Glimmer: harnessing immersive and augmented reality to affect child behaviour and travelling safety.

Deheng Li

Student ID：[redacted]

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1.0 Abstract

With the rapid development of China's transportation system, the increase in car ownership and the number of drivers, China has become an automobile society. Daily commuting in cars with families are becoming increasingly frequent and challenging with children's safety being a notable area of concern. Parents not only have to pay attention to driving safety and the external traffic conditions they are navigating, but also have awareness of their children's behaviour as passengers within the automobile. Driver distractions from external conditions and circumstances, along with disruptions from child passengers within the vehicle can lead to driver safety issues. Distraction and interruptions for a parent, from a focus on driving, elevate the level of stress, negative emotions, and potential safety of a journey. This place the occupants of the vehicle at higher risk of an automotive accident, and puts children at risk of injury.

This design study aims to provide a more positive experience for drivers, families, parents and children while driving. In this design research project, visual representation in augmented reality (AR) and interactive design are explored to reduce restlessness and boredom in children while travelling, allowing them to creatively engage with virtual and physical environments both inside and outside the vehicle.

Design research methods include secondary research and iterative design developments. Virtual characters are designed to accompany children on their journeys allowing them to immerse themselves in the world they create and interact with. By engaging the children with positive activities, a safer driving atmosphere is facilitated.

2.0 Acknowledgements

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Thank you too, to Klaus and his family for lending a hand in the development of my project. Your wisdom and all the interesting information you shared enlightened me every step of the way.

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CONTENT:

3.0 Introduction

With the rapid development of China's transportation system, the increase in car ownership and number of drivers, China has become an automobile society. However, road safety has also become more complicated to manage, with children's road safety being a notable area of concern. Training and education are also one of the pillars for improving and addressing road safety issues (Topolšek et al.1). In China, the accident rate for children aged 1-6 exceeds 30%. Road safety is one of the biggest causes of harm to children's lives and health. Globally, traffic injuries are also the leading cause of death and injury among people aged 5-29. (Ma)

Cars are popular as they are convenient travel options for families (Wang 4). The purpose of cars is not only a simple means of transportation, but also an important part of life. (Laurier et al.4). The interior space of the car can also have a negative impact on the shared travelling experience. It can affect their mood, reduce the driver's attention and increase fatigue, and has been known to cause arguments among family members due to confinement in fixed seating, reducing tolerance levels. This can **a**ffect the relationship between family members during travel, compromising the safety of all the occupants of the automobile, and potentially contributing to the cause of a traffic accident (Nadrian et al.4).

To prevent these scenarios, we need to pay more attention to matters related to driving safety and how to provide an efficient and safe driving environment. Safety is important for all the passengers in the car, and passengers' behaviour simultaneously plays a positive and negative role driving safety. From Dunn's point of view, passengers can help the driver with auxiliary tasks other than driving, chat to relieve fatigue, plan appropriate routes, or provide guidance on traffic safety operations. But they can also be distracting and divert the driver's attention. In particular children as passengers are the ones that drivers pay the most attention to when driving, resulting in drivers engaging in less likely dangerous behaviours, but also their attention may interfere with their safe driving due to the need to check the children's status. (Dunn et al.1).

4.0 Context review

4.1 Driving distraction

Distraction is a leading cause of fatal accidents and occurs frequently while driving (Magaña et al.1). Drivers of various ages and genders will have differences in behaviours and reasons for being distracted and may be affected by internal and external factors (Prat et al.1). Common forms of distractions include talking to passengers, adjusting in-car facilities, chatting, or messaging on mobile phones, and taking care of children in the back seat. Research indicates that the proportion of conversations with passengers is very high, and the proportion of interactions with children is at the forefront of interactions（Royal et al.1). According to a survey of parents (Taubman Ben-Ari and Noy), 165 Israeli mothers and 73 fathers believed that travelling with their children in the car was stressful and interfered with their driving. Additionally, 32% believed that they will be focused on the children (rather than the road conditions). Most parents believe that children should not leave their car seats or unclip their seat belts, however sometimes they will compromise on this, in an effort to calm children's behaviour. (Taubman-Ben-Ari et al.1028)

The continued interaction between the driver and children may be a factor in a fatal accident (Dunn et al.3). Because they need to communicate with children, observe their behaviour, and even deliver food directly, reducing the degree of driver control over the vehicle. Parents are prone to distraction when in the car with their children aged 1-12 years old, they all had the experience of feeding their children within a month, 90% of drivers believe that they feed their children more frequently than using their mobile phones, they also helped their children pick up toys while driving. (Macy et al.6)

Driving with children as passengers has a higher risk of fatal accidents, as the children may do things that distract the driver. Additionally, the adult driver may try to manage the child's behaviour or interact with the child in the car. Adults, children, and infants can all interfere with driving, but the frequency of communication with children is higher. (Rudin-Brown et al.59). The frequency of interaction with children is 8 times that of adults and 2 times that of infants (Koppel et al.1236). This increases the risk of collisions (Dunn et al.10). In a Finnish study female drivers alone with children were more likely to be involved in fatal accidents than male drivers with children. (Maasalo et al. 37).

Both male and female drivers are more likely to make mistakes on normal roads when carrying only children aged 0-9 years than when there are adult passengers in the car because of the distraction, but for women drivers carrying only children are twice as likely as male drivers to be involved in a fatal car accident. Moreover, women are more likely to be involved in crashes when carrying children while driving more than when children are not in the car (Maasalo et al. 449), because mothers of younger

children may be fatigued, which may lead to an increase in car accidents (Livingstone et al. 3). From Koppel's analysis of 25 children and 19 drivers on trips lasting between two minutes and three and a half hours, 76.4% of drivers used their rear-view mirrors to observe children, 12% interacted with children in the back seat, and 8% helped children such as giving food and play, and they communicate and interact more often with children.

Koppel recommends drivers should also receive education on how to deal with the potential risks of children's interactions (Koppel et al.1236). When there are adult passengers in the car, they can help take care of the children so that the driver can focus on driving. (Maasalo et al. 25).

When only children are carried, the risk of collision is higher than when carrying both children and adult passengers. Drews, identified that passengers also have a positive effect on driving. They will often observe and point out different traffic conditions to help drivers, such as traffic signs or road exits, helping drivers drive safer (Drews et al. 399). Passengers have a more positive effect on the driver in the evening and on winding roads (Vollrath et al. 653). Passengers can also help the driver detect emergencies in advance, but their communication with the driver will also have a negative impact on driving, conversely passengers may have a positive effect on drivers in reducing collisions in congested conditions (Lee et al. 1706).

Lee's research shows there are some downsides, as young passengers and young drivers can cause single-vehicle accidents on clear roads (Lee et al. 1703). Young drivers are more likely to be involved in a collision when carrying young passengers than when older drivers are with them**.** The positive effects of having young passengers are less because young drivers are more likely to be careless when with young passengers. The impact of passengers on driving safety, may also depend on the age of the passengers. Compared with driving alone, people with passengers are more likely to be distracted and unable to deal with traffic chaos (Lee et al. 1703). Additionally, distraction is a major cause of pedestrian collisions, and communicating with passengers is one of the causes (Sheykhfard et al. 2).

Therefore, by reducing distractions generated by children during travel, a safer journey experience can be attained. To do this a clear design strategy that protects the driver from distractions is required. To achieve this my design strategy focused on modifying the source of distraction - the child. , under the guidance of this strategy, I designed ‘Glimmer’ an immersive game, which requires quietness to effectively carry out tasks, with virtual characters as partners to give children companionship and fun. Children as they travel can explore the virtual world together, and can be guided to support behaviours contributing to a safe driving atmosphere.

4.2 Impact on children

4.2.1 Unequal space allocation

From Barker's quantitative research study, more attention has been paid to the relationship between cars and children. Over 93% of children made at least one journey during the week data was gathered. A third travelled in cars every day, and the average number of journeys for children surveyed across the week was nine. This also reflects that cars are an integral part of children's lives. As an important part of the car, the space inside the car is also a shared space between passengers. It is also an entertainment place and activity space for children, and cars have also become more child centred. However, the way children's seats are allocated is determined by the parents' wishes, which may cause children to sit with people they don't like. In addition, car cabin space isolates children from direct interaction with other vehicle occupants and the outside world, which also can make children feel bored. For children, external landscapes and views are important aspects of their travel experience. They like to see the scenery, and children will play with mobile phones and other technological devices to alleviate the negative impact of spatial isolation (Barker et al.62).

