TÉCNICO LISBOA

Supporting Children's Mobility in Public Transport

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Abstract

Nowadays, children in some countries have a lot of encouragement to use public transportation, for instance on their way to school, instead of using private means of transports, like their parents' cars. These incentives, like the entitlement of free public transportation at both subway and bus, are a big step towards the autonomy of children on making their home-school trip every day by themselves. But we still have some serious gaps regarding the children's mobility like the safety issues associated with children traveling alone and the privacy issues regarding the use of online mobile applications. This project proposes a solution that consists of a Discord Chatbot that helps children, from ages 9 to 12, making their way from home to school and the other way around, with the company of their friends to make it safer. Children can also choose a different place than their school to go to.

Keywords

Mobility; Safety; Privacy; Children's Autonomy; Public Transports

Resumo

Hoje em dia as crianças em alguns países têm muitos incentivos para usarem transportes públicos, por exemplo no caminho para a escola, em vez de usarem meios de transporte individuais, como os carros dos pais. Estes incentivos, como o direito a usar transportes públicos de forma gratuita como o metro e o autocarro, são um grande passo para o aumento da autonomia das crianças para realizarem o percurso diário casa-escola sozinhos. Mas ainda existem algumas sérias lacunas relacionadas com a mobilidade das crianças, como as questões de segurança associadas a crianças que viajam sozinhas e as questões de privacidade associadas ao uso de aplicações móveis online. Este projeto propõe uma solução que consiste num chatbot para o discord que ajuda as crianças, entre os 9 e os 12 anos, a fazer o percurso entre casa e a escola e vice-versa, na companhia de amigos para tornar a viagem mais segura. As crianças têm também a opção de escolher um local diferente, para além da escola, para onde podem ir.

Palavras Chave

Mobilidade; Segurança; Privacidade; Autonomia das crianças; Transportes Públicos

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1

Introduction

Contents

This thesis is part of a larger research project that has been carried out for the last three years in Portugal [4,5,10]. Building up on this past work, this thesis aims to address children's independent mobility, aiming to deploy an online mobile application that will improve this lack of independent mobility, from a technical standpoint.

Mobility is a great concern in today's world because it has a direct impact in the environment. Having this in consideration, urban dwellers are encouraged by public policies to use public transportation instead of using private transportation. If this measure really goes forward it will decrease the number of vehicles on the road which leads to less pollution [14].

In order for people to use public transportation they have to be rewarded in some way (for instance monetarily) [16]. Because of this, in Lisbon children aged 4 to 12 years are entitled to free public transportation at Carris and Metro [15]. This measure was taken to attract children to use more public transportation because a report from 16 different countries, Australia, Brazil, Denmark, England, Finland, France, Germany, Ireland, Israel, Italy, Japan, Norway, Portugal, South Africa, Sri Lanka and Sweden, concluded that Portugal and Italy are among the countries with the lowest aggregate rank scores of children's independent mobility [1].

This measure is great to enhance children's mobility, but we still face some problems regarding this topic. A lot of parents are very afraid of letting their kids use public transportation on their own due to the lack of safety in the streets [2]. This fear exists not only on the parents' side but also on the children side.

The project described in this document wants to encourage children's mobility, promote the use of public transportation among young people and create habits of use of public transportation from childhood. The goal is to create a mobile solution that improves children's independent mobility, focusing primarily on the child safety.

In the next sections, we will describe the objectives of this work as well the related work, the implemented solution, the evaluation and a conclusion.

1.1. Objectives

This project wants to create a mobile solution designed for children to increase their mobility and autonomy on their daily travels from home to school and vice versa. In order to accomplish this objective, the solution should:

- Increase the engagement of children in using public transports or walking by foot;
- Support children's autonomy while giving their parents a sense of safety.

The solution developed was a chatbot for Discord. This chatbot can be used at any given time and its main purpose is to help children to make their usual home-school-home everyday trip. In order to accomplish that task, the child only needs to provide his home address, his school's name and the travel method that he wishes to use, like public transports, walking or bicycling. When the child wants to begin his path, he just needs to tell the bot that he's ready to begin and the bot will reply with the indications to the destination, alongside with the estimated duration of the route.

To make this route safer and more appealing for children to travel with autonomy, the solution developed allows the child to make his path with his friends. If the child wants to go to school with some friends, he just needs to inform the bot with whom he wants to go. Then, when the child wants to begin his way to school, the bot will generate the most efficient path from the child's home to his school, crossing through all his friends' houses. Besides that, the bot will also send a message to all of the child's friends with the estimated time that he will take to their house and the indications for the remaining of the path.

Because the main focus of this thesis is the autonomy of children overall and not only the autonomy from home to school, the chatbot also lets children a choose a different location (like a mall or a market) and has the same functionalities for this location, as it has for the path to school.

To evaluate the solution described above, this chatbot was tested with a small group of children to check its' viability and the improvements that can be made.

2

Related Work

Contents

This section is split into three different topics: Mobility, Privacy and other related apps.

2.1. Children's Mobility

Children's independent mobility (like travelling alone from home to school) is a topic very important that represents a huge concern in modern times. Nowadays this mobility is decreasing which reflects in significant consequences for the health and physical, social and mental development of children [1].

A study was done to see, between the 16 countries studied, what were the countries where there was more independent mobility by children and to also figure out what are the main factors that contribute to this independent mobility.

As we can see in the figure 1, from the 16 countries studied, Finland is by far the country with the greatest independent mobility. Alongside Finland we also have Germany, Norway, Sweden, Japan and Denmark that consist on the top performers of this study, having a very small difference on the score between each other. On the other end we have France, Israel, Sri Lanka, Brazil, Ireland, Australia, Portugal, Italy and South Africa with the lowest performance. Between the best and the worst performers, we have England standing in the middle.

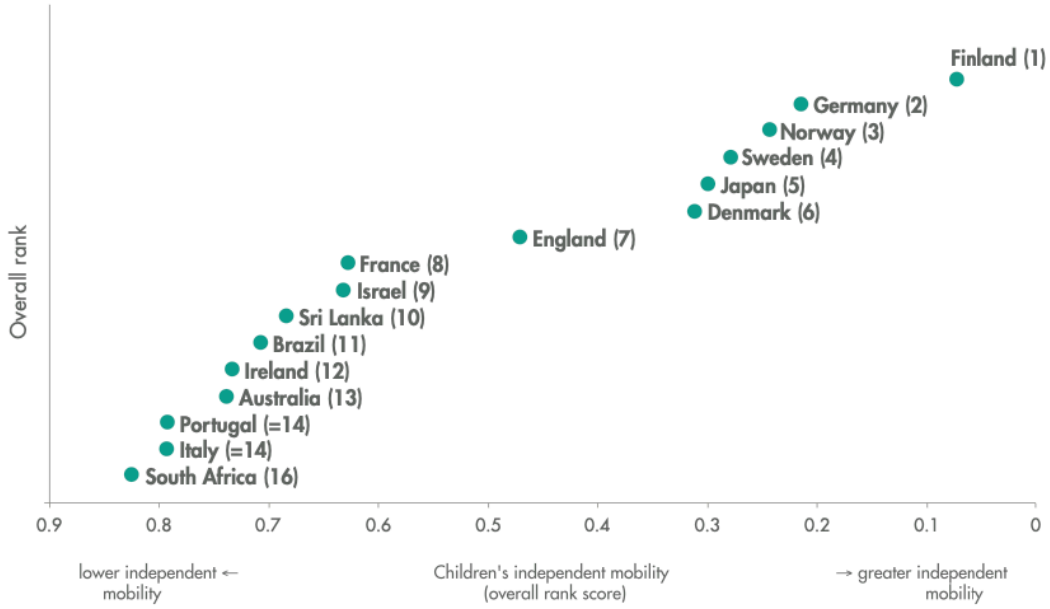

Figure 1: Differences in overall children's independent mobility

We could think that one of the factors that contributed the most for the huge discrepancy between these countries is related to the safety. When it comes to children's mobility, safety is a big concern for parents which can cause them to reduce their child's mobility. In this specific case we are talking about road safety. As we can see in the figure 2, the deaths that occur due to road traffic don't influence a lot the independent mobility of children. There's a poor correlation between the road traffic

deaths and the overall rank score of children's independent mobility, in the countries studied in this report. On one side of the figure we can see that the country with the most road traffic deaths (South Africa) is also the one with lowest independent mobility score. But on the other side of the figure we have Finland, the country with the greatest independent mobility score, having a similar road traffic death rate as Japan, Israel and Ireland, which are in the 5th, 9th and 12th position.

