays whenever the reader gets a questions right. Finally, after reading the story, the user would then answer 3 questions and choose if they want to read the classic's summary (Figure 3.11). After being on the screen with the literary classic's summary for three seconds, a button would appear on the screen which, by clicking on it, would allow them to collect another star. This time limit was selected in order to ensure the child stayed on the screen and actually read the summary, decreasing the option of them gaining a star without reading it. When the children leave the literary classic's summary screen or if they chose not to read it, it is asked if they would like to add another interest for later use by the educators when authoring new crossover stories.



FIGURE 3.10. Non-sequential screenshots from the tool from the reader's point of view.



FIGURE 3.11. Non-sequential screenshots from the tool from the reader's point of view, after reading the crossover story.

3.3. Tool Iterative Design

The development process culminated in the final prototype (presented in Section 3.2) after several design iterations. Initially, existing children's reading applications were analysed in order to find useful Interface Design Patterns that could be used to guide the design of "Crossover Stories". Then, the design was refined iteratively through four iterations, each incorporating feedback from different education professionals. This section highlights the major design decision elements in order to justify the final design and record the lessons learned for forthcoming related applications.

3.3.1. Interface Design Patterns

Before starting the design process, research on existing reading application's Interface Design Patterns was conducted to explore the different design approaches tailored for children. These patterns provide solutions to common interface design problems. The research's main goal was to inspire a design that aligns with what children are already familiar with. The search terms "Children books" were applied on Google Play and a filter was enforced to see only the applications with a 4.0 star or above classification. The same process, but with the search terms "Livros Crianças" in Portuguese was conducted. Thus, these 3 applications were analyzed: "Fairy Tales - Children's Books", "História Noturna" and "Leiturinha". Along with these applications, the website "Escola Virtual" was also analyzed due to its wide use in schools in Portugal. Figure 3.12 shows a screenshot of the tool "Fairy Tales - Children's Books".

The aforementioned applications' design is clearly centered towards children, with its bold colors and vivid illustrations. Along with images, the applications also allow sound to create a more immersive experience [47]. Although "História Noturna" is the only vertical application where the stories are read scrolling from top to bottom, all others have an arrow system at the bottom of the screen, allowing for a smoother user experience and more space to add images that make the reading more engaging, and simulating the experience of reading a real book.



FIGURE 3.12. Design of the application "Fairy Tales - Children's Books".

3.3.2. First iteration

The different prototypes were developed bearing in mind the varied children's reading application's interface design patterns, and were evaluated through usability tests. On these tests, it was asked for them to perform five tasks on the tool (the fifth task depended on the iteration). The number following each task consists of the minimum touches on the screen required to complete the task. The tasks were the following:

- (1) "Introduce the new interest Pokemon" minimum: 4;
- (2) "Delete an interest" minimum: 4;
- (3) "Edit the name of the author of a literary classic" minimum: 5;
- (4) "Create a crossover story" minimum: 11;
- (5.1) "Delete an already created story" minimum: 4;
- (5.2) "Edit the text of an already created story" minimum: 6;
- (5.3) "Edit the questions of an already created story" minimum: 6.

These task were chosen due to the different actions required to perform, along with the varied screens the users had to navigate in order to complete them. As such, the users navigate through all screens of the creator's side and perform all tasks required to create a good story for the readers. Although these usability tests were pertaining only the creator of the story's side of the application, the reader's point of view was also shown to the participants in order to get their opinion.

When the tasks were evaluated against the usability tests, the following measures were observed: completion of the task; completion time of the task; number of touches on the screen; and level of effort (low effort consists on the lowest number possible of touches required to successfully complete the task while high effort consists of at least double the touches necessary). Completion of the task is a measure that gives a direct statement on the participant's task completion, however, it alone does not give sufficient information about its fulfillment. The time taken to complete the task provides information on the system's efficiency. Shorter completion times suggest that users can navigate the system quickly and without confusion, while longer times may point to design obstacles or complexity in the task flow. The number of touches on the screen works in conjunction with the level of effort to indicate the ease of the proposed task. Low number of touches on the screen suggests that the system's interface is intuitive to complete the task and thus requires low effort. The contrary reveals potential friction points where the interface is not as smooth or clear as it should be. These measures were chosen in order to effectively assess whether the flow of actions on the design were the most optimal for the participants.

Task-independent evaluation of the interface was performed to all prototypes by checking its compliance with Nielsen's Usability Heuristics [60]. The interface and interaction were also tested on a task-centred way by running Cognitive Walkthroughs.

The first prototype tested was a non-functional low-fidelity prototype designed in Figma [61] with icons derived from the figma Material Design icons, and was tested with two education professionals. Figure 3.13 shows three selected screens of the prototype.



FIGURE 3.13. Selected screens of the first prototype.

Due to the prototype's lack of customizability on Figma, there was some confusion with its interaction and usability and thus explanations were given to the participants, making the time taken to complete a task to stretch. In Appendix A, Table 5.1 shows information about the performance of each user for each task.

All tasks were done successfully, although the level of effort and the task duration were especially high on the first task. Both participants did not follow the most direct path, which consisted on clicking the add button at the bottom of the Interest screen. Instead, 24

they went to the crossover story's screen and tried to add a crossover story. As the first step of the creation of a crossover story is to choose an interest, there was already the option of creating an interest on that screen. One participant first chose to edit the name of an already existing interest, only to go back afterwards. The participants addressed how confused they felt on their first contact with the tool, and how it took a while for them to really understand it. In order to address this issue, popup windows were implemented into the design with a basic explanation of each screen (Figure 3.14).



FIGURE 3.14. Popup window on the creator's home screen.

The participants suggested changing the interests screen from a list to a gallery with images like the screens for the crossover stories and the literary classics. The added images would not only make the screen more coherent with the others, it would also help the users in finding the interests and captivate the children more. Additionally, to address the confusion with the first task, a complete design change occurred on the task of adding an element. Instead of having the add button at the bottom of each screen, it would be at the upper left corner besides the other items, with a bigger size and a more eye catching color. Figure 3.15 shows the design change.

3.3.3. Second Iteration

The prototypes of the second and subsequent iterations are all high-fidelity. The high-fidelity version was implemented to run on a 10" tablet and was programmed using Java on Android Studio, due to its ease of database integration and ease of design for handheld electronic devices. The database stored data about the children's reading on the tool. Section 3.4 delves into more detail of the tool's implementation.

The second iteration of the prototype was tested with one education professional. Figure 3.16 shows three selected screens of the high-fidelity prototype shown to the participant. In Appendix A, Table 5.2 shows the data on the participant's performance for each task of the usability test.

Although the participant completed all tasks successfully, some elements like the keyboard and the popup windows affected the overall workflow of the tool. The keyboard did not disappear when the participant finished writing and made it so key elements on the screen were covered. The popup windows interrupted the participant's thought process and did not make it clear when or if they would go away.

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FIGURE 3.15. Before (left) and after (right) iterating the interest's screen. The participants suggested changing from the list layout to an image gallery.



FIGURE 3.16. Selected screens of the high-fidelity prototype.

On the screen where the participant could confirm or edit their choices, they commented that, although they did not want to edit any of their choices, their instinct was to press the edit buttons, since they were so eye catching. On the screen where the user could see the generated questions, they stated that they felt like they could choose another option on the questions because of the questions' design. Due to these comments, the following design changes were made: the size of the edit buttons was reduced and their placement was changed, and the design for the list of questions after they were generated was also altered. In this design change, instead of having each question appear after scrolling down, buttons were implemented to better navigate to each question. The popup windows' placement was changed from the center of the screen in most actions, to the bottom. It was also made to be non focusable, meaning there was no need to click first on the screen to interact with the objects. Figure 3.17 and Figure 3.18 show the design pre and post alteration.



FIGURE 3.17. Before (left) and after (right) iterating the edit buttons' design. The size of the buttons and their location was altered to not attract the participant's attention.



FIGURE 3.18. Before (left) and after (right) iterating generated questions' design. Before, the design was confusing, as it was unclear whether the user could edit the questions or not and had to scroll down to get to the latter questions.

3.3.4. Third Iteration

The third iteration of the prototype was tested with one elementary school teacher after the children had also tested the tool, who expressed no difficulties in navigating the tool from the reader's point of view. The prototype used in the usability test included all of the changes made previously as well as the data added on the "Interests" screen by the children (Left Image on Figure 3.19). These new interests are automatically added to the creator's profile to notify them of the new interests added. In Appendix A, Table 5.3 shows the data on the participant's performance for each task.

The education professional had no difficulties completing all but one task, Task 1), which consisted of adding an interest to the tool (all tasks were presented in Section 3.3.2). There was an issue encountered due to the visual clutter the new data created, which overwhelmed the user. The added data had the same visual design as the background of the add button, making it completely invisible to the participant. The user tried several times to edit an already existing interest. Thus, the design was changed to resolve this issue (Figure 3.19). The background of the added interests was changed to white in order to not create visual clutter, and text such as "Added by the reader" was inserted on top of it. Additionally, the text "Add new interest" was put on top of the add button.

The size of the writing fields was also an issue to this participant, which mentioned it was annoying how some questions were too long and did not fit into them. Also, when executing Task 3), which consisted on editing the classic's author, when they were finished 28



FIGURE 3.19. Before (left) and after (right) iterating the interest's screen. The background of the interests with no associated image was changed and text was added to guide the user.

they clicked on the enter key and it did not immediately go into the next field, which they expected. Both design changes were implemented, and Figure 3.20 shows the difference after iterating on the questions field.



FIGURE 3.20. Before (left) and after (right) iterating on the size of the question field. Before the question could not be read completely and the user had to scroll on the text field to see it.

3.3.5. Fourth Iteration

The fourth iteration of the prototype was done with three elementary school teachers. In Appendix A, Table 5.4 shows the data on the participants' performance for the usability tests' tasks.