4.2.2 Interior space isolation

Laurier said the car's space, which acts as a boundary between the passenger and the driver, also creates a barrier to communication between front and rear passengers. They cannot communicate face to face and can only see each other through the rear-view mirror, making it difficult to correctly understand each other's intentions. In addition, as vehicle speed increases, the vehicle noise volume increases, which can be a hindrance for young children who may not be able to communicate effectively through gestures (Laurier et al.14). Children are also more likely to want the front seat in the car, as there is no one else competing for the opportunity to communicate with their parents and it comes with an unimpeded view. In this position, they can fully engage in conversations with their caregivers. During this time, they would ask questions, talk about their daily experiences, or make requests. (Laurier et al. 14).

4.2.3 Attention in Children

In the interaction between children and adults, if they want to have a conversation with adults, they may initiate some questions to attract the adult's attention so that the conversation can continue (Eilittä et al 1). Generally, the adults in the front seat will sometimes listen, but once the attention of the child in the back seat is gained, the children will know that they have received more attention and are likely to be more distracting. Stopping this kind of interchange may require the use of reprimands or a calm approach. Parents should guide their children to have a better understanding of the concept of family support, thereby affecting their children's bad behaviour (Laurier et al.14).

Miller, an author from Child Mind Institute, points out in his article how to deal with children's negative emotions such as anger. When children are angry because they want to get something specific or get more attention, they can be helped to understand how to make the right choice by setting rules and rewards. When children try to attract others' attention, they should be given other things to do, such as arranging an activity for them during this time when they are working and giving positive encouragement and attention to good behaviour. If children are using some behaviours such as making noises in places where silence is required, they should be made aware of the occasions when they can do so, and then given alternative behaviours (Miller). The most effective way to reward is to intermittently reinforce positive behaviour, and to give rewards periodically and intermittently. When children are in a negative mood, they should not be overly criticised, because for some children, not being praised and rewarded is already a form of criticism. (Cook et al. 7). Offering a reward to advance in the game is a motivational factor and a design mechanic of this design project.

4.2.4 Boredom during travel

Anderson's research used social stimulation methods such as wanting to play with their parents, or behavioural methods such as playing with toys when facing chronic boredom. The process of regulating attention is fundamental to alleviating boredom, and distraction is one of the ways to deal with boredom. Children with stronger self-control cope better with boredom, and most children use social strategies that rely on others to regulate their emotions (e.g., playing with siblings), and behavioural strategies that address boredom (e.g., doing puzzles) that may be good for the child while being bored. It can stimulate children's creativity when they are bored and reduce the constraints on thinking, which also has significance for health. And parents' care and interaction also have a positive effect on children's relief from boredom (Anderson et al. 1).

The state of boredom can also be thought of positively, as it can inspire people to use their imagination and thinking (Darden et al.33). (Harris et al.586) In the survey on boredom, most of the participants believed that boredom is a kind of active thinking time. And it is believed that boredom can stimulate creativity unconsciously. For children, they should be allowed to have down time and space so that they can learn to observe, think, and gain more experience, (Belton et al.799), (Belton et al.588)

In addition to the safety aspect for driver and passengers alike, the game has modules designed to stimulate children's creativity, provide them with space for imagination, and reduce children's boredom during the journey in an entertaining and interactive way.

4.3 Diverting children’s attention

Children, when faced with stressful times or mood swings, have less knowledge than older people about how to improve the situation. They may improve their bad moods by seeking comfort, distraction, or escaping from problems, but these situations tend to a broader variety of solutions as they grow older (Drake et al.2). Skinner lists children's distraction as one of the commonly used methods (Skinner et al.130). For example, behavioural distraction is mainly used in early childhood through games, and imagining more interesting things is a cognitive distraction method that is used in early childhood to adolescence. Using distraction is a more effective method of relieving children’s negative emotions than allowing them to vent them (Drake et al.2).

From the emotional analysis case of a two-and-a-half-year-old boy operating an iPad game digital learning software, if you want to promote children's interests, you need to let them have a positive way of thinking and distract them to get positive results. This in turn allows children to creatively solve problems and have a stronger understanding of new experiences. At the same time, positive interactions between adult caregivers and children can have a positive effect on the development of children's self-esteem and creative abilities (Khalaf et al. 1).

Drawing can divert children's attention and take them away from negative emotions, as it is more fun and effective when used as a distraction. When children are drawing, they will be more focused and forget about negative distractions, which can effectively improve their uneasy mood. Being creative helps them enter their imaginary world and offers a key element in improving their mood. For preschool children, integrating art into preschool education can effectively promote children’s ability to cope with negative emotions (Drake et al. 181).

Research shows that in children aged 7 to 10, drawing has a positive effect on improving their mood. Even when depicting negative events, drawing can be a distraction. After a child reaches the age of two and grows older, the ability to understand things and express emotions improves, and a child gradually no longer relies on the support of his parents. But in terms of cognition of painting, as they start to reach 10 years old, they may gradually lose interest in painting. Therefore, the improvement of mood by drawing may be more effective for children 7 years old or younger (Brechet et al. 221).

This can be done through games or imagining interesting things, which is also conducive to children's creative problem-solving. Combined with augmented reality (AR) game settings can help children discover fun in boring journeys. By combining virtual painting with real scenes, virtual paintings drawn by children themselves can be placed into the actual scenery to create a unique experience. Their own virtual space, and virtual playmates will interact with the environment and increase the mode

of intermittent rewards so that children's behaviour can improve in stages, which will increase children's happiness on the journey.

Gamification means using game concepts and elements as well as interesting interactive experiences in non-game application scenarios (Deterding et al.9). Younger children (5-7 years old) tend to lose patience with tasks and want to finish the whole process faster. In addition, children often want to take a break, talk about interesting things that happened recently, or directly ask for the next activity (Brewer et al.389). The need for a reward model is an integral part of promoting active participation and motivation (Miller et al.12). Li et al.'s research on gamification showed that the overall attitude was positive. Attractive game environment can increase people's interest in learning and make people work harder to get to the next step (Li er al.110).

4.4 Technical outlook of Augmented Reality (AR) devices

4.4.1 Definition and application scenarios of AR technology

AR combines virtual technology with physical scenes (Nijholt et al.1). AR can combine verbal and non-verbal interaction, or it can be a combination of visual and voice recognition sensing mechanisms. Virtual characters and pets are popular in AR and have facilitated new forms of socialisation while helping and guidance on health, diet, medication, etc. in daily life. As an example of the application of AR technology, AR glasses provide a way to obtain information that may replace mobile phones in the future (Azuma et al.27) because of their convenience of use in multiple scenes to obtain more information at the same time.

For example, in Heath's article, he introduces an advanced AR glasses device, ‘Orion’. The innovation of Orion lies in its integration of a neural wristband, which uses electromyography technology to interpret user gestures and supports interaction with artificial intelligence. It can also be used for 3D games, video calls, and other forms of virtual communication. The technological advancements in this device demonstrate the development potential of AR technology and provide fundamental conceptual support, as well as more possibilities for implementation, for the future progress of this contemporise technology project, including, the interactive forms in the game, and the interaction logic (Heath).

(Nijholt et al.304). In the AR world, virtual characters can understand events in both the virtual and real worlds. They can participate in interactive games, alleviate loneliness, perceive people's needs, and provide feedback, serving as companions that continuously accompany the users. For example, in (Schmeil et al 267)’s AR outdoor experience, virtual characters can guide users on a tour of a university campus and provide explanations. They have the capability to offer information, suggestions, training, and demonstrations. Currently, interactions with virtual characters require the use of head-mounted devices.

4.4.2 The role of AR in entertainment

Mobile technology devices can transform how people interact and engage with activities in the entertainment industry, such as gaming, sports, tourism, and performances. They can also enhance the visual and video effects of media and expand into broader entertainment fields. Based on the results of a case study on AR puzzles, compared to video games, AR games are more adaptable and serve as a highly interesting and effective learning tool, with people showing a preference for tangible AR interactions (Parekh et al.).

4.4.3 Graphic Animals

AR animals cannot be displayed to real scenes and can avoid places where pets are not allowed. Unlike completely mechanical animals, AR pets' behaviour, likeness is more realistic, and do not add difficulties for people with limited mobility (Norouzi et al.).

Therefore, in this project, the characters in the game can interact with children without being limited by the environment and locations. The AR technology also provides more entertaining interaction and characterisation, being a virtual companion for children can also be a more long-term and personalised experience.