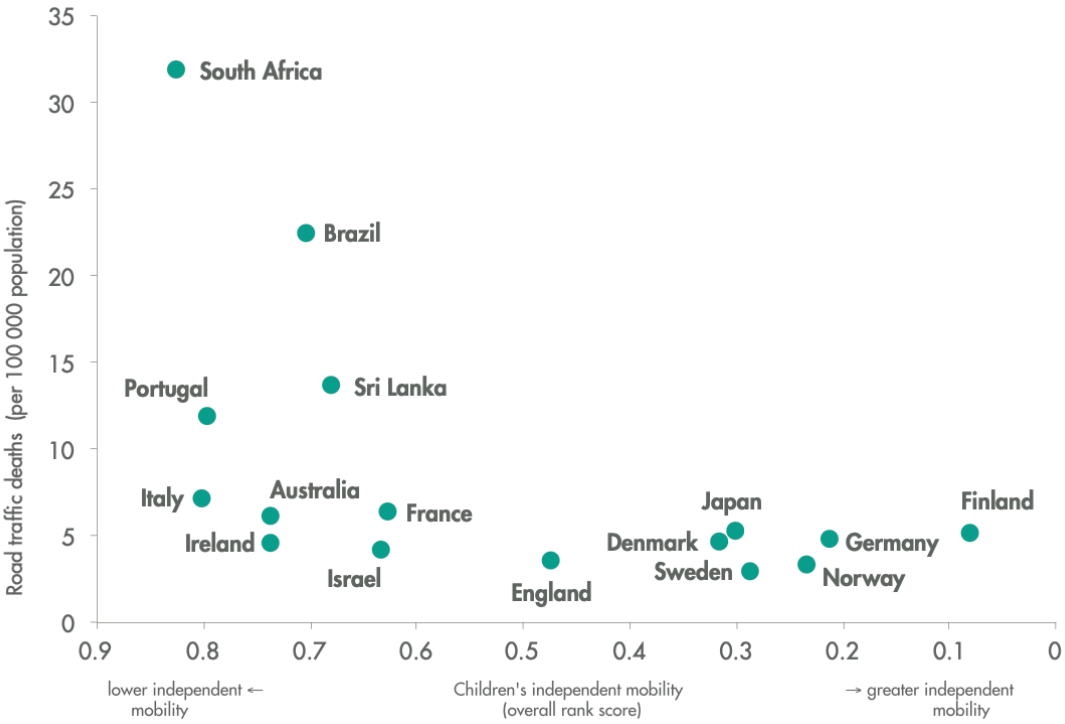

Figure 2: Impact of road safety on children's independent mobility

We can analyze clearly that there's a threshold on the 10 road traffic deaths per 100 000 population. Every country above these values (South Africa, Brazil, Sri Lanka, Portugal) have a lower independent mobility score but below this threshold the influence of this factor on the children's independent mobility is practically none.

Despite what studies show about more vulnerability of girls over boys [9], there are no significant differences in children's independent mobility between the two genders, on the countries studied in this report.

This study [1] also shows that, besides not having a huge impact, children with mobile phones have more independent mobility mainly when travelling on local buses. This is expected because children that have a mobile phone can contact their parents anytime if something bad happens. This gives the parents some comfort because they are one phone call away from their child and this gives a sensation of safety. By feeling safe, parents tend to let their child have more independent mobility because they are less worried about their safety. Based on this, we can assume that mobile phone ownership leads to a sense of safety.

These factors, and many others, directly or indirectly affect children's mobility in some way. A factor, however, that has significantly more impact on them, given that it is such a "factor" that decides the independent mobility of children. This factor is the child's parents. The parents are the ones who decide the level of independent mobility that their own child may have [2]. This decision is mainly taken based on the security of their child, or in other words, the parents' fears [2].

This study [2] examines the impact of parents' fear of strangers on children's independent mobility and it also examines whether the parents' trust on other residents mitigates this impact.

As we can see in the figure 3, when parents have a fear of strangers that reflects significantly in the independent mobility of their child. We can see that we have a strong connection between these two elements ($p \leq 0.05$) and when there's a parental fear of strangers we have low values of independent mobility for both boys (0.66) and girls (0.65).

Regarding informal social control, we can conclude from this table that parents of independent mobile children are able to perceive more informal social control from this neighborhood. This means that parents trust in their neighbors and that reflects in less fear of strangers. As we said before, less fear from the side of parents reflects in a more independent mobility from their children (1.31 in boys and 1.33 in girls).

	Boys (*n*=598)		Girls (*n*=647)	
Factor	**OR**	***P***	**OR**	***p***
Parental fear of strangers[a]	0.66	**0.000**	0.65	**0.000**
Informal social control[a]	1.31	**0.015**	1.33	**0.003**
Parent perceives that their neighbourhood is friendly[a]	1.66	**0.002**	1.71	**0.000**
Child perceives lots of children the same age in their area	2.91	**0.000**	2.51	**0.000**
School neighbourhood walkability (high)	1.17	0.415	1.79	**0.001**
Parent perceives that they live on a busy road	0.63	0.088	0.56	**0.025**

a
Continuous variables.

Figure 3: Associations between independent mobility and parental fear of strangers, in- formal social control and other adjustment variables

According to Sarah Foster and her team we can conclude that the independent mobility of children depends on a very hard decision from their parents. Parents usually struggle to balance their fears regarding their children's safety and the social norms that say children need some autonomy when they grow up. The study reveals that the safety side is still the one that matters the most. It's clear that

with more fear of strangers the children's independent mobility is decreased. Besides that, against the expectations of the authors, believing that the neighbors would look out for their children barely mitigated the impact of parental fear on independent mobility.

Regarding the connection between the children's mobility and technology (like location-based systems), an article studied the correlation between these two factors [3]. This study was done with children using a device that works with proximity detection and an app that receives that information (shown in the figure 4). The authors concluded that parents think that proximity detection is better than GPS or smartphone location tracking because it improves the trust connection between children and their parents. Another study also showed that technology is a great enabler for improving children's independent mobility [4,5].

Figure 4: Proximity detection device given to children (left) and the app that controls the device (right)

As we said, this technology helps improving children's mobility and, in this case, also is concerned with the trust between the two elements. This trust is essential for the enhancement of children's mobility and needs to be thought very carefully because it's directly connected to a very delicate issue nowadays: privacy.

2.2. Children's Privacy

Privacy has always been an issue and it's a right that anyone should have. Unfortunately, this not always happens, and we can see this happening mainly on children because parents are overprotective and want to know everything their child is doing. This not always is done with bad intentions, but it's done because parents are worried about their children due to the lack of safety around them, mainly online.

There's a study made by Arup Kumar Ghosh and his team in 2018 about the relationship between mobile applications and parental control features regarding online safety [6]. A lot of parents still compare the internet to a scary and dark place where their children have to be very careful. This thought led to the creation of parental control features that let parents control what they children can and can't do on their phones. These features can go from blocking websites that parents don't want their children to access to set the time that their children can play with their smartphone.

In this study [6] 37 mobiles apps were reviewed by children and 76% of them had only a one-star rating due to lack of freedom that they felt they had. Children felt a lot of restriction and invasion of their privacy. Despite the fact that parents want to control what their children are doing, there must be a boundary because children also have the right to have some privacy.

Although most of the reviews were very negative, there were still some children that highly rated the applications. These good reviews were given due to these three major facts: the apps helped to control unhealthy behaviors, the apps helped to keep them safe and some apps allowed them to negotiate with their parents for more freedom. This last theme is very important for the solution that this project presents in the next section.

Comparing the features of the apps and the respective reviews by the users we can see, in the figure 5, that children's reviews were more positive when the apps allowed them to regulate themselves (self-monitoring), when it controlled bad habits (impulse control) and when it allowed to keep them safe (risk coping).

The reviews weren't that good when the app invaded their privacy (monitoring), when added a lot of restrictions (restriction) and when it supported bad parenting along with lack of communication (active mediation). There's also a relation between active mediation and self-monitoring because when children are given more freedom to make their choices and be self-aware, they also can negotiate better the rules set by their parents.

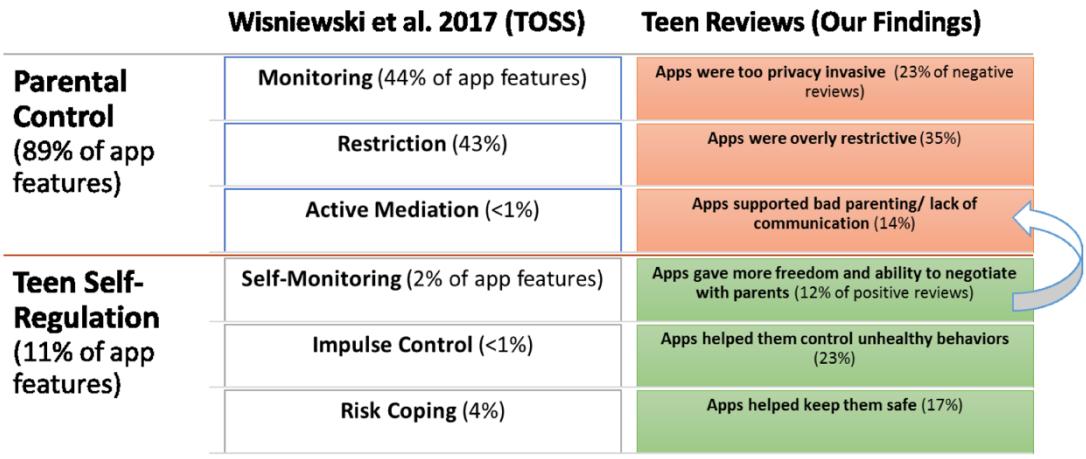

Figure 5: Children reviews to mobile application features

This study concluded that an application should be designed focusing primarily on the children needs, meaning that the designers should assume that their end users are children because this may provide children cues that show they have agency and choice, increasing their sense of personal autonomy and control [6]. Besides that, children complained a lot about their lack of freedom and privacy so the designer should focus on features that help them but that also gives them some control.