The issue encountered on the previous iteration (Section 3.3.4) with the visual clutter on the interest's screen continued and was not resolved. The participants were still confused on the interests screen and their vast options. On Task 2) (all tasks were presented in Section 3.3.2), which consisted of deleting an interest, one participant clicked on the interest itself and tried to delete it through the menu located on the top right corner. Additionally, when one tried to delete one of the interests located at the last row by pressing on it, the screen jumped to the first row. On the last task, one participant read the whole story again, expecting to see the questions at the end to then edit them.

The changes made on this iteration, following the teachers suggestions were the following: an option to delete the item on the interest and crossover themselves was added; the interest screen design was altered (Figure 3.21); and when the creator reaches the end of the story, they are automatically redirected to the questions.



FIGURE 3.21. Final interest's screen iteration. The design of the button to add an item was changed, as well as the text color.

This fourth iteration culminated into the tool's final design, presented in Section 3.2. The summative evaluation of the tool's final design is described in Section 4.4, while its implementation details are outlined in the following Section 3.4.

3.4. Tool Implementation

The high-fidelity prototypes developed (see Section 3.3), and thus the tool's final version (see Section 3.2), were implemented to run on a 10" tablet using Java on Android Studio. This section depicts the tool's implementation details.

3.4.1. Tool Project Structure

Android Studio is a tool that allows for easy mobile tool designing and database implementation. This platform was used to develop the tool and its project structure is described as follows. Figure 3.22 depicts a simplified class diagram of a few selected classes of the project. Details about the non-selected classes can be found in Appendix B. 30



FIGURE 3.22. Class Diagram of a few classes from the Android Studio project. The straight lines and unfilled arrows represent a class extension, while the dotted lines represent a class usage. An example reading is: "Class *InteresseModel* extends *AbstractTables* class and uses the *TABELAS* enumerate class".

The application is composed of one main activity, which then separates into fragments, each consisting of a different screen. Each screen of the application has a corresponding Java class, denominated "nameOfTheScreenFragment" that extends the Fragment class from androidx.fragment.app.Fragment, and contains the necessary functions that are needed for it to run. Each screen also has a corresponding .xml file with the screen's design, denominated "name_of_the_screen_fragment", located on the layout folder. There exists 24 Java classes corresponding to this description.

Most "nameOfTheScreenFragment" classes are composed of the same functions that initialize the screen, such as OnCreateView(), onViewCreated() and onDestroyView(). Figure 3.23 shows the functions and attributes of the ObrasFragment class, that deals with the main literary classic's screen. Class ObrasFragment is a good example of all other "nameOfTheScreenFragment" classes due to its inclusion of the function popupEditDeleteMenu(), that deals with the popup menu that appears when selecting an item (see Figure 3.9 on Section 3.2), which also appears in the fragments containing the interests and the crossover stories; its showObrasList(), which deals with the Grid View Adapter; and its initializing functions, such as prepareMenu(), prepareListeners(), OnCreateView(), onViewCreated(), and onDestroyView().

The animations used are stored in the *anim* folder and consist of fade_in and fade_out. The drawables are located in a folder of the same name and consist of the .png images of the icons, design elements and logo, as well as .xml files with different design elements.

In order for better organization of the code and to make the design coherent and easy to modify, the values commonly used, like the size of the buttons, font size, strings, colors, among others, are stored in a "Values" folder, which contains an .xml file for each topic: dimens.xml stores the commonly used dimensions for the design; themes.xml stores the design's colors, and string.xml stores the commonly used strings, such as the application's name.

Additionally, there exists four more Java class files that contain functions the other classes use regularly. The *DbBitmapUtility* class is used with the *android.graphics* package with functions that handle the database's images, such as converting bitmaps to Byte



FIGURE 3.23. Attributes and functions of ObrasFragment class.

arrays and vice-versa, and resizing and cropping them. The *ChatGPTFunctions* class contains functions pertaining ChatGPT, and the *AuxFuntions* class contains functions that are used by several other classes, such as creating the popup windows. Finally, the *MainActivity* class launches the application.

3.4.1.1. Navigation and Communication between Fragments: To aid the navigation of the application, an .xml navigation graph was designed and stores each necessary action to transition from one screen to another. The communication between fragments is made through a Bundle, an android class that can pass relevant information between activities, such as the id of the requested item, for example.

An example of the communication between fragments is described as follows. In the class *InteresseFragment*, which corresponds to the creator's interest's screen, when the user selects an interest, a bundle is initialized with the id of said interest as value, and with corresponding key "bundleKeyInteresse". The parentFragmentManager().setFragmentResult() will then set the given result for the requestKey, in this case "requestKeyInteresse". This result will be delivered to a FragmentResultListener with setFragmentResultListener() with the same requestKey. Then, the tool navigates to the next fragment, in this case, *IntroduzirInteresseFragment*.

In the class *IntroduzirInteresseFragment*, which corresponds to the screen of the individual interest, the function onCreate(@Nullable Bundle savedInstanceState) has a setFragmentResultListener with the key from *InteresseFragment* "requestKeyInteresse". Then, function onFragmentResult() sets a global variable to the bundle result with the key "bundleKeyInteresse", in order for the screen to be correctly initialized with the details of the requested interest.

3.4.1.2. *Menus:* A set of screens from the creator's point of view will also initialize their menu (located at the top right corner) from one of the three existing .xml menu files. The screens on the reader's point of view do not have menus, and instead have only 32

the reader's score. The three menus are the following: *interest_menu*, which contains the option of deleting an interest, is only initialized on the individual interest's screen; *crossover_menu* that contains the five options the user can do on a specific crossover story is thus only initialized on the individual crossover story's screen; and *select_menu*, which contains the options "Select Item" and "Delete All", is initialized by each screen that contains multiple items disposed into a grid, such as the interests', the literary classics' and the crossover stories' screens.

3.4.1.3. *Grid View Adapter:* The screens displayed in a gallery design contain a grid layout, which is initialized with a grid view adapter on their own Java class *Grid-ViewAdapter*, and is updated whenever one of the items on the screen is modified. The adapter collects all items of the requested type from the database and populates the grids with the requested fields from the items.

3.4.1.4. Database Functions: A database was implemented on the project and is described in Section 3.4.2. Each database table has a corresponding Java class denominated "nameOfTableModel", that extends the AbstractTable class, which contains abstract methods getParameterNames() and getParameterTypes(). An additional Java class DatabaseHelper initializes the database when it is first created, and contains useful functions pertaining to the database, such as each model's insert, delete and update functions. It also contains all tasks that handle the database items, such as filtering and get specific items based on other criteria, using SQL. Additionally, an enumerate class called "TABELAS" was created to store the name of all the created tables, and is heavily used in the DatabaseHelper class.

The item's edit and delete actions are dealt with in the database via update and delete functions for each item located on the DatabaseHelper class. Furthermore, to enter the reader's point of view, it is first asked to enter an id and if the particular session will have hints or not. The user id and all information relevant to the current user session will be stored in the database. If the id already existed, a function will retrieve the user score from the database and update the textfield for the score. If it doesn't, the score textfield initializes as 0. Every time the user completes reading and answering the crossover questions, their score is updated.

3.4.2. Database

A database was implemented to run alongside the application in order to store data about the children's reading on the application, to make the story creation process smoother, and to analyze the results more effectively. It was first designed on the Bouml [62] application, to better analyze the tables' relationships before implementing it on Android Studio. It was iteratively updated to better align with the application as this one was also iterated. Figure 3.24 depicts the tool's database model. It was coded with the *android.database* package, more specifically using the following classes:

• android.database.sqlite.SQLiteOpenHelper;



FIGURE 3.24. Tool's database model. The text was translated from Portuguese into English for this dissertation.

- android.database.sqlite.SQLiteDatabase;
- android.database.Cursor;
- $\bullet \ and roid. \ data base. \ Curs or Index Out Of Bounds Exception.$

The database is composed of 12 tables and has the "Crossover" table at its center, which inherits from tables "Story_Size", "Age_Range", "Classic" and "Interest". The first two mentioned tables are populated when the application first runs on the device, with each two data objects: "Short" and "Long" for the table "Story_Size", and "Less than 9 years old" and "More than 9 years old" for the table "Age_Range". The table "Classic" is populated when the story's creator, in this study's case, the education professional, adds a literary classic into the tool. The table "Interest" is populated when either the reader or the creator add an interest into the tool, with its "Creator" field as either "Reader" or "Creator", user types from the "User Types" table.

After the crossover story is automatically generated, the story's text is divided into paragraphs, which is what will be shown to the reader, and put into the "Paragraph" table. A crossover story is thus composed of a strict set of paragraphs. The fields "Text" correspond to the paragraph's text; "Image" to the corresponding paragraph image, which will later be added by the creator; and "Position" to the position the paragraph holds on the story's text (the first paragraph of the text will have the number 1 has its position).

Then, the three automatically generated questions for the crossover story are put onto the "Question" table. Each question will have the text of the paragraph where the answer 34 to the question resides ("Answer_Paragraph") and its position ("Answer_Paragraph_ Position"), and the question's hint that was generated beforehand ("Hint"). For each question, four options are generated. Each is put onto the "Option" table with its text in the "Option_Text" field and the indication if it is the correct option for its question in the "Correct" field, which is a boolean.

The last four tables pertain to the storing of the reading data. Table "Users" contains an id number, user score, and user type, which is inherited from the table "User_Types". This last table was populated when the application first runs on the device with the objects "Reader" and "Creator".

The table "User_Session" stores a new entry whenever a user logs in to the application, and stores its data, as well as the time the user spent on the application and if there was hints or not ("Has_Hints"). Finally, the table "Story_Session" stores a new entry every time the user chooses to read a new story, storing the time spent reading the story, how many times the user got the questions wrong ("Jumps"), their score ("Score") and if they chose to read the summary of the literary classic the crossover story was based on ("Saw_Summary").

3.4.3. Creating the stories with ChatGPT

The educators create the crossover stories through the tool, by informing it of the children's literary and non-literary interests. Then, under the hood, the tool automatically creates a set of prompts to request ChatGPT-40 [63] to generate the story and its title, questions, and hints. ChatGPT's response is automatically parsed by the tool and presented to the user. Then, the user uses the editing features of the tool to curate and edit the automatically generated story.