4.5 Design Precedents

4.5.1 Nio Nomi

NOMI, as an AI assistant or companion used in cars and can sense and convey various information while creating a positive and relaxed atmosphere. It offers a more direct and convenient way to issue commands. Passengers can activate Nomi in the car using voice commands, and it will turn towards the caller, understand the command, and assist with basic in-car operations. In other scenarios, it can engage in simple interaction with children, remind passengers of important matters, plan routes, or assist in resolving traffic incidents, thus helping to adjust the in-car atmosphere. However, it is limited, executing specific commands also distract the driver, with some operations still requiring manual input on the central control screen (60minutes), (Nio global).

When it comes to accompanying children, the interaction logic is relatively basic, the methods are somewhat limited, and the amount of information it can convey is minimal. Nevertheless, NOMI's advantage lies in its modular design, and it has extensive resources for daily interactions with users, helping it to enhance product iteration and improve the overall experience. Its concept as an in-car companion, operational logic, and some of its features serve as inspiration for this project.

4.5.2 Peridot

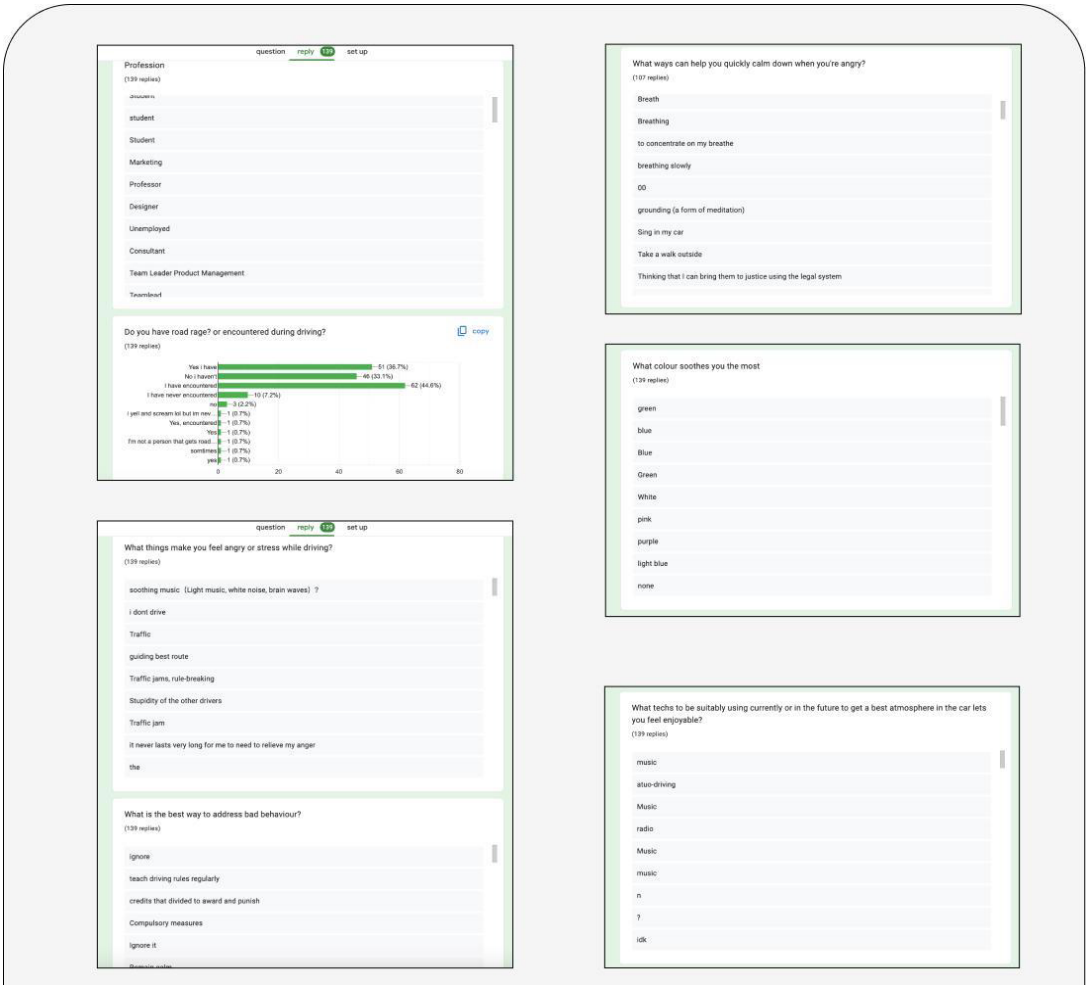
"Peridot" is a game developed by Niantic. It is an AR-based game where players nurture magical creatures. You can feed them, give them toys to increase their happiness, and help them grow. The game integrates real-time location, allowing users to move and interact with their environment on their mobile devices. Players can walk, run, fly, pick up balls, and perform other actions, interacting with the real world on the screen through touch. Regardless of the viewing environment, you can experience the joy of raising a pet. AR is the main way to play, allowing characters to be displayed in the real world. Interaction is done through touch on smart devices, like the process of nurturing and training. By increasing intimacy through gentle touches, the characters relax, which in turn boosts their happiness and supports their growth. As users walk, it feels like they are accompanied by a real pet (Choi et al 309). In the game, players can undertake exploration tasks to earn rewards, which benefit the character's development and enhance the interaction between users and characters. Due to the limitations of screen size, the immersive experience cannot be fully achieved. Additionally, since the game characters are positioned as pets, there is no verbal communication, which limits the variety of exploration methods. Nonetheless, Peridot's product positioning, interactive gameplay, and approach to exploring the environment provided important insights for the development of an AR glasses-based game for this project.

5.0 Methods & Design Process

5.1 Preliminary research and analysis

The initial idea for this project originated from the road rage and aggressive driving issues in China. Through comprehensive exploration and research, including survey questionnaires, it was discovered this is a common global problem.

A summary of frequently reported behavioural issues from the questionnaire was compiled. A preliminary analysis of this issue was undertaken, focusing on environmental factors, human factors, personal traits, and psychological factors.