Regarding these conclusions, in the figure 6 we can see the approach used currently for designing applications versus the solution that another study proposes [7]. The current approach works on a one-to-one simplistic way: every time a new application is developed another application in order for the parents to control and monitor their children's mobile activity. This model has a flaw that can't be fought: the development of new technologies always outpaces the development of the apps to control the first.

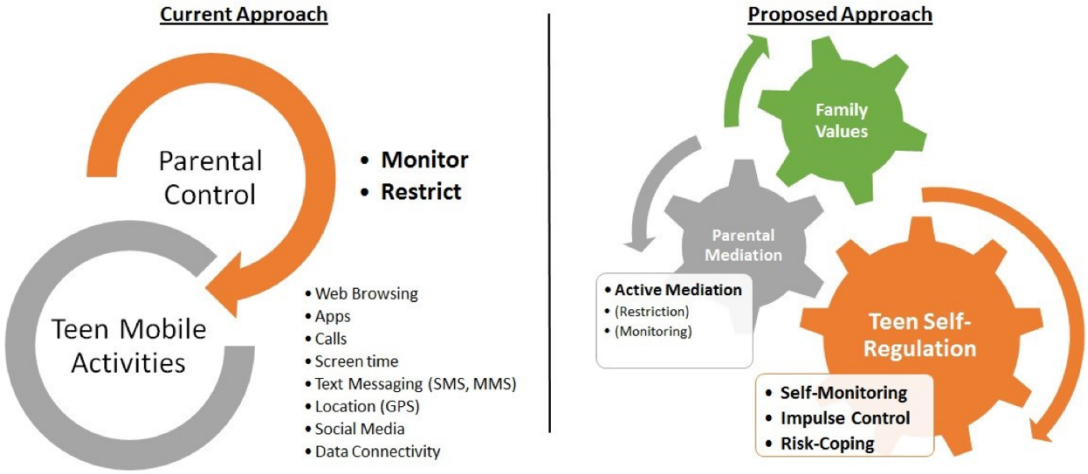

Figure 6: Current versus Proposed Approach for online safety applications

On the other side we have the new approach that focuses on the family values (this depends for each family) by emphasizing teen self-regulation and parental mediation. This new model doesn't instantly focus on the control of parents over their children's mobile activity but tries to enhance something that almost doesn't exists on today's apps: the settlement between the child and the parents that support both parental mediation and teen self-regulation.

Teen self-regulation is already a challenge by itself because it's hard to design an application in a way that makes children to make better decisions without the help of their parents. It's not always about how something is done but how it's presented. If some data is presented in a way that attracts children, it's easier to influence them.

The main conclusion taken by these studies is that when designing an application for children, the best way to protect the privacy of children that use these applications is by having a perfect balance between parent control and the children self-regulation. Parents tend to be overprotective and control the mobile activity of their children, but this represents an invasion of privacy that needs to be mediated [7].

Regarding all of these monitoring applications used by parents we should be aware of the child surveillance data assemblage and child data rights assemblage. There are very few instruments to safeguard children's rights and so this is a very important topic. One of the most known instruments to safeguard children's rights is the UNCRC (United Nations Convention on the Rights of the Child) that offers the potential to a new assemblage. This is an assemblage that protects children while not claiming complete ownership over them [8].

2.3. Related Applications

There are some applications that already cover these topics like Healthy Routes [11], Family Link [12], Pokémon Go [17]. We're going to focus on two of them that cover specifically the Mobility and the Privacy issues respectively: Healthy Routes and Family Link.

Healthy Routes is an application that focuses on the topic of mobility along with climate change [11]. The main goal of this app is to create the healthiest itinerary from point A to B. The healthiest itinerary consists on the route that takes the roads with higher percentage of shade, lower levels of allergens, greater accessibility or less noise, depending on the user.

To gather all the data needed to create these itineraries, the app uses a software created by Green Urban Data (creators of Healthy Routes) that monitors and measures the environmental data in cities. In the figure 7 we can see that the app can measure the difference of temperature that exists in different spots of the city.

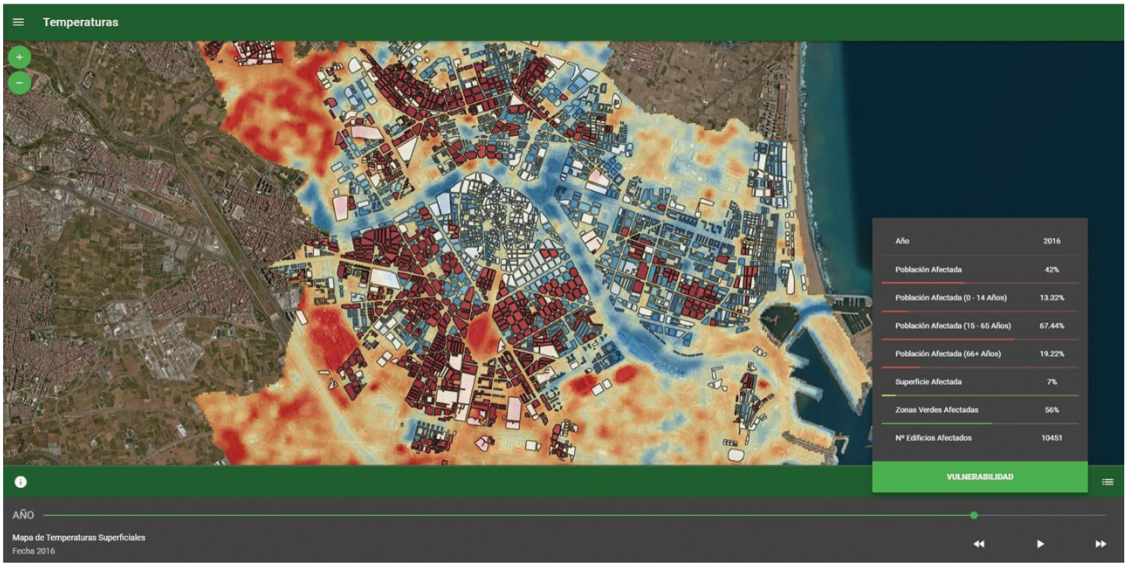

Figure 7: Green Urban Data software displaying temperature differences in a city

The Healthy Routes application is very helpful, for instance, for elderly people that can't deal with huge difference of temperatures. Knowing this, the app will make a route from the starting point to the destination choosing primarily streets with higher percentage of shade.

In the figure 8 we can see an example of the application showing the shortest route and showing an alternative one (the healthy route), created based on the data gathered by the Green Urban Data software, that takes 6 minutes instead of 5 minutes but the user is 35% less exposed to the sun.

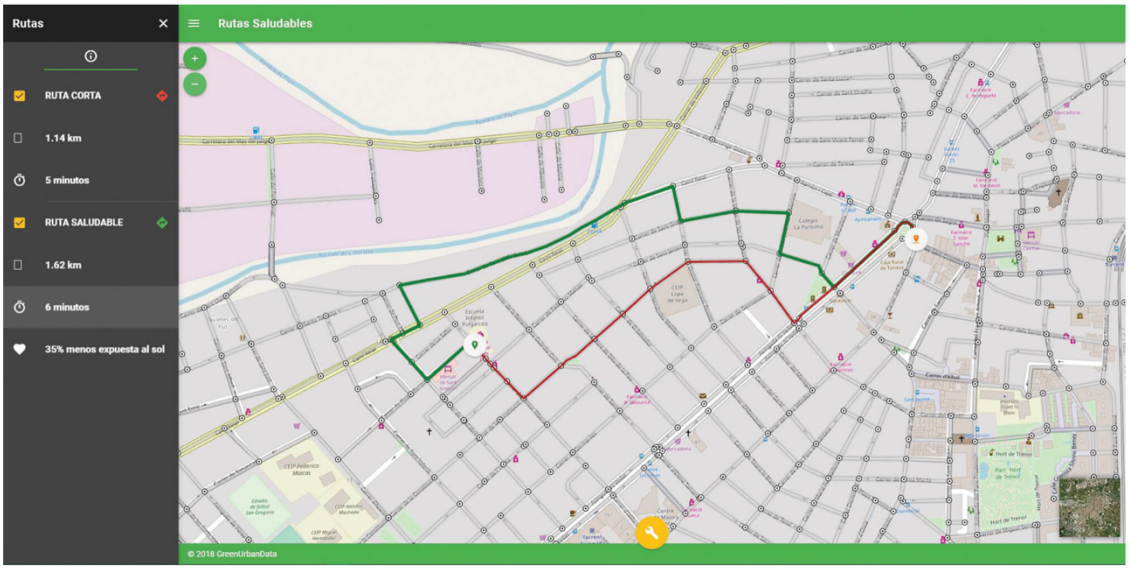

Figure 8: Healthy Routes interface

Based on the information gathered from the users that use this application, local governments can create new urban strategies to improve their cities like creating new bike lanes in routes that are used a lot. By doing this, the city is promoting the use of more sustainable ways of transportation, reducing the pollution.

Although the main goal of this app is to help cities to adapt to climate change, it also shows a great step towards the enhancement of mobility.

Compared to the solution proposed in this thesis, although not being targeted to children, this application lacks on the privacy aspect. Healthy Routes gathers the location of their users whereas the solution proposed doesn't use the children's location. Nowadays privacy is a very important and delicate topic that needs some effort put into.