The curated set of prompts was constructed by studying ChatGPT's response to several ones in order to create the best story possible. The list of prompts that gave the best results was obtained using the prompt-chaining technique [64], which involves breaking the main tasks into smaller sub tasks. The LLM will then use the response of the sub task as part of the input to the subsequent prompt.

The list (which was translated to English from Portuguese for this dissertation) is presented as follows. The text in italics in between $\langle \rangle$ is inserted by the program.

- (1) "Create a story with less than 5 paragraphs and less than 600 characters of a specific moment between $< chosen \ literary \ classic>$ and $< chosen \ interest>$ ".
- (2) "Rewrite this story in language more suitable for 9-year-olds: < generated story>"
- (3) "Change the words in Brazilian Portuguese to words in Portuguese from Portugal from this story: <generated story>"
- (4) "Give me only a title without using bold, italics or any formatting for the story: $< generated \ story >$ "
- (5) "Create 3 very simple questions, without using bold, italics or any formatting, with language suitable for 9-year olds, of 4 multiple-choice items with an emphasis on <chosen literary classic> about the story: <generated story>"

- (6) "Rewrite in Portuguese from Portugal: $< questions \ obtained \ from \ prompt \ 5 >$ "
- (7) "Story: <generated story>. Questions: <questions obtained from prompt 5>. Give me the answer and the paragraph of the story where the answers to each question are found with the following structure without using bold, italics or any formatting: "1. Text of the question ? Correct Answer: c) Text of the Correct option Paragraph of the story: Text of the paragraph containing the answer."
- (8) "Story: <generated story>. "Questions: <questions obtained from prompt 5>. Based on these story questions, give me just one keyword, other than character names, for each question so that I can answer the questions (total 3 keywords) in the following structure without using bold, italics or any formatting: word, word, word."

If the creator chooses to create a long story, prompt 1 changes "... with less than 5 paragraphs and less than 600 characters..." to "... with more than 5 paragraphs and less than 750 characters...". On prompt 7, the c) option is given only as an example, and ChatGPT puts the correct answer in random positions. The list consists of eight prompts, where prompts one through three create the story adequate for the age range; prompt four creates a title for the story, prompts five through seven create the questions and their answers and finally, prompt eight gives hints for the created questions.

ChatGPTFunctions is a Java class with functions developed to receive a response from ChatGPT with the mentioned above prompts. Its getResponse(String query, int queryIndex, final VolleyCallback callback) function creates a new Volley request and posts a previously prepared JSON object onto the ChatGPT queue. Volley is a networking library for Android that makes handling network requests simpler and more efficient. The prepared JSON object is structured as follows:

```
{
    "model": "gpt-4o",
    "temperature": 0.7,
    "max_tokens": 550,
    "message": {
        "role": "user",
        "content": <prompt>
    }
}
```

The model chosen was the ChatGPT-40, the most recent ChatGPT model as of the writing of this dissertation, which gave the best results comparing with its previous versions. The temperature, which can vary from 0 to 1 and affects the LLM's probability distribution over the possible tokens at each step of the generation process, is kept at 0.7, which allows for a more creative response [65]. The max_tokens corresponds to the maximum number of tokens that can be generated in the chat completion, and stay at 550, 36

in order to not receive an extensive response. In the "content" field, one of the prompts from the previously mentioned prompt list will be written by the program.

The getResponse() function would then receive and give the ChatGPT response in a form of another JSON object. It is also necessary to input a personal bearer key in order to converse with ChatGPT.

The packages with their respective classes used in the ChatGPTFunctions class are the following:

- com.android.volley.RequestQueue;
- com.android.volley.Response;
- com.android.volley.RetryPolicy;
- com.android.volley.VolleyError;
- com.android.volley.toolbox.JsonObjectRequest;
- com.android.volley.toolbox.Volley;
- org.json.JSONArray;
- org.json.JSONException;
- org.json.JSONObject.

When the user clicks on the "Generate Crossover" button, a function *makeSequential-Requests* calls the getResponse() function with each necessary prompt and then updates the text fields on the screen with the crossover story's information, and stores them on the database.

3.4.4. Adding images

Stories with visual queues are more enjoyed by children and help to capture the children's attention, as stated by their educators. Therefore, for each paragraph of the story, it was included a related image. These images were created with either ChatGPT or through Designer [66], an AI-powered tool that creates images out of a chosen text prompt. For the crossover stories, the main focus of each paragraph was extracted and put into either tool manually, and the generated image that fit the paragraph the best was chosen. The process of generating the images is done outside of the tool, and these can be added to each paragraph after the story is created. One prompt given to ChatGPT to create the images is: "Give an image per paragraph of the following story, keeping the character's physical appearance like hair color, eyes color, and clothes, consistent: <generated story >." ChatGPT may encounter copyrights' issues if either the children's interests or the literary classics are too recent, but it offers to adjust its prompt to create images with similar appearances as the ones requested.

CHAPTER 4

Evaluation

This chapter describes the summative evaluation of the tool's final version, described in Section 3.2, and presents the results obtained from the conducted experiment with the children. Section 4.1 presents the surveys distributed to the children before and after their exploration of the tool. Section 4.2 describes the procedure of the experience conducted in order to obtain the results and Section 4.3 briefly describes the treatment of the obtained personal data. Finally, Section 4.4 presents the results and statistical analysis of the surveys after the children's exploration of the tool.

4.1. Surveys

In order to better understand children's reading habits before and after their first contact with the tool, a survey was developed and applied to them. It was based on the most recent cycle of the PIRLS [8] survey, which was conducted in 2021, and only the most relevant options and questions for this study were chosen, since more questions were also added on by the children's educators' suggestions. This was done in order to not make the survey too long and thus tiring the children.

The developed survey is depicted in its entirety in Portuguese in Appendix C, and it is divided into four sections pertaining different aspects of the children's reading habits. Sections 1 through 3 are applied to the children before their contact with the tool, while Section 4 of the survey is applied after their exploration of the tool. Sections 1 "About you" and 2 "Reading habits" were directly adapted from PIRLS, with an added question 5 on the latter section about their opinion on reading on electronic devices. Question 2 on Section 3 "Library and books" adds a question asking their opinion on the available classics on the tool ("The Selfish Giant" and "Adventures of Pinocchio") before their contact with the crossover stories. Section 4 of the reading habits survey is an added section with questions pertaining the children's motivation to read the classics and their reading enjoyment of the crossover stories. It also asks their opinion about the existing interests on the tool and if they would like to see others. The last question inquires if they would recommend the tool to a friend.

These questions are fundamental in assessing the dissertation's objective of boosting their reading motivation. This last section of the survey is meant to be filled only after their first contact with the tool.

The System Usability Score (SUS) is an evaluation tool which assesses the usability of a system, and has been widely used in the field. It consists of a 10 question survey with each item being rated on a five-point Likert scale ranging from "Strongly Disagree" to "Strongly Agree." [67]. An adaptation of the SUS survey was given to the children after their exploration of the tool to better understand their opinion about the tool itself. The questions were adapted as Putnam et al. [68] suggested to make them more understandable for children in the chosen age range. Putnam [68] includes two adaptations, one for children from ages 7 to 8 and another from 9 to 11. Because our chosen age range is from 8 to 10 years old, the younger option was chosen.

The survey structure was adapted to be in compliance with the previous survey, which followed the PIRLS structure, meaning that its answer scale was inverted (most positive answer on the left and most negative on the right). Figure 4.1 and Figure 4.2 show an example question from both the PIRLS survey and the adapted SUS survey, respectively, translated from Portuguese into English. Table 4.1 shows a summary of the different sections of the surveys, along with their moment of delivery. The developed surveys are depicted in Appendix C.



FIGURE 4.1. Example question of PIRLS survey.



FIGURE 4.2. First question on the adapted SUS survey following the PIRLS survey structure.

4.2. Procedure

To assert the tool's effectiveness in increasing children's motivation to read, an experiment was conducted in Lisbon, Portugal. The participants were recruited from two elementary schools in Lisbon. One was a private school which welcomes children from nursery school to Grade 4 of elementary school, while the other was a public elementary school from Grade 1 until Grade 4. This allows for socio-economic diversity among the participants. The children that wanted to participate on the experiment had their legal guardians give their explicit written consent.

The experiment was done in groups of either two or five children in the same room, depending on their time availability and the school's room size that was given to run the experiment. First, it was explained to them what the experiment entailed and for what it was. Then, some questions were asked to better understand their reading habits and 40

Survey	Section	Description	Moment of Delivery
Reading habits	1-"About you"	Sociodemographic questions, such as age, gender, language spoken at home, parent's educational level, and amount of books at home	Before contact with the tool
	2-"Reading habits"	Questions pertaining to their reading habits, such as how much time they spend reading outside of school; their reading tastes, such as their preference between stories, magazines, comic books, and books that explain things; and their opinion on reading in general and on electronic devices	Before contact with the tool
	3-"Library and books"	Questions about how often they borrow books from the library, as well as questions asking for their opinion on the selected lit- erary classics "Adventures of Pinocchio" and "The Selfish Giant"	Before contact with the tool
	4-"Experience"	Questions about their time assessment of when they'll read the aforementioned clas- sics and about their opinion of the crossover stories	After contact with the tool
SUS	-	Questions pertaining their opinion of the tool	After contact with the tool

TABLE 4.1. Summary of the different sections of the surveys applied to the children.

their literary and non-literary likes and dislikes. Afterwards, it was asked for them to fill the reading habits survey and then explore the tool by reading at least one story and responding to its questions.

There were three stories available: one combining the literary classic "Adventures of Pinocchio" with soccer (see Appendix D), one combining "The Selfish Giant" with Pokemon and one combining "The Selfish Giant" with the series "Miraculous: Tales of Ladybug and Cat Noir". The interests and literary classics were chosen based on the educators suggestions. These classics are on the National Reading Plan [69].