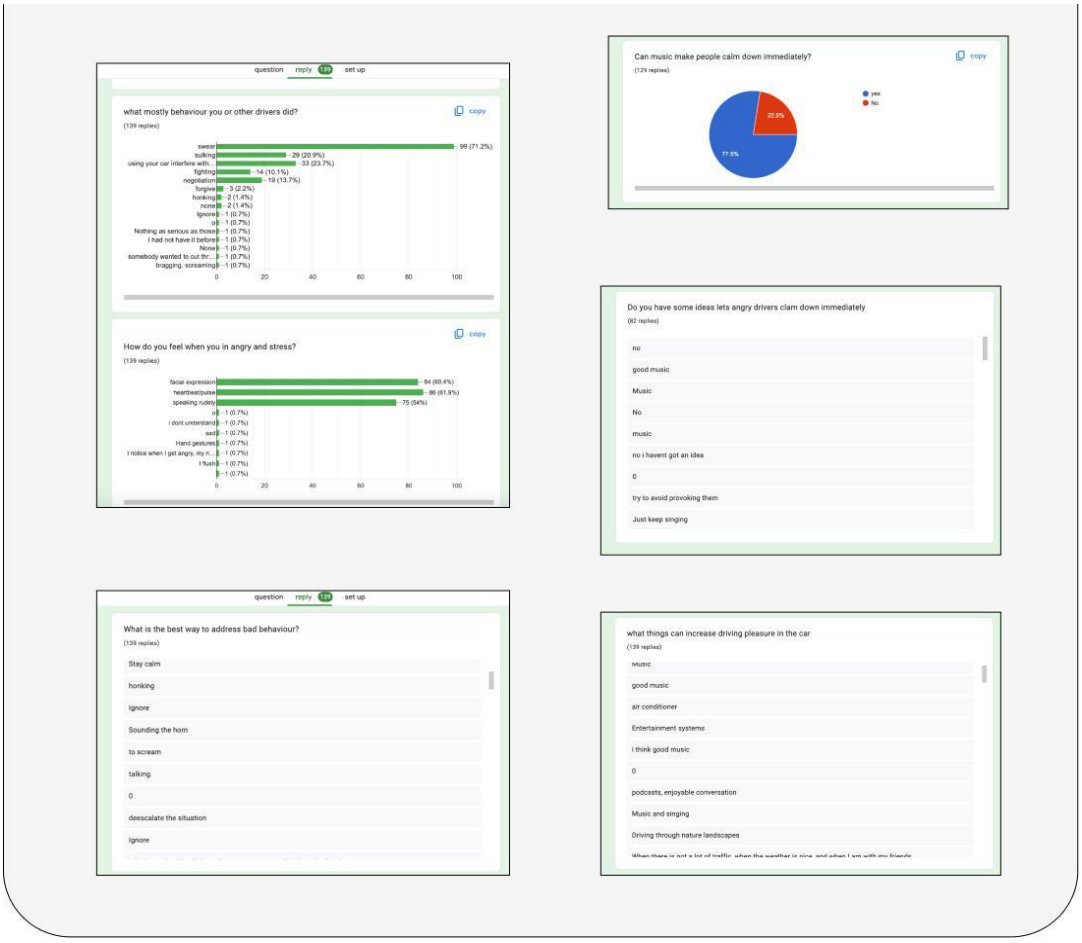
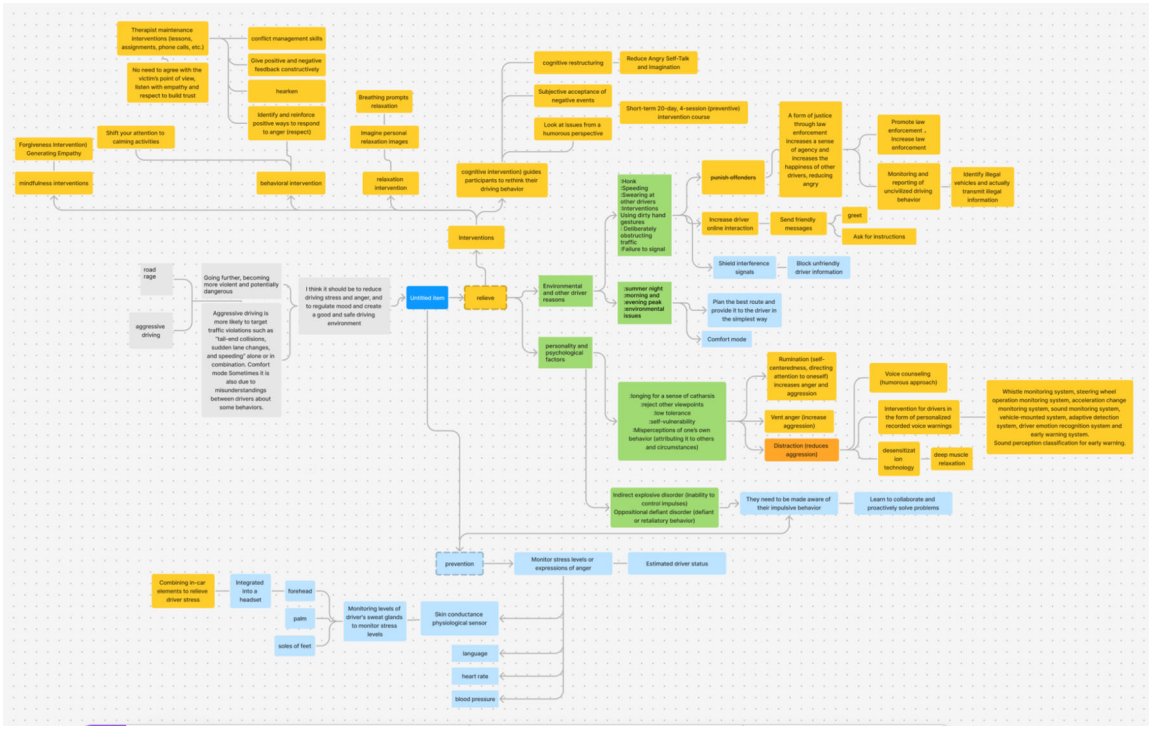


Fig. 1,2. Research at google forms, made by author, 2024.

From the table above in the authors' survey, the characteristics of users of different ages, genders and professions can be seen in the 139 responses from around the world. These responses provided insights into people's various understandings and perceptions of road rage, where they briefly described their own experiences and the different forms of anger they encountered while driving. Additionally, the survey feedback the factors that contributed to their negative emotions. Furthermore, it investigated the methods people used to alleviate these feelings, such as music, colours, or deep breathing. These are provided key points for the next phase of research.



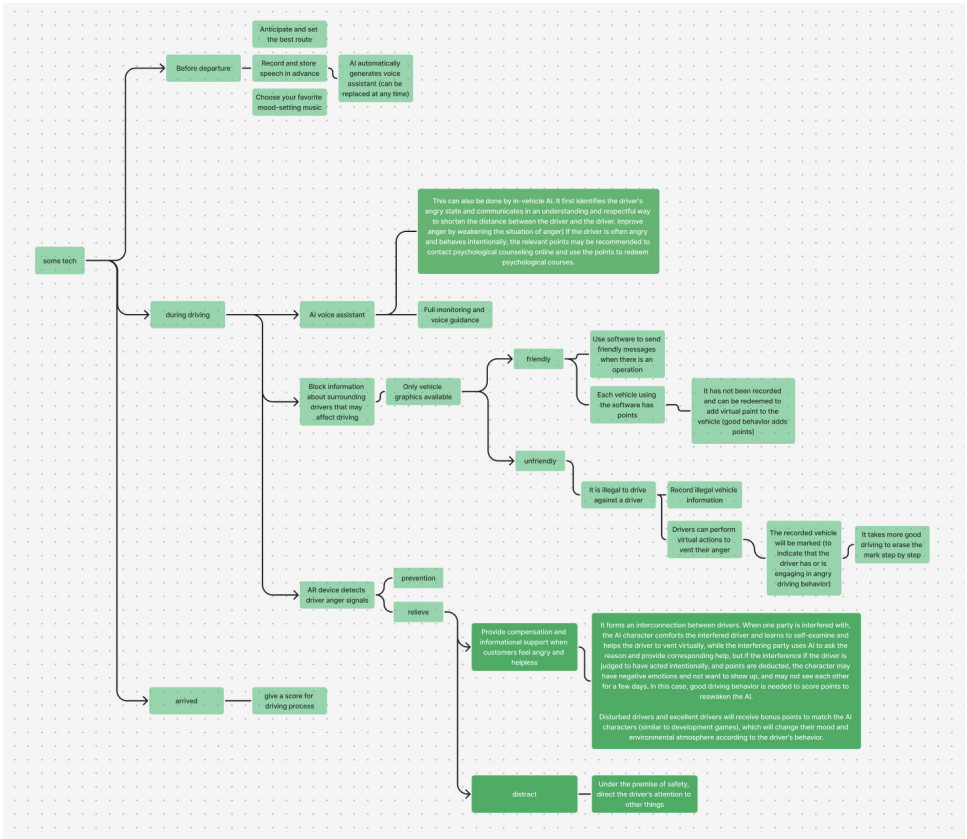


Fig. 3,4. Initial mind mapping, by author, 2024.

A summary of frequently reported behavioural issues from the questionnaire was compiled, proposing the idea of implementing software in vehicles to assist drivers. This could involve increasing online interaction with drivers, facilitating contact with family members, sending friendly messages via the software, or directly blocking distracting factors. More extreme measures, such as punishing violators to satisfy other drivers' sense of justice, were also considered but ultimately abandoned.
In everyday driving, it has been observed that offering positive emotional support and helping drivers reduce external distractions can be beneficial in improving their mood, especially when issues arise from family members or other drivers. This also raises another question: how to guide drivers to make the right decisions when driving alone, and what role the vehicle can play in this process.

In addressing this problem Audi's designers introduced the concept of AR glasses, allowing for more natural gestures to interact with in-car hardware (Audi), with a driver-centred approach to enhance operational convenience while driving. This made me focus more on whether such technology could help alleviate negative emotions in drivers. However, no significant progress was made in specifically addressing the issue of driver anger. After further research and investigation, it became clear that many challenges need to be addressed, such as drivers' psychology, the traffic environment, and the related technologies.

Through previous studies, it was found that the driver's emotional response comes not only from the external traffic environment, but also from the interaction with passengers in the car, especially the children's behaviour factors. Subsequently, the focus was shifted to studying how to solve the boredom of children deeply during travel, allowing them to divert negative emotions and focus on game tasks, thereby reducing interference to the driver and reducing the safety risks caused by driver distraction.