Family Link is an application that is focused on the privacy topic [12,13]. This application main goal is to allow parents to control their children's mobile activity.

As we can see by the figure 9, the parents can set some ground rules by blocking or allowing certain apps and websites. They can also check the device activity in order to know what apps does their child use and for how long. Lastly parents can also balance the screen time by locking the device when they want to, like when it's time to study or sleep.

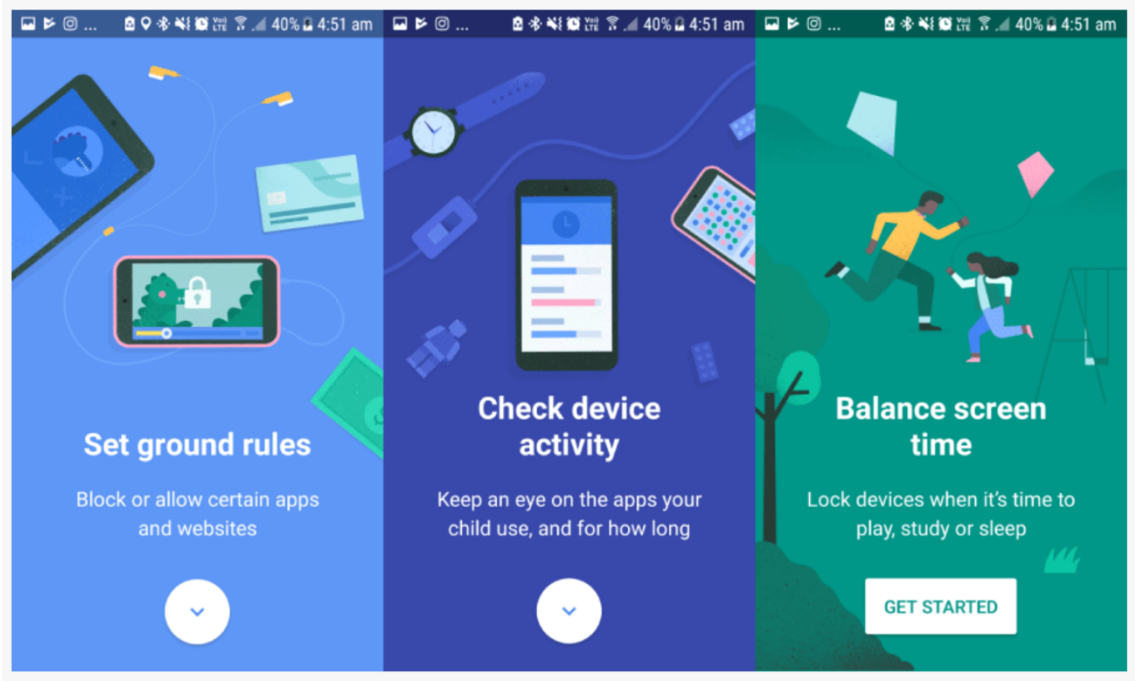

Figure 9: Google's Family Link app features

Here's (figure 10) an example of how the parents can: track what apps their child uses the most, approve the download of another app and see what apps their child's teacher recommends.

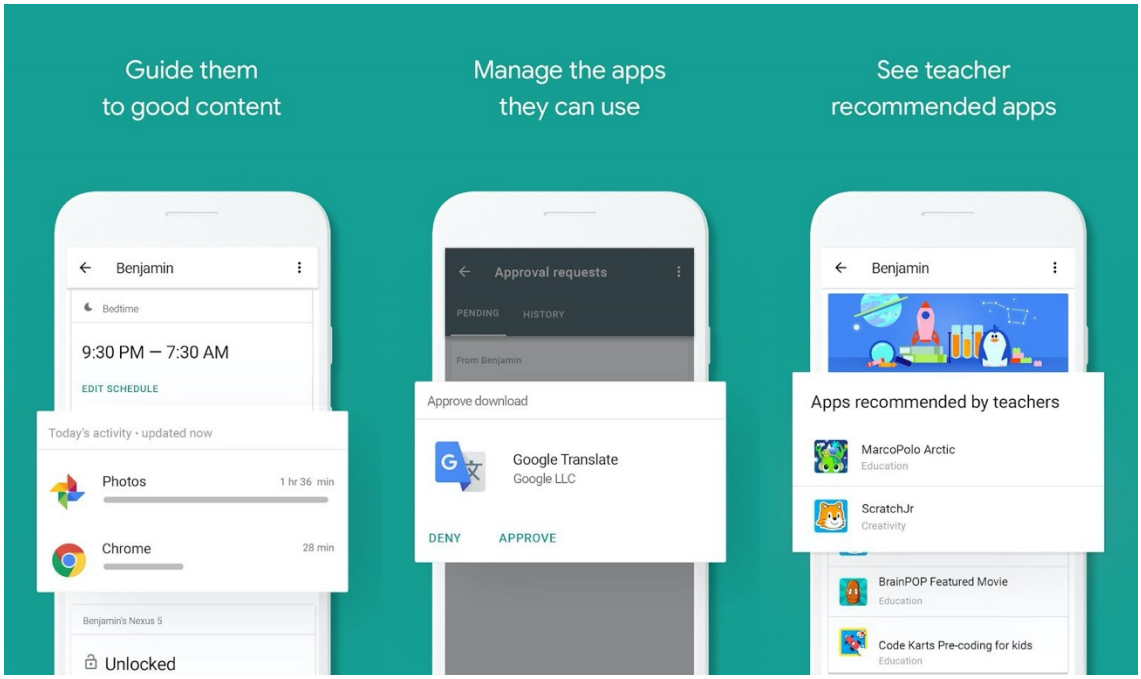

Figure 10: Family Link examples

This application is great for parents because they can see everything their child does and can control the activity of their child as well. But in terms of privacy this is a big invasion of children's privacy and will surely make children uncomfortable with the lack of freedom and privacy. In this application the control is completely on the parents' side and children don't have an opinion.

The solution presented on this thesis doesn't give the option for parents to track their children but allows and encourage children to travel together with their friends, making the path they make safer. Besides that, the solution doesn't use the location of the children at any given moment, so this tackles the privacy issue presented by Family Link.

3

Solution Proposal

Contents

This thesis focuses primarily on the encouragement of children's mobility through a chatbot on Discord that aims to help them increase their independent mobility and travel in groups. Discord is a text and voice communication app where users can create groups and communicate between them (like WhatsApp). The solution developed was a chatbot that will be in the group alongside the children. A chatbot is a software application that communicates with the user, in this case by text. The chatbot was developed for Discord because during the quarantine the number of Discord users rose significantly [18].

With this in mind, this chatbot will focus on 3 main features: Navigation, Safety and Privacy.

3.1. Navigation

The solution is successful if children can make their way to the destination. The child, after joining the group, can begin interacting with the chatbot. The first tasks are defining some variables like the home address, the name of the child's school, and the travel method used (like walking, bicycle, public transports, …). With only this information the chatbot can already give the child the route between home and school. In order to do so, the user just needs to tell the chatbot that wants to begin the route between point A and B and the chatbot will reply with a private message containing the duration of the route and all the indications to the destination.

3.2. Safety

The chatbot has a feature that allows the users to add some friends to their route. For instance, if I want to go to school with my friend Maria and Filipe, I tell the bot they are my "school friends". With this information gathered, when I tell the chatbot that I'm leaving home for school, he will automatically generate the best path from my house to school, passing through Maria and Filipe's houses. The chatbot will send a private message to the user with the estimated time of the route and the indications to the first house, then the second house and finally the school. Besides that, the chatbot will also send a private message to both Maria and Filipe saying the user is leaving his house and that will take approximately x minutes to arrive at theirs. Maria and Filipe will also receive the indications for the remaining of the route. Parents of the children who tested the chatbot using this feature said that they felt safer on letting their children travel with a friend instead of going alone.

3.3. Privacy

In terms of privacy of the child, this solution tackles this issue in two different approaches. First, in terms of the data provided by each child, everything is stored in a database that no third-party application has access to. This database can only be accessed by his own administrator. Apart from the data stored in the database, when children are setting their home address in the chat group all the

users of that group can see what each child is writing but this is not a privacy issue because a child will only create a group with the friends that he wants to. Only those friends can see what the child wrote in the chat group.
Second, this chatbot doesn't use the localization of the children at any moment, unlike applications such as Google Maps that use the localization and store that information. This chatbot not only doesn't use the localization of the children using the bot, but also doesn't store the paths that each child made [19].

3.4. Chatbot

This section describes all the functionalities of the chatbot and its implementation on the Discord app.

3.4.1. Functionalities

When the user joins the group immediately receives a private message from the chatbot introducing himself and explaining how the user can interact with it.

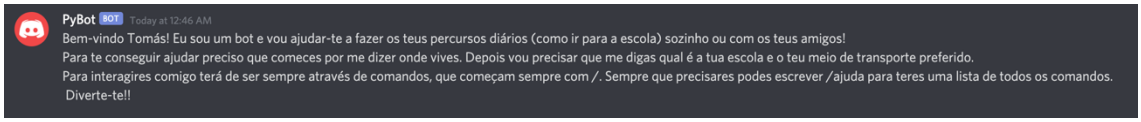

Figure 11: Welcome message

As it's told by the chatbot, the user must begin by inserting his home address. In order to do that he must use the "/definir_casa" command. When the chatbot receives this instruction, it creates a file for this user in the database and defines his home as the text inserted right after the command. For instance, if the user writes "/definir_casa Avenida da Liberdade, n 4" the chatbot will save the home address as "Avenida da Liberdade, n 4".