The study also addressed the analysis of whether the child paid more attention and was more motivated to read the story if knew one had to answer a few questions afterwards. As such, half of the participants were randomly assigned to the "hints variable" group, where a screen would appear before they start reading their chosen story warning them they had to answer three questions and showing the hints for them.

After the participants from both groups finished their individual exploration, they would fill the final section of the reading habits survey and finally the SUS survey. In the end, it was given a debriefing document in the style of a participation diploma (see Appendix E). Because there was only one tablet where the children could use the tool, the other children in the meantime were doing a design exercise where they could choose the best character that depicts "reading" and "sharing knowledge", and that will be selected as the mascot of the tool. They gave their opinions on the three available characters (Figure 4.3) and created stories for them to pass the time. The character that was the most liked was an owl, with its vibrant colors, the animal's symbolism and the different elements depicted in the image.

At the end of the experiment, a debriefing document, expressing thanks for the participant's participation and reminding of the experience's objectives and the investigator's contact, was distributed. A text debriefing document was given to the education professionals, while, as mentioned above, a debriefing document in the style of a participation diploma was given to the children (Appendix E).



FIGURE 4.3. Set of characters shown to the children.

4.3. Data treatment

As per the ethic's guidelines from the institution's ethical commission, a consent document was signed by all professional educators and the legal guardians of the children before the execution of the experiment (Appendix F). The document stated the experience's goal and description; the investigator's contact; the treatment of their personal data; and how the experience was completely voluntary. The data gathered for this experience included personal data like the participant's gender, age, parent's educational level, and language spoken at home. The data was stored on a personal computer during a maximum period of one week before it was anonymized and then transposed into excel.

4.4. Results

The experiment was conducted with 20 elementary school children from the third and fourth grade. Out of the participants, 11 were boys and 9 were girls, and 14 were 10 years old and 6 were 9 years old (AVG=9.7, STD=0.458, where AVG stands for Average and STD for Standard Deviation hereafter).

The results obtained from both surveys allow us to perform a summative evaluation of the tool and of its goal of motivating children to read. The statistical analysis was 42 carried out in the jamovi tool [70] in order to analyze it. When applicable, the Shapiro-Wilk statistical test [71] was conducted to check the normality assumption, which revealed that none of the variables were normally distributed. Thus, it was not possible to perform parametric statistics tests, such as the widely used t-test, due to its assumption of the normality of the data. Therefore, the Kruskal-Wallis [72] non-parametric statistical test, which determines if there are statistically significant differences between the variables' medians and is effective in smaller sample sizes, was conducted on the analysis of the results.

4.4.1. Reading habits

Most of the children reported to always speak portuguese at home (80%, n=16), with only 3 (15%) children stating to almost always speak it and only 1 (5%) to never speak it at home (Figure 4.4). However, all children spoke and understood portuguese, and none spoke of any complications in reading the portuguese crossover stories. Some (40%, n=8) reported to have more than one full bookshelf of books at home (Figure 4.5), which translated into more than 200 books. This shows that their home environment already encourages reading [18]. Unfortunately, half the participants did not know if their parents had an academic degree (Figure 4.6), which, according to Chiu et al. [18], is a significant indicator on their reading habits.



FIGURE 4.4. Percentage of children reporting how often portuguese is spoken at home.

20 participants				
0-10 11-25 26-100 101	–200 <mark>–</mark> More than 20	0		
Quantity of books in your house	20%	20%	20%	40%
Og	6			100%

FIGURE 4.5. Percentage of children reporting the quantity of books in their house.



FIGURE 4.6. Percentage of children reporting if their parents had an academic degree.

Some (40%, n=8) participants reported to read less than 30 minutes per day outside of school (Figure 4.7), and the majority read for fun and things they chose themselves (Figure 4.8) at least once or twice a week (80%, n=16 and 90%, n=18, respectively). They had a wide range of literary tastes (Figure 4.9), with at least half reading stories, comics or books that explain things at least once or twice a week. Only 2 (10%) participants agreed they read only when they were forced to and only 1 (5%) thought that reading was boring (Figure 4.10). Their overall opinion about reading was very positive, with 19 (95%) participants agreeing that they like to read.

20 participants Did not respond Less than 3	0 minutes 🧧 30 minut	es to 1 hour <mark>=</mark> 1 hour to 2 hou	ırs 🧧 2 hours or mor	e	
How often do you read outside of school	5%	40%	35%	15%	5%
C	9%				100%

FIGURE 4.7. Percentage of children reporting "How often do you read outside of school everyday?"

20 participants				
Did not respond	er or almost	never 📒 On	ce or twice a month 🧧 Once or twice a week 📒 Everyday	or almost every day
Read for fun	10%	10%	30%	50%
Read things chosen by me	10%		25%	65%
(0%			100%

FIGURE 4.8. Percentage of children reporting "How often do you do these things?"

20 participants									
 Did not respond Neve Everyday or almost ever 	er or a y day	lmost ne	ver 📒 Onc	e or twice a	a month	Once or twice a	week		
Stories or fables –	1	0%		30%	10%	20%			30%
Magazines	1	0%			40%			35% 5%	10%
Comics	5%	5%	20	%			45%		25%
Books that explain things –	1	0% 1	0% 10	%		35%			35%
00	%								100%

FIGURE 4.9. Percentage of children reporting their reading variety.



FIGURE 4.10. Percentage of children reporting their opinion on reading.

The participant's opinion on reading on an electronic device (Figure 4.11) before using the tool was negative. Most (65%, n=13) were uncomfortable reading on an electronic device and 16 (80%) preferred to read books physically. They also read less on an electronic device compared with printed books.

Most (70%, n=14) children reported going to the library to borrow books at least once or twice a month (Figure 4.12). When it comes to their opinions of the classics available on the tool before reading the crossover stories, there was a wide variety (Figure 4.13). Some (40%, n=8) did not want to read "Adventures of Pinocchio" (25%, n=5 knew it), while 9 (45%) participants did not know about "The Selfish Giant", with 5 (25%) not wanting to read it.

20 participants							
Disagree completely Disagree	<mark> </mark> Agree A	gree com	pletely				
I like to read more on an electronic device than physically		25%			55%		20%
I read more on an electronic device than physically				65%		25%	10%
I'm uncomfortable reading on an electronic device	10%		25%		50	%	15%
Oc	%						100%

FIGURE 4.11. Percentage of children reporting their opinion on reading on an electronic device.

20 participants							
 Did not respond Never or almost At least once a week 	st never	r <mark>–</mark> Some	times pe	er year 🧧 Once or twice a month			
How often do you go to the library to borrow books	5%	15%	10%		50%		20%
C)%						100%
FIGURE 4.12. Perce	entag	e of ch	ildren	reporting how often t	hey	borrow	

books from the library.

20 participants

20 participante

Did not respond 📕 I do not know of it and do not want to read it 📒 I do not know of it, but want to read it I know of it and do not want to read it I know of it and want to read it I already read it

Adventures of Pinnochio	10%	15%	20%	25%	30%
The Selfish Giant	5%	25%	20% 5%		45%
0	%				100%

FIGURE 4.13. Percentage of children reporting their opinion on the two proposed literary classics.

The data shows common reading habits and enjoyment in Portugal, according to the PIRLS report [8]. Participants refer to the children who evaluated the "Crossover Stories" tool and students refer to the ones who took the PIRLS portuguese survey. A high percentage (60%) of students reported to enjoy reading, while 48% read less than 30 minutes outside of school per day, which also closely corresponds to the participant's answers. The participant's book borrowing habits also seem to comply with the results indicated on the report, which state that 56% of students borrow books at least once a month. However, the participants' answered quantity of books at home varied drastically from the PIRLS results, with only 9% of students reporting to have more than one full 46

bookshelf of books at home, compared to the participant's 40%. Although with low diversity in reading habits, the existence of an established reading enjoyment does not impact the tool's evaluation in a negative way. In fact, it analyses its effectiveness in boosting children's motivation to read among those with the most common reading habits.

4.4.2. SUS questionnaire

The SUS questionnaire results evaluate the usability of the system by the children. The survey's questions used a five-point Likert scale ranging from 1 to 5 and the results are summarized in Table 4.2. All statements refer to the tool and the analysis refers to their level of agreement with the statements. Hereafter, the "Bias" column indicates the direction of a favourable scoring for each statement, where a positive bias (+) indicates that a higher score represents a more favourable response, whereas a negative bias (-) indicates that a higher score represents a less favourable response. In other words, success is higher when higher scores are obtained in positive statements and lower scores are obtained in negative statements.

TABLE 4.2. Results of the adapted SUS questionnaire.

Code	Statement (Abbreviated)	Bias	AVG	STD
SQ01	I would continue to use it if I had time	+	3.90	1.070
SQ02	The app was difficult to understand	-	1.55	0.887
SQ03	I thought the app was easy to use	+	4.68	0.478
SQ04	I would need help to continue	-	1.85	1.140
SQ05	I knew what to do next	+	4.40	0.995
SQ06	I sometimes felt confused	-	1.95	1.100
SQ07	I had to do complicated things	-	1.65	0.993
SQ08	It will be easy to use by my friends	+	4.37	0.684
SQ09	I'm proud on how I used the app	+	4.40	0.995
SQ10	There were a lot of things to learn	-	2.55	1.360

In general, the participants slightly agreed they wanted to continue to use the app if they had more time (AVG=3.90, STD=1.070). They thought that the app was not difficult to understand (AVG=1.55, STD=0.887) and agreed that it was easy to use (AVG=4.68, STD=0.478). They disagreed that they would need help to continue to use the app (AVG=1.85, STD=1.140) and agreed that they knew what to do next while using it (AVG=4.40, STD=0.995), also stating they did not feel confused (AVG=1.95, STD=1.100) or had to do complicated things (AVG=1.65, STD=0.993). They agreed that the app would be easy to use by their friends (AVG=4.37, STD=0.684) and that they are proud on how they used it (AVG=4.40, STD=0.995). Besides the very positive results, they tended to be neutral about thinking there were a lot of things to learn to use the tool (AVG=2.55, STD=1.360).