5.2 Integrate and delve deeper

5.2.1 Initial project progress

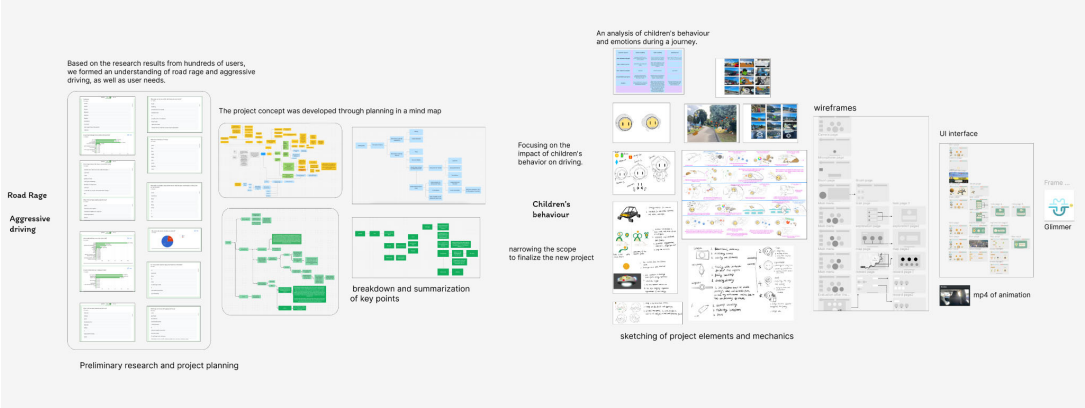


Fig. 5. Development process of Glimmer, work by author, 2024.

From the study of road rage and aggressive driving, it integrates and develops the next research direction centred on children. From the analysis of children's behaviour and emotional changes in the three stages before, during and after the trip, we started on the development of possible solutions. From the previous survey, we learned that the isolation of space in the car and the dedicated allocation of space affects the mood of children. The lack of suitable people to communicate makes them feel bored, which leads them to find ways to get the attention of others.

These views in Section 4.1 have influenced this design project, and thus the idea of designing an intelligent companion ‘Glimmer’ has been created, which is like a passenger or a friend who can interact with children and assist during a boring journey. Inspired by the concept of gamification in Section 4.4, it has been combined with the concept of intelligent companions to present it in the form of games, adding fun and engagement to the journey.

While travelling one can observe the environment, explore, and evaluate oneself, relax, enhance family relationships, and promote social interaction (Crompton. 408). Exploration is one of the elements that can enhance the experience on every trip anew. Every time you arrive at a new place or even pass the same road, the environment will have changed, offering new experiences. For this definition, it extends to the game content, exploring and experiencing engaging new content from different places. The following scenes and character images are developed with discovery and travel at its core.

5.2.2 Name definition of project

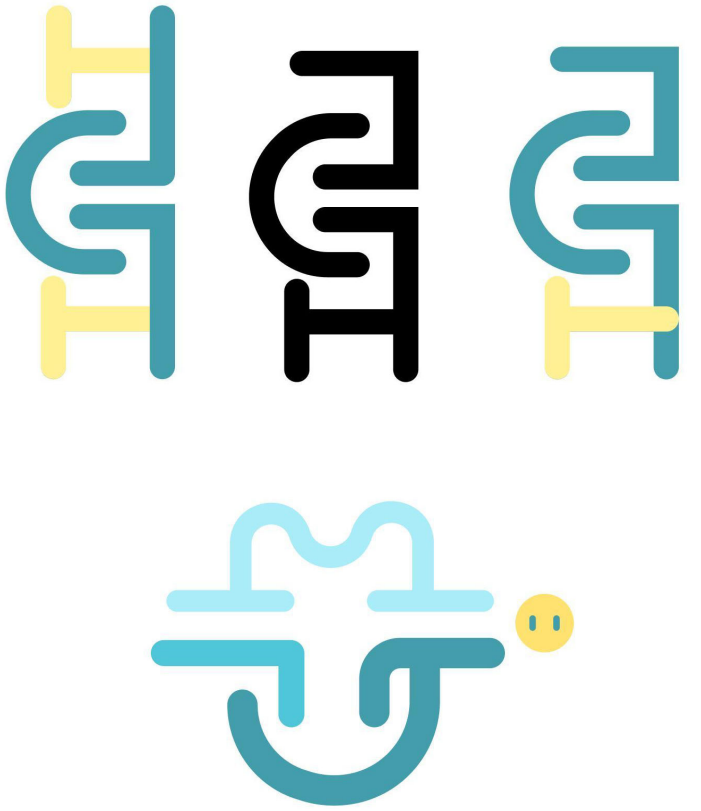


Fig. 6,7. Logo development of Glimmer, work by author, 2024.

The name of the project, Glimmer, means a shimmer, a hidden glimmer or soft light from something (Collins dictionary), which expresses the underlying meaning of the project. The characters in the project are like glimmers of light, illuminating the negative and dark corners of the children's hearts on the journey, providing them with warmth and companionship, and conveying positive emotions. The logo is shortened from glimmer to glim, and the letters are arranged in different combinations, symmetrically designed. I finally choose the one that best fits the theme combining the letters M and I in the form of a winding road, with the miniature image surrounding the letters as a companion on the way.

5.2.3 Game scene planning

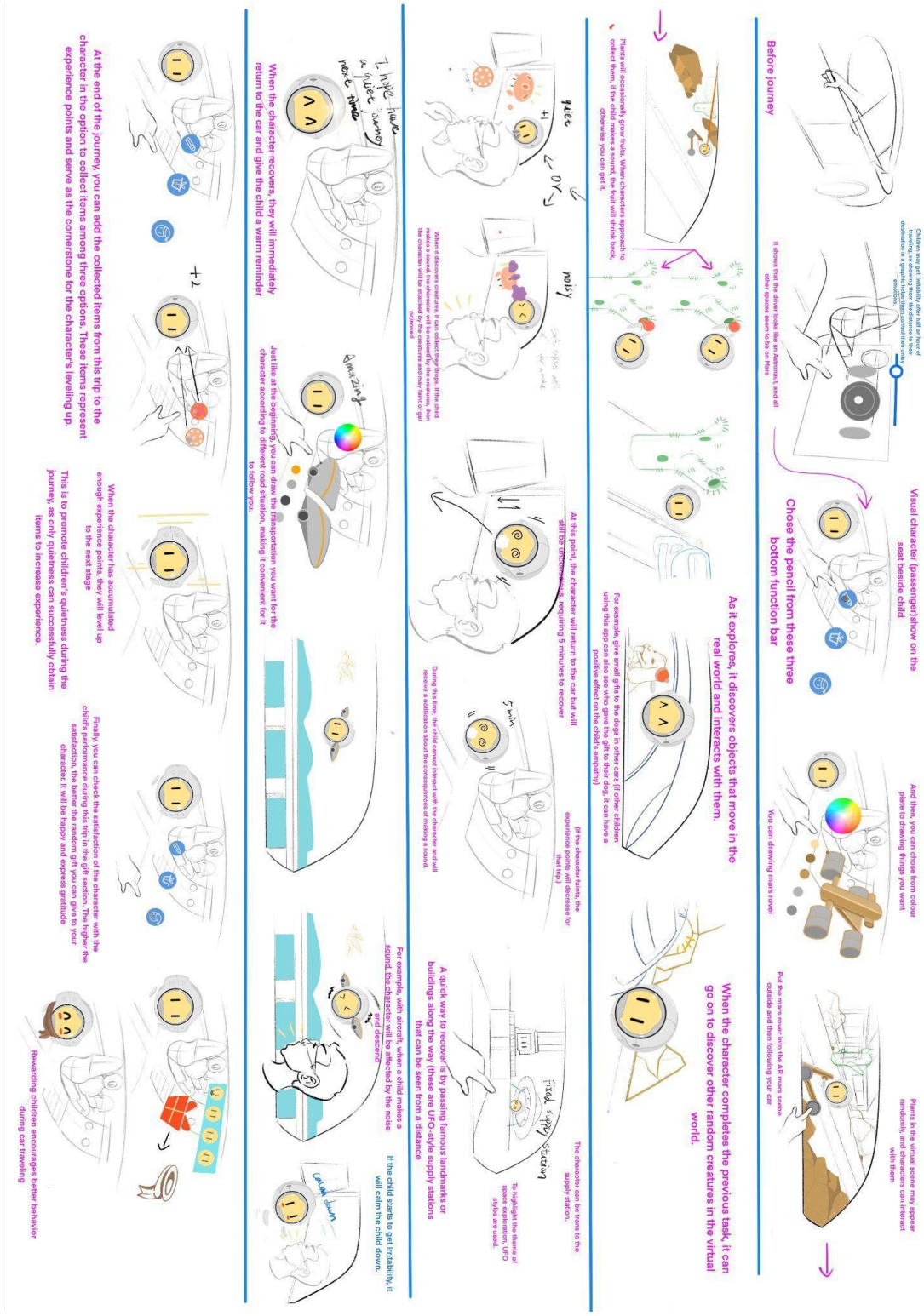


Fig. 8. Preliminary planning sketch of the game scene, designed by author, 2024.