Similarly to the last command, the user must also set his school and his favorite travel method, using the "definir_escola" and "/definir_transporte" commands.

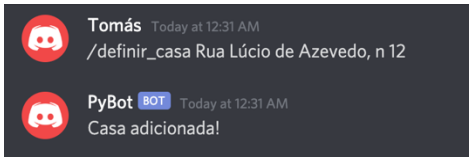

Figure 12: Set home

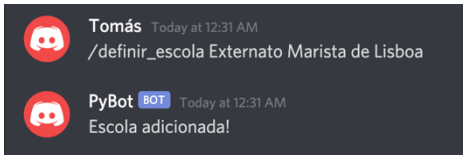

Figure 13: Set school

Figure 14: Set travel method

At any given moment the user can always change his home address, school or travel method using the same commands used earlier. If the user doesn't remember some of the information given before, there are some commands to check: we have the "/verificar_casa" and "/verificar_escola" commands that when used return the home address and school name, respectively.

Figure 15: Check home

Figure 16: Check school

As mentioned before, the chatbot allows children to travel with their friends to make the itinerary safer. In order to do that the user needs to set his friends through the "/adicionar_amigo_escola" command. This command allows the user to add as many friends as he wants to his route to school. If the user adds a friend by mistake or just doesn't want to go to school with that friend anymore, there's a command that removes a friend from that list: "/remover_amigo_escola".

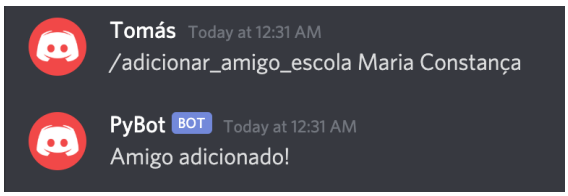

Figure 17: Add friend school

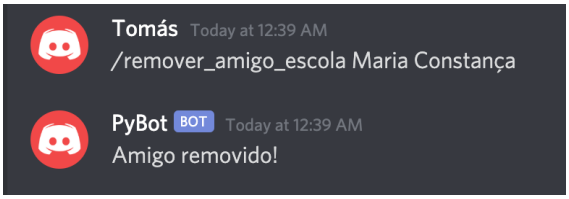

Figure 18: Remove friend school

When everything is set and the child wants to go to school, he just has to type "/caminho_casa_escola". The chatbot will send a private message to the child giving him the indications to school and the estimated duration of the route. If the child didn't add any friends previously, the chatbot will only give the directions straight to school. But if the child has friends to travel with, the bot will calculate the best route from the user house to his school, passing through his friends' houses. It will also send a message to his friends warning them that the user is leaving his house and that will arrive at their house in x minutes. Here is an example where the child has 2 friends and wants to go from home to school:

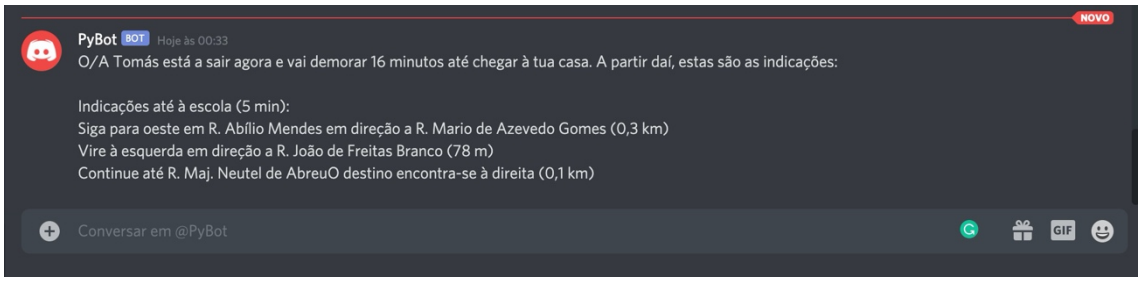

Figure 19: Indications received by the user

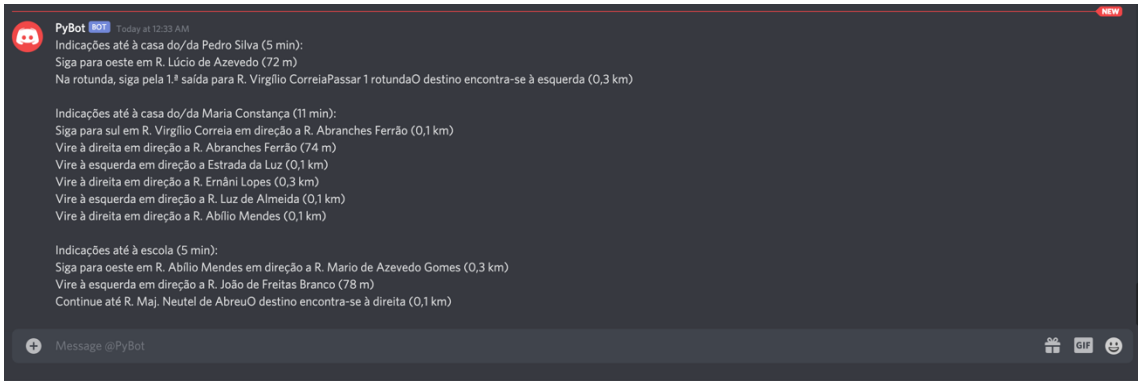

Figure 20: Indications received by first friend

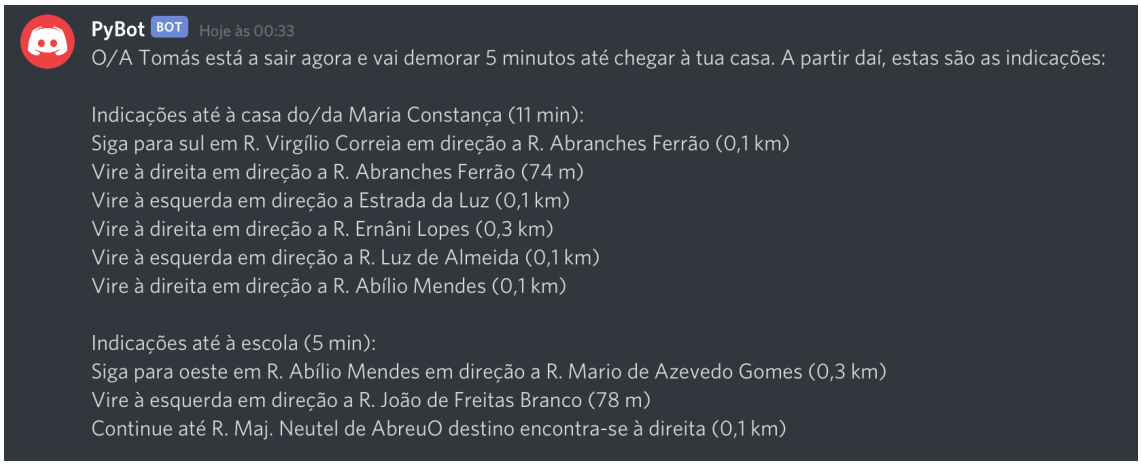

Figure 21: Indications received by second friend

This can also be done from school to home with the "/caminho_escola_casa" command.

Aside from the route home to school and school to home, the chatbot also allows the child to choose a different place (like the mall, the market, a candy shop, …) that he wants to go. In order to do that the user uses some very similar commands: the user begins by indicating what is this place using the "/definir_outro" command. If the user wants to travel with friends just has to add them using the "/adicionar_amigo_outro" command. There's also a "/remover_amigo_outro" that permits the user to remove a friend from his list. And finally, after all of this is set, the user can begin his route using the "/caminho_casa_outro" command.