Overall, the results indicate a positive experience with the tool, with the tool's usability score standing at 80.5 out of 100. Although the questions used were an adaption of the

SUS questionnaire, the score is considered strong, within Sauro's [73] benchmark of 68, that states a perceived usability above average. This shows the children had a positive experience while exploring the tool and thus, reading the crossover stories.

In addition, an analysis of how different reading-related variables affected the SUS score was conducted to determine which types of children enjoyed the tool the most. The results comparing the SUS score by grouping them based on the chosen reading related variables are shown on Table 4.3. Hereafter, the "n" column stands for Sample Size. The first line can be read as "11 participants did not have hints and had an average SUS score of 80.75, with a standard deviation of 14.634".

Grouped by	Statement	n	AVG	STD
Hints	Did not have hints	11	80.75	14.634
	Had hints	9	80.25	16.791
Time Reading Per Day	Less than 30 minutes	8	75.93	18.580
	More than 30 minutes	11	84.32	12.707
Read for Fun	Not everyday or almost	8	75.93	18.411
	Everyday or almost	10	83.25	13.041
Uncomfortable Reading on Devices	Disagree	7	76.78	15.042
	Agree	13	82.50	15.600
Adventures of Pinocchio	Does not want to read it	9	75.00	13.017
	Does not know but wants to	4	94.37	5.694
	read it			
How Soon will Read the Classics	Sooner	9	84.17	15.000
	Later	9	75.56	16.500
Liked Reading Crossover Stories	Disagree	3	69.17	8.250
	Agree	17	82.50	15.790
More Interested in the Classics	Disagree	5	72.00	12.390
	Agree	13	83.04	16.100

TABLE 4.3. Results of the usability score grouped by the chosen reading related variables.

The Kruskal-Wallis Statistical Test [72] was conducted to the SUS score's average according to the Hints categories. No significant differences (p = 0.879) were found among the two categories, which included with or without hints. This result shows that the children's enjoyment of the tool did not benefit from the existence of hints before reading the stories, meaning their reading experience was not affected by knowing they had to later answer questions about the story. The statistical test also did not find any significant differences according to the other reading related variables present in Table 4.3.

Furthermore, children who read more than 30 minutes a day had a higher usability score average (n=11, AVG=84.32, STD=12.707) compared to children who read less 48

(n=8, AVG=75.93, STD=18.580). Children who read for fun everyday or almost every day (n=10, AVG=83.25, STD=13.041) also had a higher usability score average compared to children who read for fun less (n=8, AVG=75.93, STD=18.411). These results show that the tool is more enjoyed by children who already have an enjoyment for reading and an established reading habit.

Children who did not know the classic "Adventures of Pinocchio" but still were curious to read it had a higher enjoyment of the tool (n=4, AVG=94.37, STD=5.694), compared to children who were not curious to read it (n=9, AVG=75.00, STD=13.017).

However, it is clear that its enjoyment affects children's motivation on how soon they will read the literary classics. The more they enjoyed the tool, the sooner they want to read the classics, meaning they chose either to read the classic "Still this week" or "Next week" (n=9, AVG=84.17, STD= 15.000). A similar statement can be made regarding their enjoyment of the crossover stories - the more they enjoyed the tool, the more they enjoyed reading the stories (n=17, AVG=82.50, STD=15.790) and the more interested they got in reading the classics (n=13, AVG=83.04, STD=16.100). An interesting fact is that it seems children who were uncomfortable reading on an electronic device (n=13, AVG=82.50, STD=15.600) actually liked the tool more than children who were not (n=7, AVG=76.78, STD=15.042). Therefore, this shows that children who may not be used to reading on an electronic device, can still enjoy exploring the tool and reading the crossover stories.

Overall, the children who liked the tool the most according to their SUS score were children who already had an established reading habit and who got more curious about the classics. Children who read more frequently, whether for longer durations or for fun, reported higher SUS scores for the tool. Enjoyment of the tool was also linked to increased motivation to read literary classics sooner and their enjoyment of the crossover stories.

4.4.3. Relationship between children's reading habits and tool usability

To evaluate the relationship between children's reading habits and their enjoyment of the tool, a correlation matrix was constructed. First, the missing values on the surveys were addressed. The SUS survey contained 10 questions and the reading habits survey consisted of 31 questions (the surveys are described in Section 4.1). With 20 participants, there were 2 missing values out of 200 answers on the SUS questionnaire, and 18 missing values out of 620 on the reading habit's survey. To make a correlation matrix with the obtained results, these missing values were replaced by the median of each variable, since all were not normally distributed and were skewed either towards the minimum or the maximum value. The correlation matrix was calculated with Pearson's Correlation Coefficient. A significant correlations between the SUS survey questions and the children's reading habits, 10 correlations were chosen to highlight, due to their connection with reading motivation, on Table 4.4. All other significant correlations are shown in Appendix G.

TABLE 4.4. Set of 10 significant correlations between tool usability and reading habits obtained when calculating the correlation matrix with Pearson's Correlation Coefficient. Note: * p < 0.05, ** p < 0.01, *** p < 0.001.

SUS variable	Reading habits variable (Abbreviated)	Correlation	Significance
$\mathrm{SQ01}$	Selected reading	0.619	**
$\mathrm{SQ01}$	Likes reading	0.591	**
$\mathrm{SQ01}$	Liked reading crossover stories	0.652	**
$\mathrm{SQ01}$	Wants more crossover stories	0.542	*
SQ02	Only reads when forced	0.471	*
SQ07	"The Selfish Giant"	-0.498	*
SQ09	Books that explain things	0.706	***
SQ09	Liked reading crossover stories	0.739	***
SQ09	Wants more crossover stories	0.583	**
SQ09	More interested in the classics	0.583	**

The results show that the more the children agreed to want to use the tool for more time, the more they read books they choose themselves and they liked the activity of reading and the crossover stories. The more they thought the app difficult to understand, the more the participants are forced to read. In addition, the more they thought they had to do complicated things on the app, the less the children wanted to read the classic "The Selfish Giant". To finalize, how proud they felt while playing the tool played a major role in their enjoyment of crossover classics and their curiosity of the classics.

The results show that children's intrinsic motivation, in this case depicted by their desire to continue to explore the tool, positively affected their reading and enjoyment of the crossover stories. Meanwhile, difficulty understanding the app or performing complex tasks reduced their motivation to read classics, as it likely affected their sense of competence. Pride in using the tool, which reinforces their autonomy, was a key factor in their enjoyment and curiosity about literary classics.

4.4.4. Children's reading motivation

To assess if the child's motivation rose after exploring the tool, the questions on Section 4 of the Reading habits' survey, which were answered after their contact with the tool, were analyzed and are shown on Table 4.5.

Question RQ410 did not follow the 4-point Likert Scale ranging from 1 to 4 like the other five questions, but had the following 4 options: "Still this week", "Next week", "Next month" and "Never". The options are ordered from the most positive to the most negative for this study, making the statement have a negative bias. Figure 4.14 transforms question RQ410 from "When do I want to read the classics" into "I want to read the classics soon", and has its options inverted and transformed into the 4-point Likert scale, in order to better analyze it in conjunction with the other questions from section 4. A data for the 50

TABLE 4.5. Results of Section 4 of the reading habits survey, which was answered after their first contact with the tool.

Code	Statement (Abbreviated)	Bias	AVG	STD
RQ410	When do I want to read the classics	-	2.61	0.979
RQ421	I liked to read the stories	+	3.25	0.716
RQ422	I want to read more crossover stories	+	3.00	0.725
RQ423	I am more interested in the classics	+	3.00	0.745
RQ424	The stories would be better if they had	-	3.15	0.875
	other of my favorite interests			
RQ425	I will recommend this app to a friend	+	3.15	0.875

20 participants

📃 Did not respond 📃 Disagree completely 📒 Disagree 📒 Agree 📒 Agree completely



FIGURE 4.14. Percentage of children reporting their opinion on the classics and crossover stories, which questions correspond to section 4 of the reading habits survey.

question on the figure can be read as "4 participants agree completely that they want to read the classics soon".

Although the participants tended to be neutral on how soon they would want to read the classics (AVG=2.61, STD=0.979), 9 (45%) children indicated agreeing or strongly agreeing to want to read the classics soon, i.e. in that same week or in the following one. Only 2 (10%) participants disregard the classics completely, with 2 (10%) others choosing not to answer. Meanwhile, they did like to read the stories on the tool (AVG=3.25, STD=0.716), with 17 (85%) agreeing or strongly agreeing with the statement. The participants would like to read more crossover stories (AVG=3.00, STD=0.725), translating into 13 (75%) children agreeing or strongly agreeing with it, but would prefer if they had more interests of theirs (AVG=3.15, STD=0.875). They agreed that they got more interested in reading the classics (AVG=3.00, STD=0.745, with 70% agreeing or strongly agreeing) and they would recommend the tool to a friend (AVG=3.15, STD=0.875, with 80% agreeing or strongly agreeing).

From these six questions pertaining reading motivation, an average score was calculated for each participant, which will correspond to their Motivation Indicator hereafter. This indicator suggests the children's motivation to read the literary classics after reading the crossover stories. Each participant's Motivation Indicator (maximum value = 3) was divided into "Negative" (*indicator* < 1.5) or "Positive" (*indicator* \geq 1.5) and the results are shown on Table 4.6. A positive result translates into the participant liking the stories they read on the tool and wanting to read the classics more.

	Motivation Indicator	Usability Score
n	Negative	5
	Positive	15
AVG	Negative	76.00
	Positive	82.00
STD	Negative	11.800
	Positive	17.300

TABLE 4.6. Results of the usability score grouped by the Motivation Indicator.