From the introduction and application of AR technology in Section 4.5, AR can increase immersion, multi-scenario applications, simplify operations, and promote new social interactions. These points prove the usability of AR, so this is also the inspiration for this design project, and the development of Glimmer based on the potential of AR and its technological capability

Children can use this AR technology to increase their entertainment immersion while seeing the surrounding things during the journey. This scene (Fig.7) shows the overall planning of the game process for Glimmer, including the whole process from before the child gets in the car to the destination. First, the child uses the AR device in the car to select and open the application. The virtual character will accompany the child as a passenger or friend and will be displayed beside the child in real size.

The character will explore the world outside the car with the child during the journey. There are different function buttons displayed below in the interface. By selecting the painting module, children can draw their imagined creativity and put it into the real scene.

Different virtual environments are set up beside the road to integrate with the real scene, and the characters can interact with environmental elements. attention is paid to the voice and behaviour of children, which is the key point of this project. The AR device will detect the volume of the child's voice. When creatures appear randomly on the roadside, the character (played by the child) can quietly contact them at the same time if the child is silent, but if the child makes a sound, the character will be attacked by the creature, resulting in the loss of a health point. Sending them to the supply station will allow the character to recover. This also includes a detail that the supply station is usually located near a city landmark, with the intention of broadening children's understanding of unfamiliar cities.

Later, towards the end of the journey, children can get rewards and incentives for good performance, which will help the progress of the character for future journeys and gaming experiences within Glimmer.

5.2.4 Virtual character design

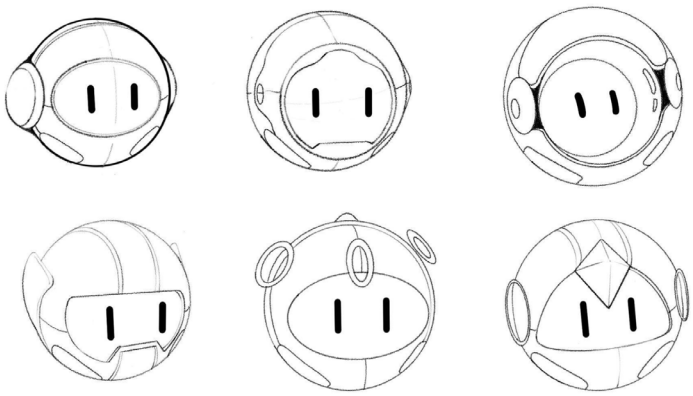
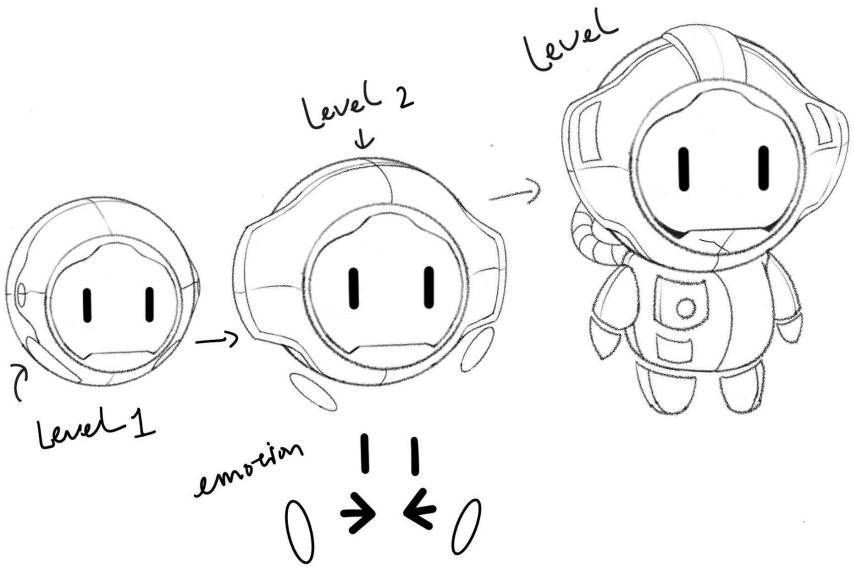
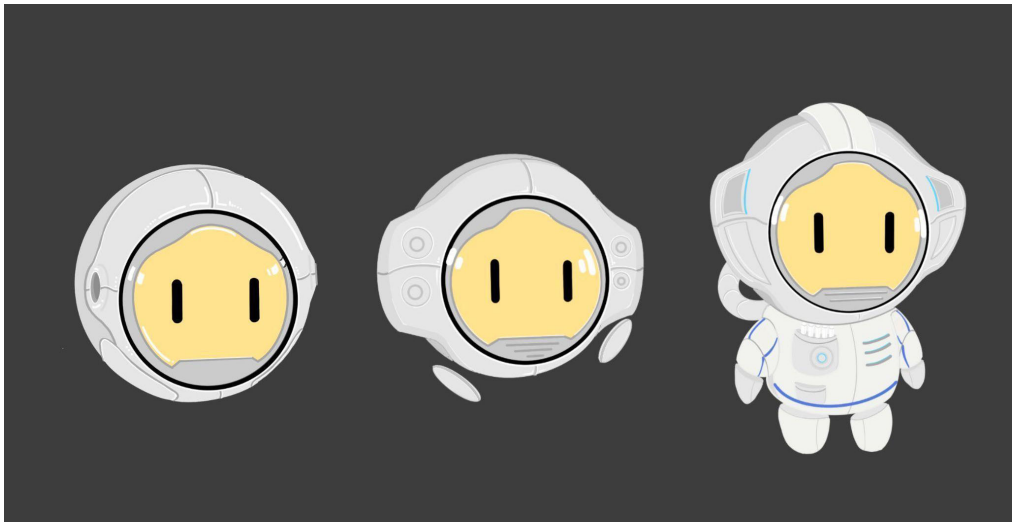


Fig. 9. Initial character sketch, design by author, 2024.

The scene and character settings of Glimmer are based on alien environments and astronauts. Since outer Space is still new to us, and astronauts are our visualisation of space exploration, I am utilising the image of astronauts as the protagonist of the game. In the early stage of the project design, different character images were developed based on the appearance of space suits. Its appearance mainly adopts the helmet part of the space suit, which is also its main body. The round shape also expresses the meaning of liveliness, friendliness, approachability, softness, and smoothness, giving people a harmonious and warm feeling (Felton), which is more in line with the positioning of children's games and makes children feel close. It is also redesigned to add robot elements, adding eyes to its mask to express the character's expression and state in different states, and the hand module under the sphere is convenient for gesture communication with children and the transmission of things in the environment.


Level
Level 2
Level 1
emotion



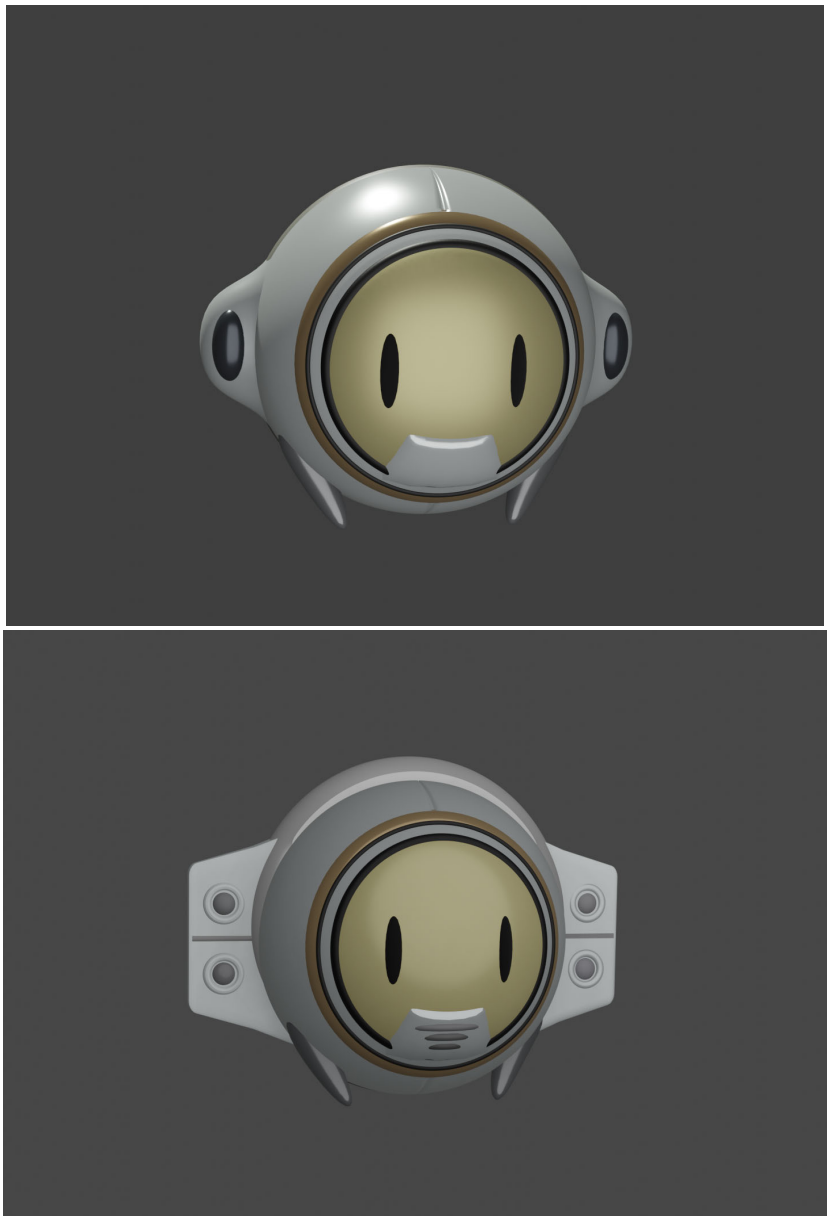


Fig. 10-13. character sketch, design by author, 2024.