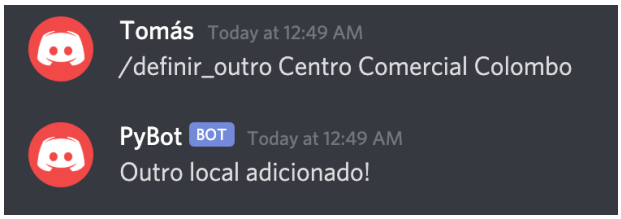

Figure 22: Set other place

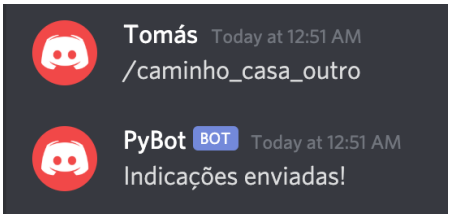

Figure 23: Start route from home to other

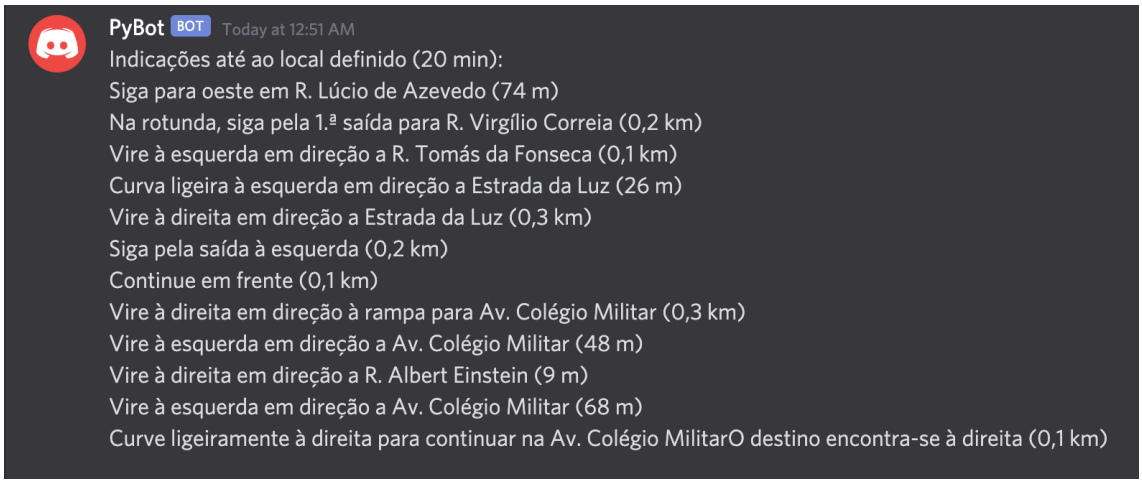

Figure 24: Indications to "other"

If the user has any doubt about any of the commands, there's a help command ("/ajuda") that lists all the commands of the chatbot and a brief explanation of how they work, as we can see below.

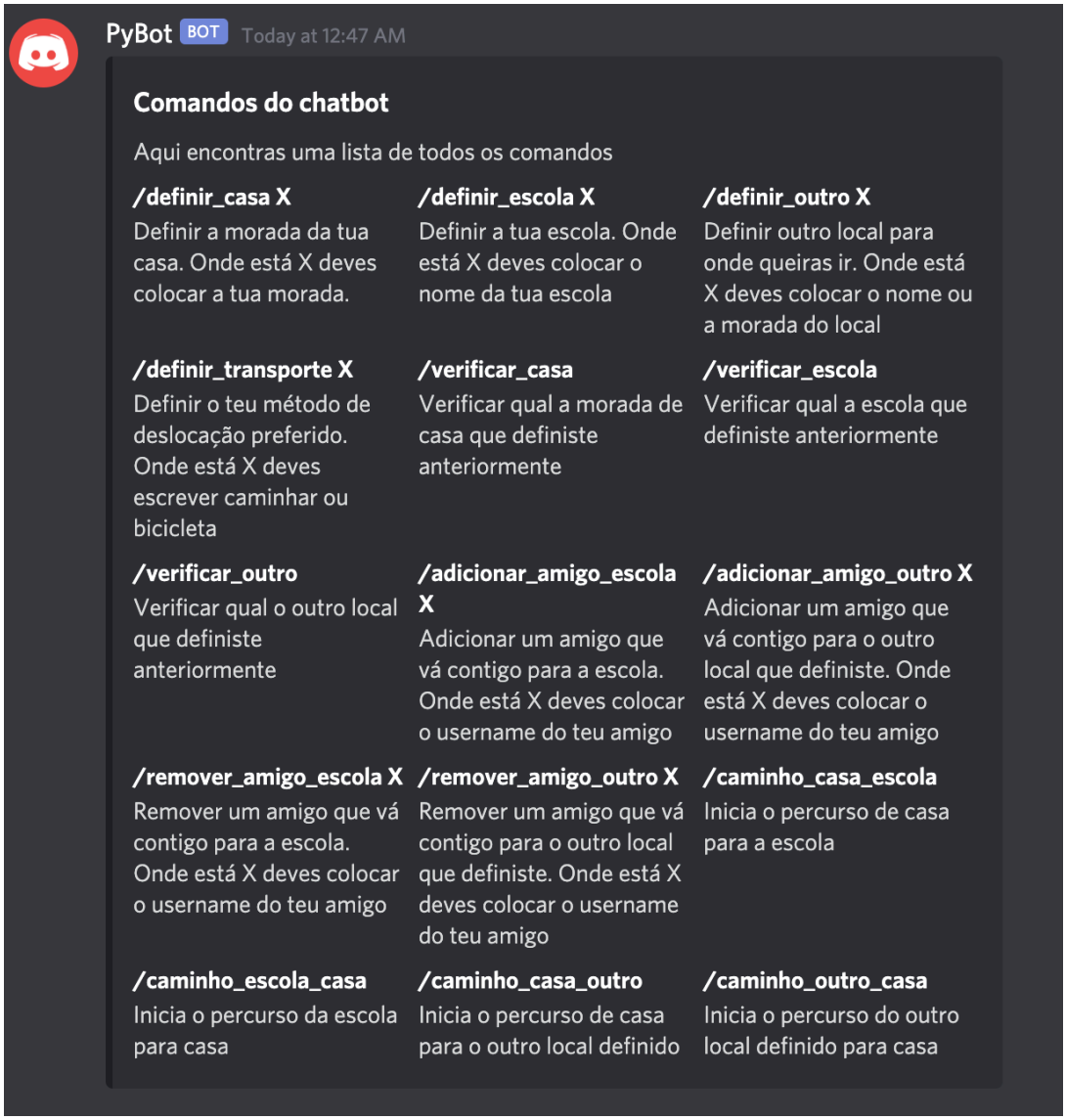

Figure 25: Bot commands

3.4.2. Implementation

In order to develop a Discord bot, we need to have 4 primary elements in consideration: the Discord users, the official Discord server and API, the bot server and the bot code.

- **Discord users**: these are the people that are connected to the server and interact in a channel by sending messages;
- **Official Discord server and API**: this is the server that hosts the Discord application and it's maintained and run by Discord itself;
- **Bot server:** this is an official hosted server that is running the bot code continuously 24/7;
- **Bot code:** this is the actual code behind the bot that lets it do what it needs to do.

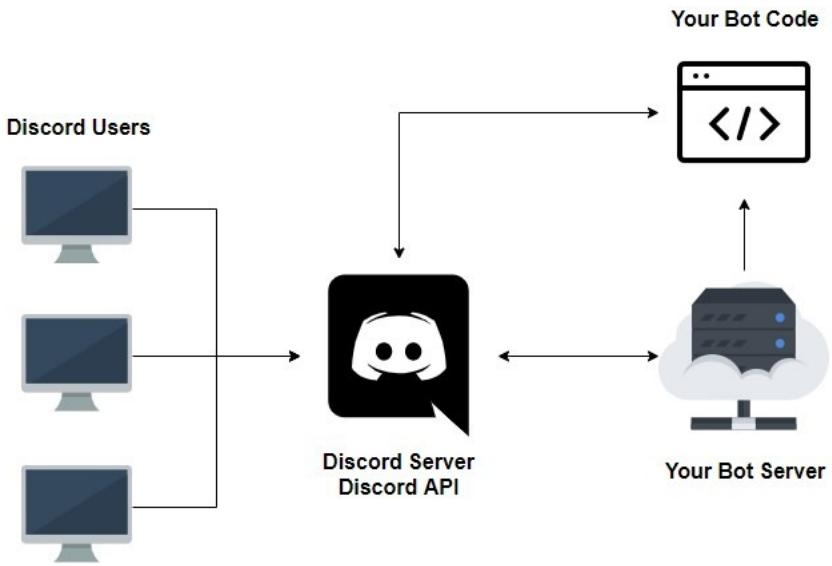

Figure 26: Discord bot diagram

The bot code was developed in Python with 4 main libraries essential for the success of the bot:

- **Discord.py**: this a library for python that is essential for creating applications that use the Discord API;
- **Pymongo**: a library that allows Python to communicate with MongoDB;
- **BeautifulSoup4**: a library that turns html data into normal text;

- **Google Maps Directions API:** a service that calculates directions between locations using an HTTP request.

This solution needs a database to store all the information given by the users, like the home addresses, schools and others. It was used the MongoDB software for the database and the pymongo library to communicate between the database and the code itself.

To calculate all the routes, it was used the Directions API provided by Google Maps Platform. This is the API used by Google Maps that given an origin, a destination and the travel method it returns the indications for the best route. This API has some limitations mainly regarding the path that presents. The path chosen by the API is the optimal path (according to the documentation). This means that we have to accept that path, without being able to change the parameters of what an optimal path is.

Finally, to keep the bot always running, the code was hosted on Heroku. Heroku is a platform that enables developers to run applications entirely in the cloud.

4

Evaluation

Contents

This chapter describes the methodology used to test the chatbot implemented with real users. All the results of the studies performed, were retrieved by the children's perspective where they are testers on the first study and informants on the second one [20].

We weren't able to perform usability tests as we wanted due to the COVID-19 world's pandemic state. From March until September all schools were closed so it wasn't possible to make any tests with children [22]. In September schools opened again for the beginning of the new school year but we were still living a pandemic state and that affected severely the use of public transports [23]. Besides that, parents are very apprehensive as well about their children using public transports, so they prefer to take them to school themselves [24].

4.1. Methodology

The evaluation of the chatbot has two main goals:

1. Assessing the users' opinion on the features/interface of the bot;
2. Evaluating both the security and privacy aspects of the bot.