The children's reading motivation and engagement by using the tool was positive. Although 5 participants had a negative result (*indicator* < 1.5), their enjoyment of the tool was still high (AVG=76.00, STD=11.800). As expected, the children who had a positive result (*indicator* \geq 1.5) and subsequently liked reading the stories and had their curiosity peaked on the classics, had a higher enjoyment of the tool (AVG=82.00, STD=17.300). A significant correlation (p < 0.05) between the Motivation Indicator and the Usability Score was found when calculating their correlation matrix with Pearson's Correlation Coefficient. Thus, the use of the tool positively impacted reading motivation and engagement.

Table 4.7 shows the most relevant results when grouping the Motivation Indicator (reminding the maximum value is 3) with the chosen variables. "Read Classic's Summary" sample size is only 18 due to the existence of 2 outliers. There is a significant difference $(p \leq 0.01, \text{ obtained when executing the Kruskal-Wallis Statistical Test, hereafter) between boys and girls when it comes to their enjoyment of the stories and motivation to read the classics, with boys being the ones with the higher average score (AVG=2.11, STD=0.394). Children who read for fun and who read books that explain things at least once a week (AVG=1.88, STD=0.581 and AVG=2.01, STD=0.441, respectively) had higher motivation to read the classics and enjoyed the crossover stories more. Children who agreed to like to talk about what they were reading with other people (AVG=1.91, STD=0.480) and who would like to have more time to read (AVG=1.91, STD=0.556) also had a higher average score. The children who went to the library to borrow books at least once a month had a higher Motivation Indicator average (AVG=2.00, STD=0.494). Like with children's 52$
Grouped by	Statement	n	AVG	STD
Gender	Boy	11	2.11	0.394
	Girl	9	1.46	0.549
Read for Fun	Less than once a week	2	1.58	0.25
	At least once a week	16	1.88	0.581
Read Books that Explain Things	Less than once a week	4	1.25	0.534
	At least once a week	14	2.01	0.441
Likes Talking about Books	Disagrees	5	1.55	0.715
	Agrees	15	1.91	0.480
More Time to Read	Disagrees	4	1.75	0.300
	Agrees	15	1.91	0.556
Borrows Books from Library	Sometimes per year or never	5	1.27	0.455
	At least once a month	14	2.00	0.494
Hints	Did not have hints	11	1.81	0.605
	Had hints	9	1.83	0.522
Read Classic's Summary	Did not read	10	1.54	0.534
	Read	8	2.01	0.381

TABLE 4.7. Results of the Motivation Indicator grouped by the chosen reading related variables.

enjoyment of the tool, the existence or lack thereof hints makes no significant (p > 0.05) difference in their reading enjoyment or motivation. Finally, the children who read the classic's summary had a higher Motivation Indicator average (AVG=2.01, STD=0.381) than those who did not read it (AVG=1.54, STD=0.534). In general, frequent recreational reading, book discussion and library visits, as well as the reading of the summaries, were linked to increased motivation.

Again, the Kruskal-Wallis Statistical Test [72] was conducted to the Motivation Indicator and all other variables on Table 4.7. The only one with a significant difference was the variable gender ($p \leq 0.01$) with higher values of motivation for boys. This contrasts with the most recent PIRLS [8] report, where it shows that boys have lower reading scores than girls. This discrepancy may imply that the tool is particularly engaging for boys, highlighting its potential to enhance their reading motivation.

To finalize the analysis, the participants' Motivation Indicator (i.e. their motivation to read the literary classics after reading the crossover stories) was grouped by their opinions of the literary classics available on the tool ("Adventures of Pinocchio" and "The Selfish Giant") before their first contact with the tool. These results are shown in Table 4.8 and compare their level of motivation to read the classics before and after exploring the tool.

Both literary classics show similar results when comparing the Motivation Indicator for reading them after the children explored the tool. A negative Motivation Indicator (*indicator* < 1.5) was shown only when the children did not know of either classic and did not want to read them (n=4, AVG=1.42, STD=0.739 and n=5, AVG=1.47, STD=0.650,

Grouped by	Statement	n	AVG	STD
Adventures of Pinocchio	Does not know of it and does not want to read it	4	1.42	0.739
	Does not know of it, but does want to read it	4	2.06	0.343
	Does know of it and does not want to read it	6	1.53	0.414
	Already read it	6	2.07	0.501
The Selfish Giant	Does not know of it and does not want to read it	5	1.47	0.650
	Does not know of it, but does want to read it	4	2.02	0.239
	Does know of it and does not want to read it	2	1.75	0.354
	Already read it	9	1.84	0.621

TABLE 4.8. Results of the Motivation Indicator grouped by the partipants' opinion of the literary classics before their first contact with the application.

for "Adventures of Pinocchio" and "The Selfish Giant" respectively) before their contact with the tool. Hereafter, all results show a positive Motivation Indicator (*indicator* \geq 1.5). If the children did not know of the classic but still wanted to read it, they had a very high Motivation Indicator after reading the crossover stories (n=4, AVG=2.06, STD=0.343 and n=4, AVG=2.02, STD=0.239, for "Adventures of Pinocchio" and "The Selfish Giant" respectively). If the participant had heard of the classic but had no interest in reading it, after reading the crossover stories their motivation to read either of the classics, i.e. their Motivation Indicator, was positive (n=6, AVG=1.53, STD=0.414 and n=2, AVG=1.75, STD=0.354, for "Adventures of Pinocchio" and "The Selfish Giant" respectively). Unfortunately for the study, 6 children had already read Adventures of Pinocchio" and 9 had read "The Selfish Giant". Although it cannot be said their motivation Indicator was very high (n=6, AVG=2.07, STD=0.501 and n=9, AVG=1.84, STD=0.621, for "Adventures of Pinocchio" and "The Selfish Giant" respectively), showing their enjoyment in reading the crossover stories even when they already knew the classics.

The Kruskal-Wallis Statistical Test did not find any significant differences when grouping the Motivation Indicator with "Adventures of Pinocchio" (p = 0.600) and "The Selfish Giant" (p = 0.270).

To conclude, both classics showed similar positive Motivation Indicators, with high motivation noted in those unfamiliar with the stories, but interested in reading them. Even participants who had previously read the classics reported high reading motivation after engaging with the crossover stories. Overall, the tool increased motivation in the reading of both classics.

4.4.5. Stories Read

To evaluate the overall quality of the generated stories and its questions, they were shown to and critiqued by the children's educators. All confirmed that they were clear and had 54 adequate vocabulary for the age range. For the stories, they liked how they had a clear moral and logical progression. For the questions, some stated that they could be a bit long and one observed that all the options should have the same level of detail. Overall, they all had a positive opinion of both the stories and the questions created. An example of a created crossover story and its questions can be found in Appendix D.

After the experiment, some of the older children commented that, although they liked the stories they read, they thought they were too simple and could be longer. Most children (n=16) agreed that the stories would be better if they had other favorite interests of theirs (Figure 4.14) which included: "Winx", comics, "One piece" and others. The crossover story that was read the most was the one that combined "Pokemon" with "The Selfish Giant", having been read 15 times, compared to the other two crossover stories, one combining "Adventures of Pinocchio" with soccer and another combining "Miraculous: Tales of Ladybug and Cat Noir" with "The Selfish Giant", that were read 13 and 7 times respectively. The children read on average 1.28 stories, excluding 2 outliers that read 5 stories each. It is important to remind that there were only 3 stories available and a time constraint of 5 minutes. Out of 35 stories read, the summary of the classic was read 16 times and out of the 105 questions answered, the children only got 3 wrong. The findings highlight a positive reception of the stories while also pointing to opportunities for improvement by aligning the content more closely with children's interests. The small number of incorrectly answered questions indicate a strong comprehension of the ChatGPT-generated crossover stories.

CHAPTER 5

Conclusion

This dissertation presented the design, development, and evaluation of a didactic tool developed by the author to boost children's reading motivation. The tool allows children to read stories that combine their own interests with literary classics and for their educators to create more stories in that format through LLMs. This tool was iteratively designed with 7 children's education professionals' feedback, and their opinions were considered in the creation of the proposed stories and corresponding questions. To evaluate the developed tool, a user study was conducted with 20 children, where they explored the tool and answered two developed questionnaires: a survey about their reading habits based on the most recent cicle of PIRLS before their first contact with the tool, and an adapted SUS survey after their exploration of the tool and subsequent reading of the crossover stories.

The results indicate a positive user experience with the tool and a positive opinion on the generated stories. Using a curated list of prompts, ChatGPT generated engaging stories that were deemed high-quality by both children and educators. This dissertation confirms ChatGPT's ability to create captivating crossover stories that blend children's interests with literary classics, building upon and expanding the findings of Xen et al. [56], which demonstrated its capability to generate text suited for a younger audience.

Children's intrinsic motivation [11], shown by their desire to keep using the tool and their pride in using the tool, positively affected their reading and enjoyment of the crossover stories.

Based on the questionnaires distributed before and after the children's contact with the tool, a Motivation Indicator was calculated for each child, reflecting their motivation to read the literary classics after engaging with the crossover stories. A positive score (above 1.50, with a maximum of 3) indicated increased motivation. Thus, the tool successfully boosted motivation to read literary classics in 15 out of the 20 children, with 9 (45%) children reporting to want to read the classics in that same week or in the following one. Children who were unfamiliar with the available classics, but were curious about them, and children who read the classic's summary, had particularly high Motivation Indicators.

In addition, the analysis found a higher motivation to read the classics for boys, who normally have lower reading scores according to PIRLS [8]. This highlights the tool's potential to enhance their reading motivation.

As such, the results indicate a relevant potential of combining children's interests with classics to increase their reading motivation. Additionally, the results also show that children who already had an established habit of reading (i.e., read for fun at least once a week, borrows books from the library at least once a month) are more easily receptive of stories they are not familiar with, and tend to enjoy them more, which correspond to existing literature [18] [2]. The reading of the crossover stories also enhanced children's motivation to read a classic they had not heard of, by sparking their curiosity. However, the addition of hints, which showed how children's reading motivation and experience was affected knowing one had to respond to questions afterwards, showed to be non-significant.