Selecting the image that best meets the requirements of the project for detailed drawing and 3D modelling outputs for progressing the design development of Glimmer happened through iteration. The character evolves and undergoes various stages of visual transformation as a reward mechanism for successful progress in the game. The character is divided into three stages, each stage reflecting the growing up of children. Whether the character can evolve depends on the playing time and the performance of the child. This mechanic allows children to look forward to future progress of the character and promote behaviour change in upcoming travels through the anticipation of undiscovered visual rewards.

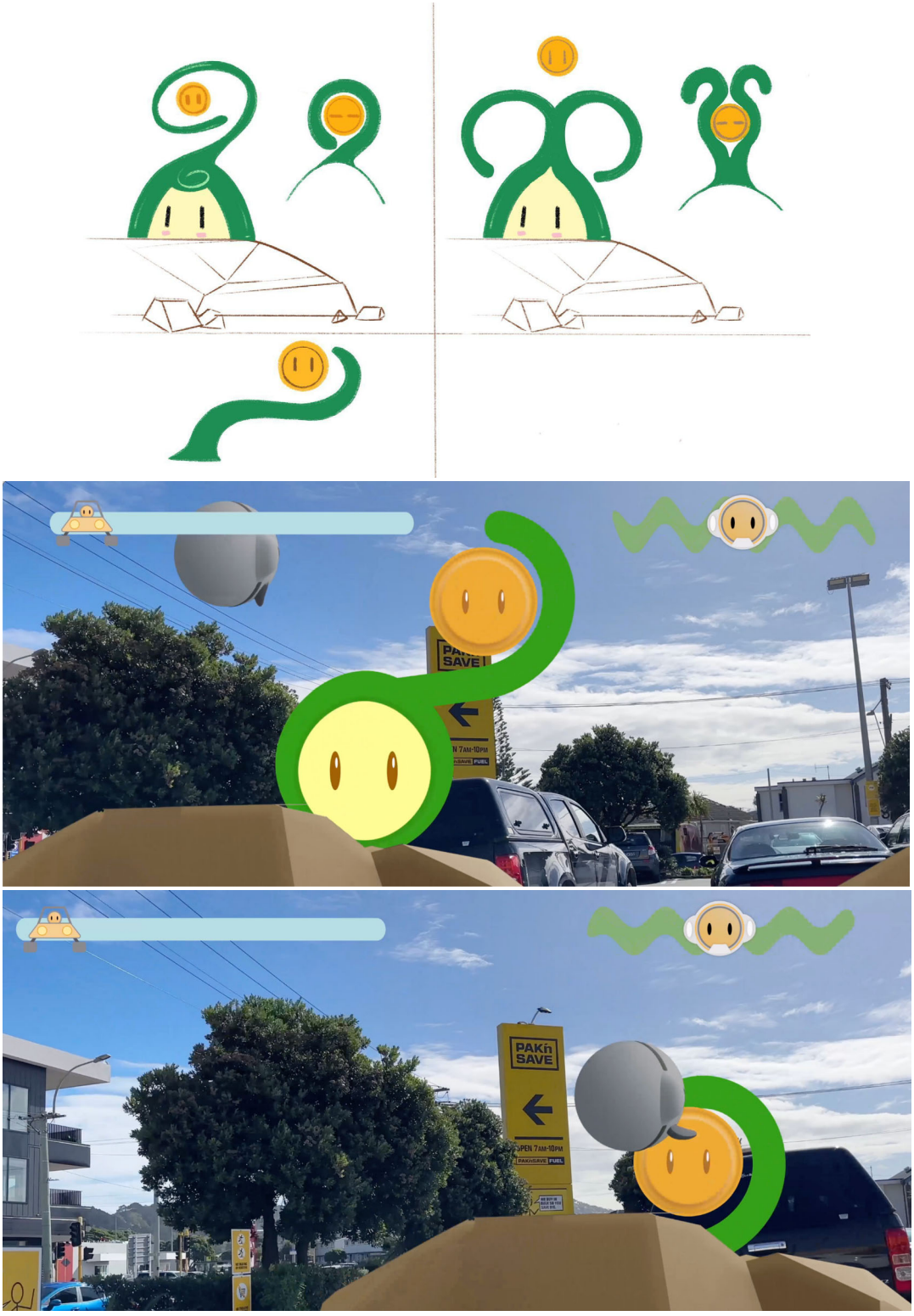


Fig. 14-16 visual creature (mimosa pudica) sketch and apply in the game, designed by author, 2024.

Glimmer, involves virtual environments and creatures, all of which have alert mechanisms. For example, mimosa pudica was selected as the plant image in the scene (Fig 16). Because of its contraction characteristics, it will retract when disturbed by a trigger in its environment. This characteristic was used in the project to visualise the project's requirements for action feedback of creatures, but the trigger mechanism has changed from contraction by touch to contraction by sound. Additional features combine a reward and noise response mechanisms. If the child approaches it quietly with the virtual character, the mimosa pudica will actively reward its fruit, adding to the game score. If the child makes a sound, the opposite result will be triggered, and mimosa pudica will shrink into the rock and the fruit will be denied and a reward cannot be obtained.

Fig. 17-19. visual creature (sheep) sketch and apply in the game, designed by author, 2024.

Sheep are one of the most common creatures in the game, and common in New Zealand, so it is chosen as a familiar animal character for a New Zealand audience to appear in the game. The character also includes the mischievous attitudes of sheep. When they are threatened, they will attack the main character, but as previously the trigger point is the player's sound, just like the mimosa pudica. If the child makes a sound, the sheep will grow larger and attack the virtual character, but if the player is quiet, they can make friends with it, which will help the subsequent game process.

When becoming friends with it, it can lead the player to hidden creatures for more rewards.

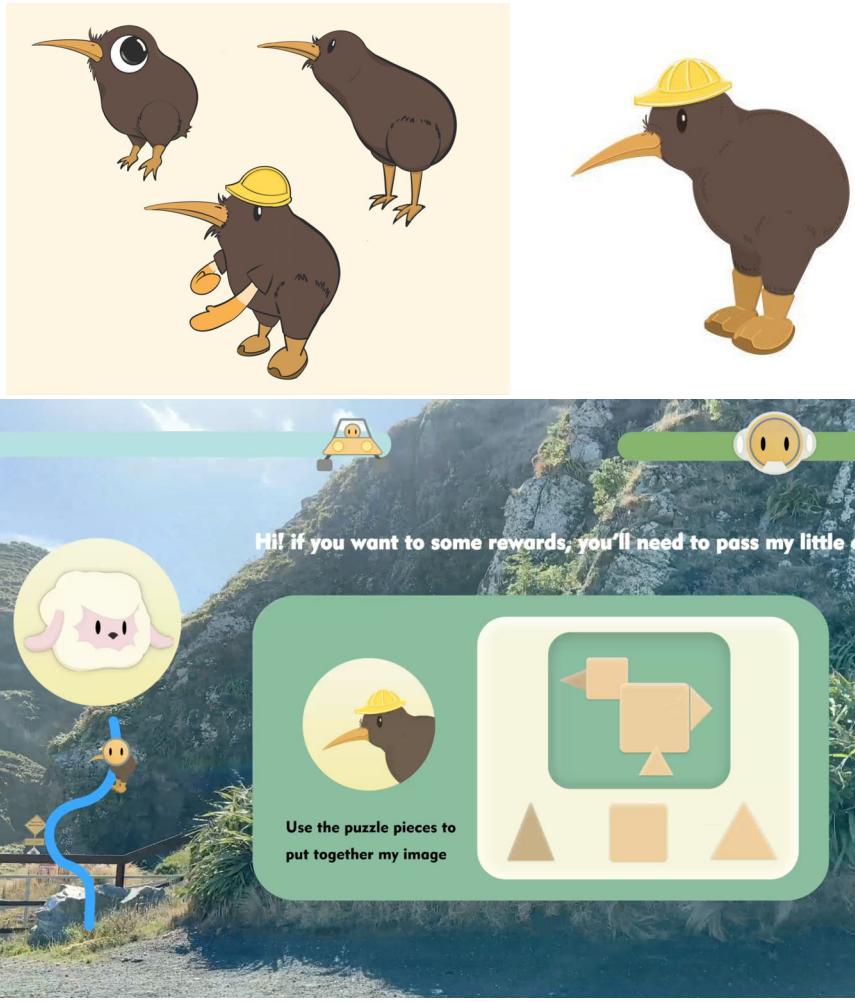


Fig. 20-22. visual creature (kiwi bird) sketches and apply in the game, designed by author, 2024.