In order to evaluate the chatbot two different studies were done.

4.1.1. First Study

Due to the pandemic state we are living in, it was very difficult to make usability tests. We contacted some schools to attempt to make these tests with more children to obtain a bigger sample, but we didn't have the approval of parents to do so. This experience was only possible because we had the consent of the parents of 3 children.

In this study we had the opportunity to test all the functionalities of the chatbot as a prototype with 3 children – a 10 years old boy, a 11 years old girl and a 11 years old boy. The children took a tester part during this experience. The two children with 11 years old went to school together on the 23rd of October. They both live in Lisbon and close to their school Agrupamento de Escolas D. Filipa de Lencastre (around 10 minutes walking). The other boy tested the chatbot on his way back home alone on the 26nd of October. He lives in Odivelas and also close to his school EB 2,3 da Pontinha Gonçalves Crespo (around 20 minutes walking).

The main goals of this study were:

- Usability of the chatbot;
- Safety that the chatbot could bring;
- Features that could be added to make the experience better.

Before beginning the testing of the chatbot, the children had to answer a questionnaire that covered these topics:

- Familiarity with technology in general (e.g. do they own a smartphone);
- Familiarity with virtual maps and communication apps (e.g. did they ever used Google Maps and WhatsApp?);
- Usual travel method to go to school;
- Travel method they wish to use to school.

A brief demonstration of the features of the chatbot was shown to all of the children before they started to interact with the chatbot. Then two groups were created - one for the 11 years old boy and girl and other for the 10 years old boy. After that they had the freedom to interact with the bot as they wanted.

The first two children started by setting all the information required by the bot and when they went to school the boy went to the girl's house and they did the remaining of the route together. On the way back home they didn't go together, they chose to go alone.

On the other side, the 10 years old boy also set all the information required by the chatbot and then did his path from school to home on his own.

After they all arrived home, a small interview was made to discuss the following topics:

- Success of the experience (i.e. if the bot worked as it was supposed to);
- Usability of the chatbot (i.e. if it was easy to interact with the bot);
- Strengths of the bot;
- Future improvements;
- Usefulness of the chatbot.

Before performing this study, the chatbot was previously tested to check if there were any flaws with the routes presented. These tests were performed on the street, making a route to the closest school.

4.1.2. Second Study

This study was performed with a class of 29 students (16 boys and 13 girls), at the Colégio Marista de Carcavelos, with ages between 10 and 11 years old. This activity took place on the 28nd of October, at the visual and technological education class for one hour and thirty minutes. The goal of this session was to present the chatbot as a proof of concept and gather as much information as possible from the class, as well as asking for possible improvements on the chatbot. This session was only possible because we had the consent of the school's Principal and teachers to conduct this study.

The session began with an interactive presentation where three main topics were brought to discussion: children's mobility, Discord application and chatbots. In every of these topics children were invited to express their knowledge about that specific topic. After the input of some children, a brief explanation of the topic was made, alongside the impact of that topic on this thesis. After the presentation a demo of the chatbot features was shown to the class.

Then we made a focus group where the class was split in groups of 3/4 children where they had to discuss between them and then write their answers to these following questions about the functionalities of the bot, the security aspect and the privacy aspect as well:

- What functionalities would you like to add to the bot?
- Come up with a solution to implement on the chatbot to solve the lack of safety that parents feel when children go to school autonomously.
- In which other situations would you use the bot, besides when going to school?
- Come up with a solution to implement on the chatbot to solve the lack of privacy felt by the children regarding their parents, without disregarding the safety aspect.

After this focus group, each child got a questionnaire to answer (similar to questionnaire of the first study). These are the main topics covered on the questionnaire:

- Familiarity with technology in general (e.g. do they own a smartphone);
- Familiarity with virtual maps and communication apps (e.g. did they ever used Google Maps and WhatsApp?);
- Usual travel method to go to school;
- Travel method they wish to use to school;
- Situations where they would use the bot;
- Features to be improved.

4.2. Results

In this section the results will be presented separately for the first and second study.

4.2.1. First Study

On this study all of the 3 children own a smartphone, has WhatsApp and had already used Google Maps or another similar application. All of the population of this study is very familiar with technology. Regarding their mobility, the two children who went to school together usually goes to school by foot and when asked if they would like to change their travel method both answered that they would like to go with their bikes. The other child goes by car and wouldn't like to change.

After testing the chatbot, we talked to the children to gather some feedback about the experience. All of them had successfully completed their path and said that it was easy to configure the bot and use it. The two children that went together said that they really liked the feature of being able to go with friends.

These children also gave some insights about the experience. Two of them said that the chatbot was very useful but maybe just for the first two or three times because then the child already knows the route. Although they had this opinion, both of them said that would like to keep using it because it's very useful when going to a friend's house they never went.

Regarding the safety aspect of the chatbot, one of the children suggested that his location should be shared with his parents along the route. Other child suggested that instead of always sharing the location, the chatbot could send a message when the child was leaving and the origin and sends another message when the child arrives at the destination.

4.2.2. Second Study

4.2.2.1. Mobility and Technology Habits

About the children's mobility and technology habits we found that 90% (26) of the 29 children has a smartphone, and 86% (25) already used applications with virtual maps like Google Maps. We found as well that also 90% (26) of the class uses WhatsApp which is a communication application like Discord.

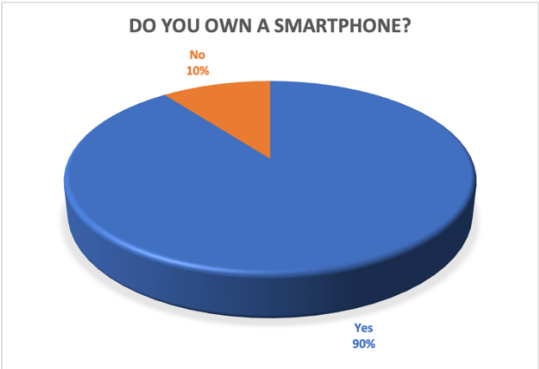

Figure 27: Owning a smartphone

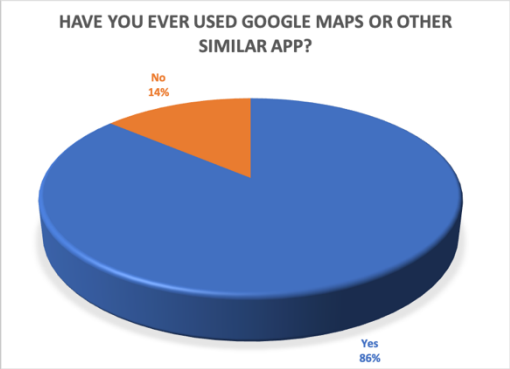

Figure 28: Used Google Maps or related apps

Regarding children's mobility we found that most of them (76%) goes to school always by car and a small percentage of them (21%) switches between car and walking. Given the opportunity to change their usual travel method, 52% (15) of them said that they would like to go to school with their bike. Nobody chose public transports, and this could be a consequence of the actual pandemic that we are living in.

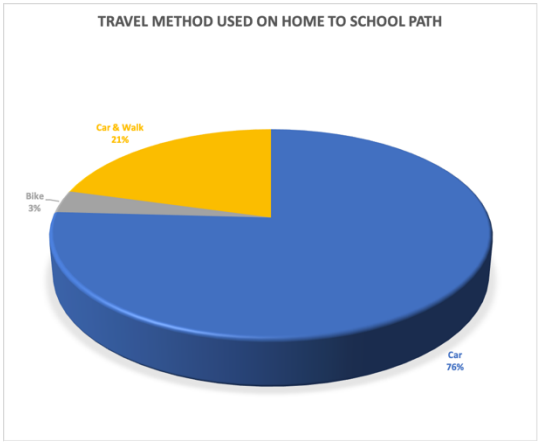

Figure 29: Most used travel method to go to school

We can see from these results that the vast majority of the children in this study is comfortable with using a smartphone and using communicating apps and applications with virtual maps. Concerning the mobility, most of the children travel by car despite the fact that they would like to experience other ways of travelling, like using their bikes.

4.2.2.2. Potential Functionalities

In the focus group we started by questioning children about what functionalities they would like the chatbot had. We retrieved several different answers but there were 3 main features that were referenced by more than one child. These features are being able to communicate with the chatbot by voice, showing a map with the route from origin to destination traced on it and being able to set more than one home. This last feature was pointed out mainly because of children that have divorced parents.