Furthermore, the results also show that a higher enjoyment of the tool translated into a higher motivation to read. Its System Usability Scale (SUS) score, which stood at 80.5 out of 100 overall, shows a positive experience with the tool itself, in part as a consequence of being designed and developed across multiple iterations with children's education professionals.

5.1. Limitations

The experiment sample size, 20 children, can be considered small. The population had poor reading habits diversity, since most of the participants already had an established reading habit and enjoyed the activity. This may be because children from only two schools participated in the experiment. However, this may also mean that the tool was successful in motivating children who have had more access to stories and, thus, may be more demanding. The reading habits survey may also have been too extensive.

Additionally, children are highly influenced when in a group, which may have affected their answers on the surveys or enjoyment of the application and stories. For example, on one outlier case, two children were competing against each other for more points on the application.

Moreover, some children had already read one of the available literary classics on the tool. This might have affected their enjoyment of reading the crossover stories in a positive or negative way that we are not able to infer.

5.2. Future Work

As future work, we intend to run additional experiments with larger sample sizes and wider reading habits diversity, and to track the long-term impact of the tool in the children, specifically to analyze if their time estimate on reading the literary classic is followed.

Furthermore, more stories could be created in compliance with the new interests the children requested. The children then would have more variety in interests and thus be more exposed to the literary classic. Moreover, the new crossover stories created can be combined with new and less read literary classics. The tool is also intended to be continuously revised in order to enhance the user experience for both target groups (i.e., children and educators).

Additionally, the tool is intended to be improved to enable the generation of more complex stories, with automatically added generated images, without the need to leave the tool. New features could also be added to the tool, such as text-to-speech, which would expose the crossover stories to children who may have more difficulties in reading. 58 As the tool is based on LLMs, it should be updated when newer text generation models, which are capable of creating more engaging stories, are created.

Additionally, inputting sound elements into the crossover stories has the potencial to aid children's immersion on it. The tool is intended to be updated to be able to integrate an automatic sound generator based on the text generated by a LLM.

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Appendices

Appendix A

Tables containing data from the usability tests conducted. These tasks can be referenced in Section 3.3.2.

Task	User	Task Status	Duration	Number of touches on screen	Level of Effort
1	$n^{0}1$	Completed Successfully	02:30	10	Very high
	$n^{0}2$	Completed Successfully	03:19	11	Very high
2	$n^{0}1$	Completed Successfully	00:25	4	Very low
	$n^{0}2$	Completed Successfully	00:18	6	Low
3	$n^{0}1$	Completed Successfully	01:02	6	Very low
	$n^{0}2$	Completed Successfully	00:43	5	Very low
4	$n^{0}1$	Completed Successfully	02:02	13	Low
	$n^{0}2$	Completed Successfully	01:33	11	Very low
5.1	nº1	Completed Successfully	00:13	4	Very low
	$n^{0}2$	Completed Successfully	00:15	4	Very low

TABLE 5.1. Data from usability tests conducted to Users n^01 and n^02 .

TABLE 5.2. Data from usability tests conducted to Users $n^{0}3$.

Task	User	Task Status	Duration	Number of	Level of Effort
				touches on	
				screen	
1	$n^{0}3$	Completed Successfully	02:17	6	Low
2	$n^{0}3$	Completed Successfully	00:21	5	Low
3	$n^{0}3$	Completed Successfully	00:54	5	Very low
4	$n^{0}3$	Completed Successfully	06:31	21	Very high
5.2	$n^{0}3$	Completed Successfully	02:36	6	Very low

Task	User	Task Status	Duration	Number of touches on	Level of Effort
				screen	
1	nº4	Completed Successfully	01:44	12	Very high
2	nº4	Completed Successfully	00:17	4	Very low
3	nº4	Completed Successfully	00:30	5	Very low
4	$n^{0}4$	Completed Successfully	00:50	11	Very low
5.3	nº4	Completed Successfully	00:37	6	Very low

TABLE 5.3. Data from usability tests conducted to Users $n^{0}4$.

TABLE 5.4. Data from usability tests conducted to Users $n^{0}5$, $n^{0}6$ and $n^{0}7$.

Task	User	Task Status	Duration	Number of	Level of Effort
				touches on	
				screen	
1	$n^{0}5$	Not Completed	01:50	6	High
	$n^{0}6$	Completed Successfully	01:00	6	Low
	$n^{0}7$	Not Completed	01:03	7	High
2	$n^{0}5$	Completed Successfully	00:56	8	High
	$n^{0}6$	Completed Successfully	00:56	10	Very high
	$n^{0}7$	Completed Successfully	00:40	7	High
3	$n^{0}5$	Completed Successfully	01:05	6	Low
	$n^{0}6$	Completed Successfully	00:27	6	Low
	$n^{0}7$	Completed Successfully	00:43	8	High
4	$n^{0}5$	Completed Successfully	00:40	11	Very low
	$n^{0}6$	Completed Successfully	00:44	11	Very low
	$n^{0}7$	Completed Successfully	01:21	12	Very low
5.3	$n^{0}5$	Completed Successfully	02:47	8	Low
	$n^{0}6$	Completed Successfully	00:36	8	Low
	$n^{0}7$	Completed Successfully	03:23	18	Very high

Appendix B

"*nameOfScreen*Fragment" and "*nameOfTable*Model" classes existing on the tool's Android Studio Project. The line with the unfilled arrow correspond to the class extending the one pointed towards.





Appendix C

Pages of the reading habits survey and SUS survey, respectively, in Portuguese. For more information, see Section 4.1.

Acerca de ti	
1 – Qual é o teu género?	Pinta apenas um círculo.
Rapaz () Bapariga ()	
Napanga O	
2 – Que idade tens?	
3 - Com que frequência falas português em casa?	Pinta apenas um círculo.
sempre português em casa 🔘	
Eu às vezes falo português e	
outras vezes falo outra	
língua em casa ()	
Eu nunca falo português em casa ()	
4 – O teu pai tem um curso superior?	Pinta apenas um círculo.
Não ()	
Não sei 🔿	
F. A. A	
5 – A tua mae tem um curso superior?	Pinta apenas um círculo.
Sim 🔿	
Não 🔾	

6 – Cerca de quantos livros existem em tua casa? (Não contes com revistas, jornais ou com os teus livros da escola.)

(11–25 livros) -- 🔿

(26–100 livros) -- 🔿

Pinta apenas um círculo.

Nenhum ou muito poucos (0–10 livros) -- 🔿

Suficiente para encher uma prateleira

Suficiente para encher uma estante

Isto mostra 10 livros



Isto mostra 25 livros



Isto mostra 100 livros

kan kan kan kan kan

Isto mostra 200 livros

Linki.

ka ka ka

Suficiente para encher duas estantes	
(101–200 livros) 🔿	Isto
	Den konte

Suficiente para encher três ou mais estantes (mais de 200 livros) -- ()



Isto mostra mais de 200 livros

Hábitos de Leitura

1 - Quanto tempo passas a ler fora da escola num dia normal de aulas?

Pinta apenas um círculo.

Menos de 30 minutos -- () 30 minutos a 1 hora -- () 1 hora a 2 horas -- () 2 horas ou mais -- ()

2 - Com que frequência fazes estas coisas fora da escola?



3 - Com que frequência lês estas coisas fora da escola (impressas ou em dispositivos eletrónicos/digitais)?

Pinta **um** círculo em cada linha.



4 - O que pensas sobre a leitura? Diz em que medida concordas com cada uma destas afirmações.



5 - O que pensas sobre a leitura em dispositivos eletrónicos? Diz em que medida concordas com cada uma destas afirmações.



Biblioteca e livros

1 - Com que frequência vais à biblioteca, da escola ou outra, requisitar livros?

Pinta apenas um círculo.

Pelo menos uma vez por semana -- () Uma ou duas vezes por mês -- () Algumas vezes por ano -- ()

Nunca ou quase nunca -- ()

2 - Qual é a tua opinião sobre estes livros?

Pinta **um** círculo em cada linha.



Experiência

1 – Depois desta experiência, quando é que vais ler a obra "As Aventuras do Pinóquio" ou "O Gigante Egoísta"?

Pinta apenas um círculo.

Ainda nesta semana 🔿
Na próxima semana 🔿
No próximo mês 🔿
Nunca 🔿

2 – Nesta experiência, leste uma história que mistura os teus personagens e interesses preferidos com personagens de obras clássicas. O que pensas sobre esta experiência? Diz em que medida concordas com cada uma destas afirmações.

Pinta um círculo em cada linha.



SUS survey, in Portuguese.

Responde aos items seguintes, escolhendo apenas uma opção:
Concordo completamenteConcordo completamenteNão concordo nem discordoDiscordoDiscordo completamente
Concordo Não concordo Discordo completamente Concordo nem discordo Discordo completamente
a) Se tivéssemos mais tempo, continuaria a usar a app
b) A app foi difícil de compreender O O O O O
c) Eu achei que a app foi fácil de usar 🔿 🥌 🔿 🦲 💮 💮
d) Eu iria precisar de ajuda para continuar a usar a app O —— O —— O —— O —— O
e) Eu sabia o que fazer a seguir enquanto usava a app O —— O —— O —— O —— O
f) Senti-me confuso/a algumas vezes enquanto usava a app O O O O O O O O
g) Para usar a app tive que fazer coisas complicadas O O O O
h) A app seria fácil de usar pelos meus amigos O —— O —— O —— O —— O
i) Estou orgulhoso/a em como usei a app 🔿 💷 🔿 🦲 🔗 🔗
j) Havia muitas coisas para aprender para usar a app O —— O —— O —— O —— O

Appendix D

One of the crossover stories available in the tool, combining "Adventures of Pinocchio" and soccer, and its questions, in Portuguese.







$\stackrel{\infty}{\odot}$ Appendix E

Debriefing documents given to the children and the education professionals, respectively, in Portuguese.





DEBRIEFING/EXPLICAÇÃO DA INVESTIGAÇÃO

Muito obrigado por ter participado neste estudo. Conforme adiantado no início da sua participação, o estudo incide sobre a leitura de crianças que frequentam o 3° e 4° ano letivo e pretende investigar a sua motivação para a leitura, ao conjugar os interesses das crianças com personagens de obras literárias numa aplicação didática.