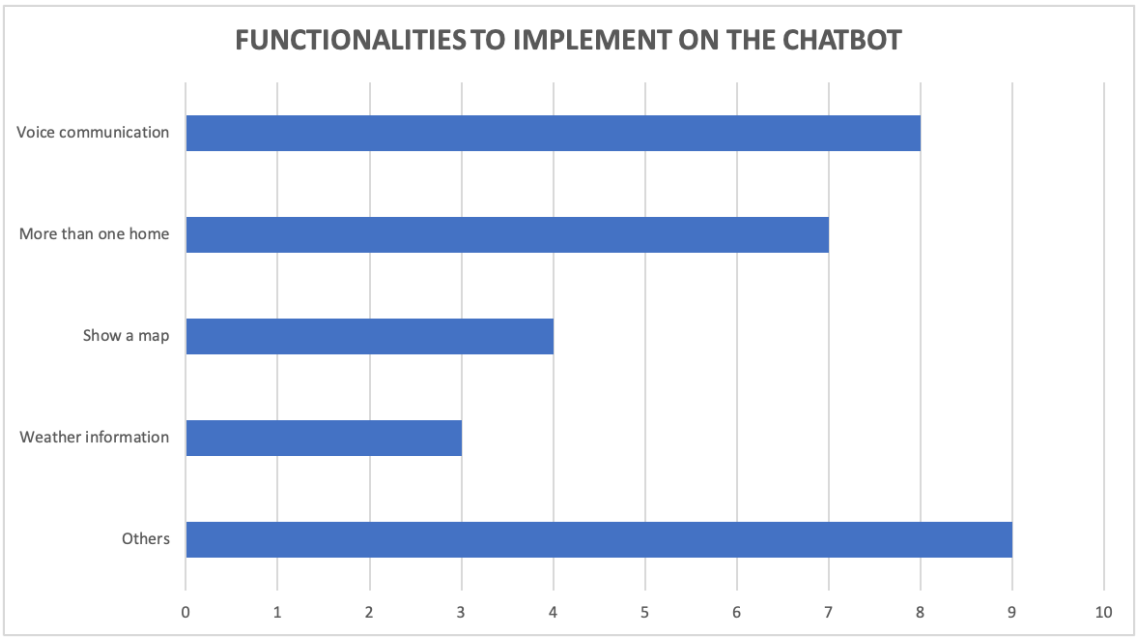

Figure 30: Functionalities to implement on the chatbot

4.2.2.3. Safety Options

When asked about suggestions for the security aspect of the chatbot we had very different but good solutions that could be implemented. Some of the features are:

- Parents being able to track their children during the route – 38%
- Chatbot suggests more than one path and the child alongside with his parents can choose the safest path – 31%
- Chatbot sends a message to parents when their child arrives at the destination – 17%
- Creation of a SOS button that sends the location of the child to the parents – 14%

Some of these solutions affect directly the privacy of children like the fact that parents can always track their child's path. In terms of security is an excellent solution but lacks on the privacy aspect. There's a study that shows the innumerous violations of privacy that many apps have and one of them is sharing location or contact information without consent [21].

The creation of a SOS button is a feature that was already suggested by children according to an unpublished work provided by the research team I'm working with [10].

4.2.2.4. Other Uses

The bot can be used to travel to other places than school so we asked in what situations children would use this chatbot besides when going to school. These were their answers:

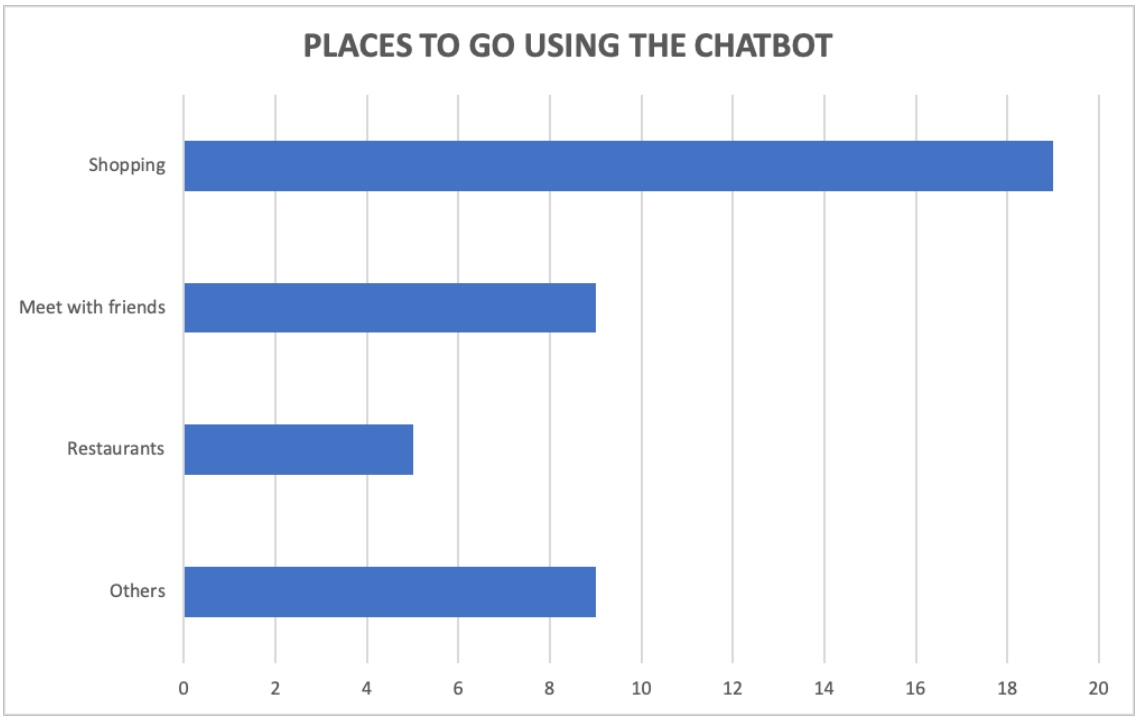

Figure 31: Places to go using the chatbot

4.2.2.5. Privacy Options

Similarly to the question about the safety aspect of the bot, we asked for suggestions to implement regarding the privacy of the children. For this question the answers were more dispersed, but we could gather same solutions that were pointed by some children:

- Children must have an option to accept or decline the friend request – 31%
- Send a message to the child's parent when he arrives at the destination – 17%
- Parents ask their child to access their location – 10%

The first feature is very interesting and could be implemented in the solution. This suggestion came from the fact that if a child adds another child as his friend, he has access to his friend's home address. If children have the option to accept or decline a friend request this privacy issue is mitigated.

5

Conclusion

Contents

5.1. Conclusions

The chatbot developed is ready to be used by children. It helps children to travel from point A to B giving them directions. It also allows children to travel with their friends making the path safer. As we can see from the results retrieved from both studies done, children of this age range (10-11 years old) are very familiar with technology so the children from the first study (who tested the prototype) had no issues interacting with the chatbot and the children from the second study (who gave feedback about a proof of concept) most probably wouldn't have issues as well. In terms of mobility the vast majority of the children that participated in both studies goes to school by car but, if given the chance to choose, at least 52% of them would like to go by bike, a more sustainable and autonomous option. This shows an interest on the children's part to travel more autonomously and the chatbot developed can help them because it supports autonomous travelling, like biking. Maybe with the use of the chatbot, parents could start giving their children the opportunity to go to school by themselves.

The solution developed on this thesis besides helping children on making their home to school trips, it also allows them to travel to any other place they choose. Children showed a big interest on going to other places like going shopping, meeting with their friends and going to restaurants. So, this feature tackles the issue brought up by the children who tested the chatbot together, regarding the lack of usefulness of the chatbot on their everyday trips.

Based on the results we can also conclude that are some important features that could be added to the chatbot like the option to have more than one house because there are some children that have divorced parents. There should also be an option for the children to accept or decline a friend request because otherwise anyone can know each other's home addresses.

Summarily, besides some features that could be added to the chatbot, this solution is ready to be used by children and the there's an interest on their part to use it as well.

5.2. Future Work

Due to the few tests performed on the chatbot, there's room for improvement. The first steps should be adding some features like the possibility to add more than one home address, the possibility to accept or decline a friend request for privacy reasons and give the children the opportunity to choose a path from some options, so the parents can help them choose a safer path.

Besides these new features, the chatbot needs more tests like the one made on the first study. Children who can test the chatbot on their own hands can give a more detailed feedback for further improvements.

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A

Questionnaire

This is the questionnaire about technology and mobility habits presented to the children on both studies.

1. Quantos anos tens? _____

2. Tens um telemóvel (smartphone) só teu?

   Sim ◯ Não ◯

3. Usas ou já usaste Google Maps ou outra aplicação de mapas?

   Sim ◯ Não ◯

4. Se respondeste que sim na pergunta anterior, selecione abaixo em que dispositivo costumas usar estes mapas digitais:

   Computador ◯
   Tablet ◯
   Telemóvel (smartphone) ◯
   Outro (ex: relógio inteligente) ◯

5. Usas aplicações de chat de grupo com os teus amigos como o Whatsapp por exemplo?

   Sim ◯ Não ◯

6. Que modo de transporte utilizas habitualmente nas tuas viagens casa-escola-casa?

Indica com um "x" a opção que representa a maior parte da tua viagem.

A pé ◯ Autocarro ◯

Bicicleta ◯ *Carpooling* [1] ◯

Moto ◯ Carro ◯

[1] Diz-se *carpooling* quando partilhas a tua viagem de carro para a escola com alguém que também vai para a escola, por exemplo, com um colega da escola que é teu vizinho.

7. Se pudesses escolher, que modo de transporte gostarias de utilizar nas tuas viagens casa-escola-casa?

Indica com um "x" apenas uma opção.

A pé ◯ Autocarro ◯

Bicicleta ◯ *Carpooling* [1] ◯

Moto ◯ Carro ◯

8. Em que situações é que achas que irias usar este chatbot?

_____

_____

_____

_____

9. Há alguma funcionalidade de que não gostaste? Se sim, qual é e o que mudarias?

Sim ◯ Não ◯

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