Reforçamos os dados de contacto que pode utilizar caso deseje colocar uma dúvida, partilhar algum comentário, ou assinalar a sua intenção de receber informação sobre os principais resultados e conclusões do estudo: Inês Nunes do Carmo, que pode ser contactada através do email: <u>indco@iscte-iul.pt</u>.

Mais uma vez, obrigado pela sua participação.

Appendix F

Consent documents given to the children's guardians and the education professionals, respectively, in Portuguese.



CONSENTIMENTO INFORMADO (ENCARREGADO DE EDUCAÇÃO)

Este documento visa solicitar a participação do seu educando numa experiência na qual irá utilizar e explorar, em conjunto com os colegas, o protótipo de uma aplicação didática que pretende estimular a leitura nas crianças. Essa experiência também incluirá uma sessão de design participativo dessa mesma aplicação didática, onde irá criar uma personagem de carácter literário e indicar os seus interesses não literários favoritos. Esta experiência terá uma duração aproximada de 20 minutos. Ainda que possa não beneficiar diretamente com a participação no estudo, as respostas do seu educando irão contribuir para a investigação sobre como aumentar a motivação das crianças para a leitura e para o desenvolvimento da aplicação didática.

O estudo é realizado por Inês Nunes do Carmo, que pode ser contactada através do email **indco@iscte-iul.pt**. Este estudo é parte integrante da sua Dissertação de Mestrado em Engenharia Informática, que se encontra a ser realizada no ISCTE - Instituto Universitário de Lisboa. Poderá contactá-la caso pretenda esclarecer uma dúvida, partilhar algum comentário ou exercer os direitos do seu educando relativos ao tratamento dos seus dados pessoais. Poderá utilizar o contacto indicado para solicitar o acesso, a retificação, o apagamento ou a limitação do tratamento dos dados pessoais.

O lscte é o responsável pelo tratamento dos dados pessoais do seu educando, recolhidos e tratados exclusivamente para as finalidades do estudo, tendo como base legal o seu consentimento em concordância com o art. 6°, n°1, alínea a) do Regulamento Geral de Proteção de Dados.

A participação neste estudo é **confidencial**. Os dados pessoais do seu educando serão sempre tratados por pessoal autorizado vinculado ao dever de sigilo e confidencialidade. O Iscte garante a utilização das técnicas, medidas organizativas e de segurança adequadas para proteger as informações pessoais. É exigido a todos os investigadores que mantenham os dados pessoais confidenciais.

Além de confidencial, a participação no estudo é estritamente **voluntária**: o seu educando pode escolher livremente participar ou não participar. Se tiver escolhido participar, o seu educando pode interromper a sua participação e retirar o consentimento para o tratamento dos seus dados pessoais em qualquer momento,

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sem ter de prestar qualquer justificação. A retirada de consentimento não afeta a legalidade dos tratamentos anteriormente efetuados com base no consentimento prestado.

Os dados pessoais do seu educando serão conservados por 1 semana, após a qual serão anonimizados, garantindo-se o seu anonimato nos resultados do estudo, apenas divulgados para efeitos estatísticos, de ensino, comunicação em encontros ou publicações científicas.

Não existem riscos significativos expectáveis associados à participação no estudo.

O Iscte não divulga ou partilha com terceiros a informação relativa aos seus dados.

O lscte tem um Encarregado de Proteção de Dados, contactável através do email <u>dpo@iscte-iul.pt.</u> Caso considere necessário tem ainda o direito de apresentar reclamação à autoridade de controlo competente – Comissão Nacional de Proteção de Dados.

Declaro ter compreendido os objetivos de quanto foi proposto e explicado pelo/a investigador/a, ter-me sido dada oportunidade de fazer todas as perguntas sobre o presente estudo e para todas elas ter obtido resposta esclarecedora. **Aceito que o meu educando** participe no estudo e consinto que os seus dados pessoais sejam utilizados de acordo com a informações que me foram disponibilizadas.

Sim 🛛 Não 🗆

(local),/ (data)
Nome:
Documento de Identificação n.º:
Data ou validade://
Representante legal:
se for parente, indicar o grau de parentesco)
Assinatura:
scte – Instituto Universitário de Lisboa • Av. Forças Armadas, 1649-026 Lisboa • 🕿 +351 217 903 000 • 🖂 geral@iscte-iul.pt
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CONSENTIMENTO INFORMADO (PROFISSIONAL DE EDUCAÇÃO)

O presente estudo surge no âmbito de uma dissertação de mestrado intitulada "Uma ferramenta para aumentar a motivação das crianças para a leitura com cruzamentos de histórias gerados por LLMs" a decorrer no ISCTE – Instituto Universitário de Lisboa, realizado por Inês Nunes do Carmo, que pode ser contactada através do email indco@iscte-iul.pt. Poderá contactá-la caso pretenda esclarecer uma dúvida, partilhar algum comentário ou exercer os seus direitos relativos ao tratamento dos seus dados pessoais. Poderá utilizar o contacto indicado para solicitar o acesso, a retificação, o apagamento ou a limitação do tratamento dos seus dados pessoais.

Este estudo incide sobre a leitura de crianças que frequentam o 3o e 4o ano letivo e pretende investigar a sua motivação para a leitura, ao conjugar os interesses das crianças com personagens de obras literárias numa aplicação didática.

O lscte é o responsável pelo tratamento dos seus dados pessoais, recolhidos e tratados exclusivamente para as finalidades do estudo, tendo como base legal o seu consentimento em concordância com o art. 6°, n°1, alínea a) do Regulamento Geral de Proteção de Dados.

A participação neste estudo é **confidencial**. Os seus dados pessoais serão sempre tratados por pessoal autorizado vinculado ao dever de sigilo e confidencialidade. O lscte garante a utilização das técnicas, medidas organizativas e de segurança adequadas para proteger as informações pessoais. É exigido a todos os investigadores que mantenham os dados pessoais confidenciais.

Além de confidencial, a participação no estudo é estritamente **voluntária**: pode escolher livremente participar ou não participar. Se tiver escolhido participar, pode interromper a participação e retirar o consentimento para o tratamento dos seus dados pessoais em qualquer momento, sem ter de prestar qualquer justificação. A retirada de consentimento não afeta a legalidade dos tratamentos anteriormente efetuados com base no consentimento prestado.

Os seus dados pessoais serão conservados por 1 semana, após a qual serão anonimizados, garantindo-se o seu anonimato nos resultados do estudo, apenas

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divulgados para efeitos estatísticos, de ensino, comunicação em encontros ou publicações científicas.

Não existem riscos significativos expectáveis associados à participação no estudo.

O lscte não divulga ou partilha com terceiros a informação relativa aos seus dados.

O lscte tem um Encarregado de Proteção de Dados, contactável através do email dpo@iscte-iul.pt. Caso considere necessário tem ainda o direito de apresentar reclamação à autoridade de controlo competente - Comissão Nacional de Proteção de Dados.

Declaro ter compreendido os objetivos de quanto me foi proposto e explicado pelo/a investigador/a, ter-me sido dada oportunidade de fazer todas as perguntas sobre o presente estudo e para todas elas ter obtido resposta esclarecedora. Aceito participar no estudo e consinto que os meus dados pessoais sejam utilizados de acordo com a informações que me foram disponibilizadas.

Sim 🛛 Não 🗖

_____ (local), ____/____ (data)

Assinatura:__

Nome:____

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Appendix G

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TABLE 5.5. All significant correlations between tool usability and reading habits obtained when calculating the correlation matrix with Pearson's Correlation Coefficient. For more information on the SUS variables, see Table 4.4. Note: * p < 0.05, ** p < 0.01, *** p < 0.001.

SUS variable	Reading habits variable (Abbreviated)	Correlation	Significance
SQ01	Selected reading	0.619	**
SQ01	Wanted to have more time to read	0.577	**
SQ01	Likes reading	0.591	**
SQ01	Borrows books from the library	0.496	*
SQ01	Liked reading crossover stories	0.652	**
SQ01	Wants more crossover stories	0.542	*
SQ01	Recommends tool to friends	0.747	***
SQ01	Quantity of crossover stories read	0.477	*
SQ02	Speaks portuguese at home	-0.458	*
SQ02	Only reads when forced	0.471	*
SQ02	Likes reading	-0.456	*
SQ02	Likes to read digitally more than physically	0.480	*
SQ02	Reads digitally more than physically	0.609	**
SQ02	Recommends tool to friends	-0.451	*
SQ03	Likes reading	0.674	**
SQ03	Likes to read digitally more than physically	-0.538	*
SQ03	Borrows books from the library	0.565	**
SQ03	Recommends tool to friends	0.627	**
SQ04	Feels happy when receiving a book	-0.496	*
SQ04	Likes reading	-0.480	*
SQ05	Mother has an academic degree	-0.477	*
SQ05	Reads for fun	0.461	*
SQ05	Likes to talk about books	0.591	**
SQ05	Likes reading	0.460	*
SQ06	Quantity of crossover stories read	-0.466	*
SQ07	"The Selfish Giant"	-0.498	*
SQ07	Recommends tool to friends	-0.512	*

SUS variable	Reading habits variable (Abbreviated)	Correlation	Significance
SQ08	Feels happy when receiving a book	0.711	***
SQ08	Quantity of crossover stories read	0.461	*
SQ09	Is a boy	-0.477	*
SQ09	Books that explain things	0.706	***
SQ09	Likes to talk about books	0.591	**
SQ09	Likes reading	0.460	*
SQ09	Borrows books from the library	0.701	***
SQ09	When will read the classics	-0.474	*
SQ09	Liked reading crossover stories	0.739	***
SQ09	Wants more crossover stories	0.583	**
SQ09	More interested in the classics	0.583	**
SQ09	Recommends tool to friends	0.774	***
SQ10	Feels happy when receiving a book	-0.607	**
SQ10	Quantity of crossover stories read	-0.464	*