The image of the kiwi bird has been chosen as one of the rarest creatures in New Zealand. Combined with its actual habits and preferences, it will use its sharp beak to poke the ground to find food, which is in line with the exploration work of scientific expedition personnel, so its appearance was added with construction elements and drawn in several different styles. To discover this rare creature in the game the player needs to make friendships with other gaming characters first. After its discovery, the kiwi will set a puzzle task with an additional reward for the successful completion.

5.2.5 Wireframe development

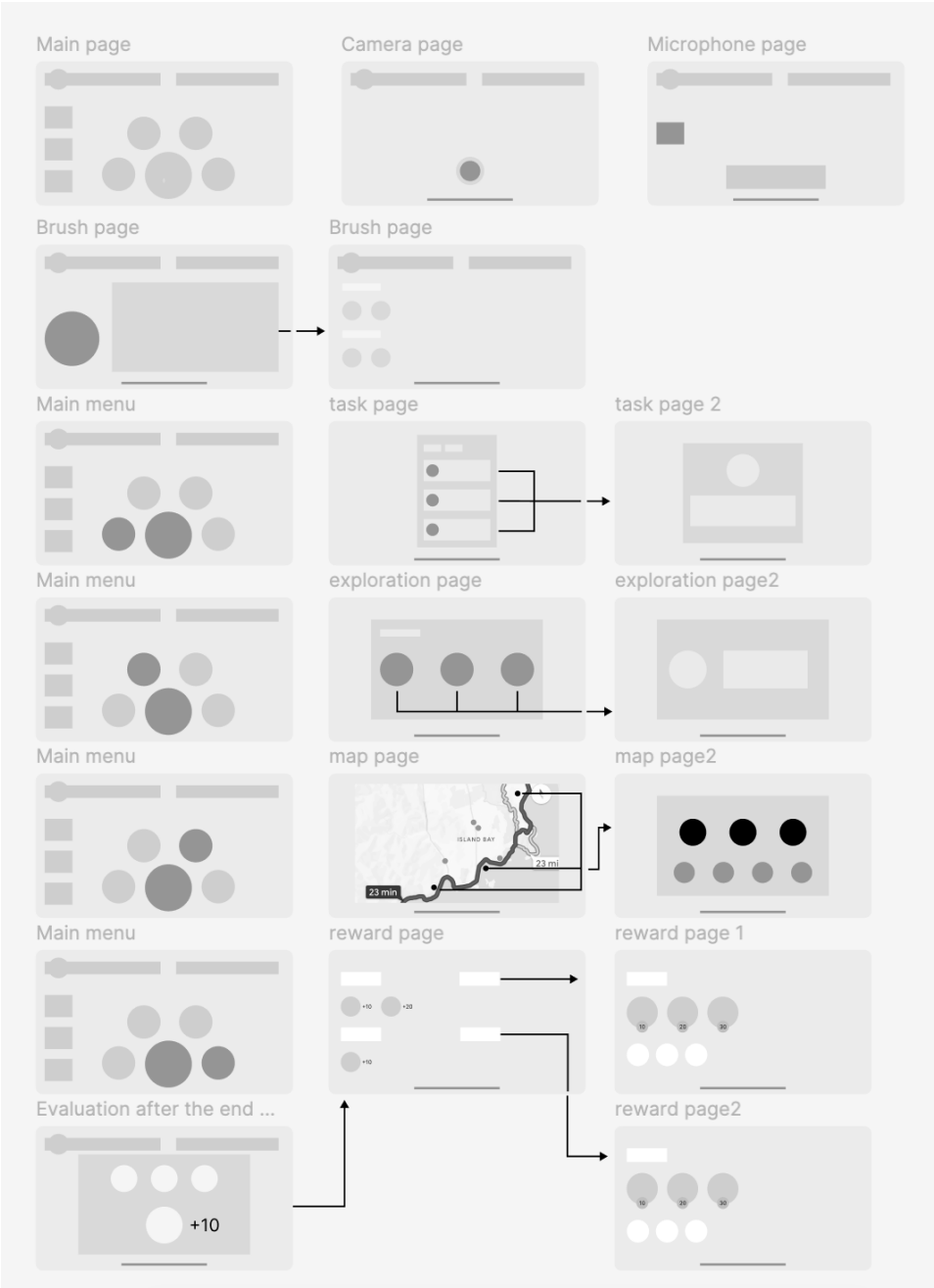


Fig. 23. First Wireframe, designed by author, 2024.

The main functions of the game application have been sketched and drafted after a literature review and game scenario planning. Shapes were used instead of icons to create a game interface based on AR devices, and the appearance and content of the interface were defined and arranged. The game includes areas and user interface

elements for camera, chat, and painting, as well as elements for exploring the environment to complete tasks After the trip, a reward section is offered to redeem various interactions with the characters in the game. All content is collated on the main screen for easy access.

5.3 Project development and outputs

5.3.1 Initial user interface testing

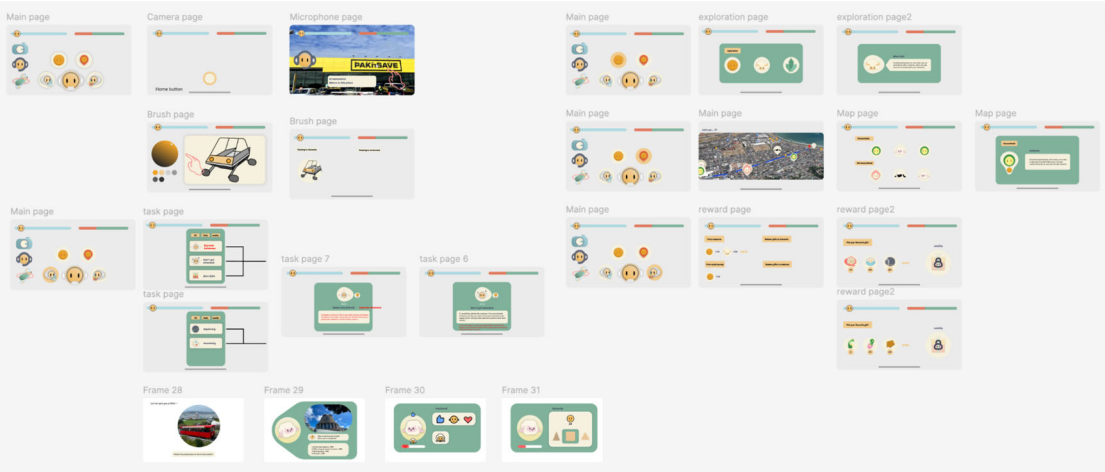


Fig. 24. Initial User Interface and Testing, design by author, 2024.

After continuous evaluation of the previous stages, I entered the development stage, drew inspiration from various sources, and iterated a design plan. I created a new user interface (UI) rendering, evaluated opinions from more people to improve its effect, and used the interface design tool *Figma* to develop a prototype for testing.

In this stage, the wireframe was iterated with more attention to detail and parallel to the game development process. Green has been chosen as the main colour due to its calm and relaxing effect and aiding in the reduction of stress and improving mood (Leo). The game is divided into 6 parts, and three creative attribute tools are concentrated on the right side of the main interface, namely camera, smart assistant, and painting. These three are mainly used to play and collect interesting information during the journey and creating their own content. The main menu in the middle can be clicked to display four functions, divided into taskbar, exploration, map, and reward, which are mainly used in the three stages before, during and after the journey. These settings are all dedicated to alleviating children's boredom, reducing children's noise during the journey, and are related to the incentive mechanism.

5.3.2 Main page

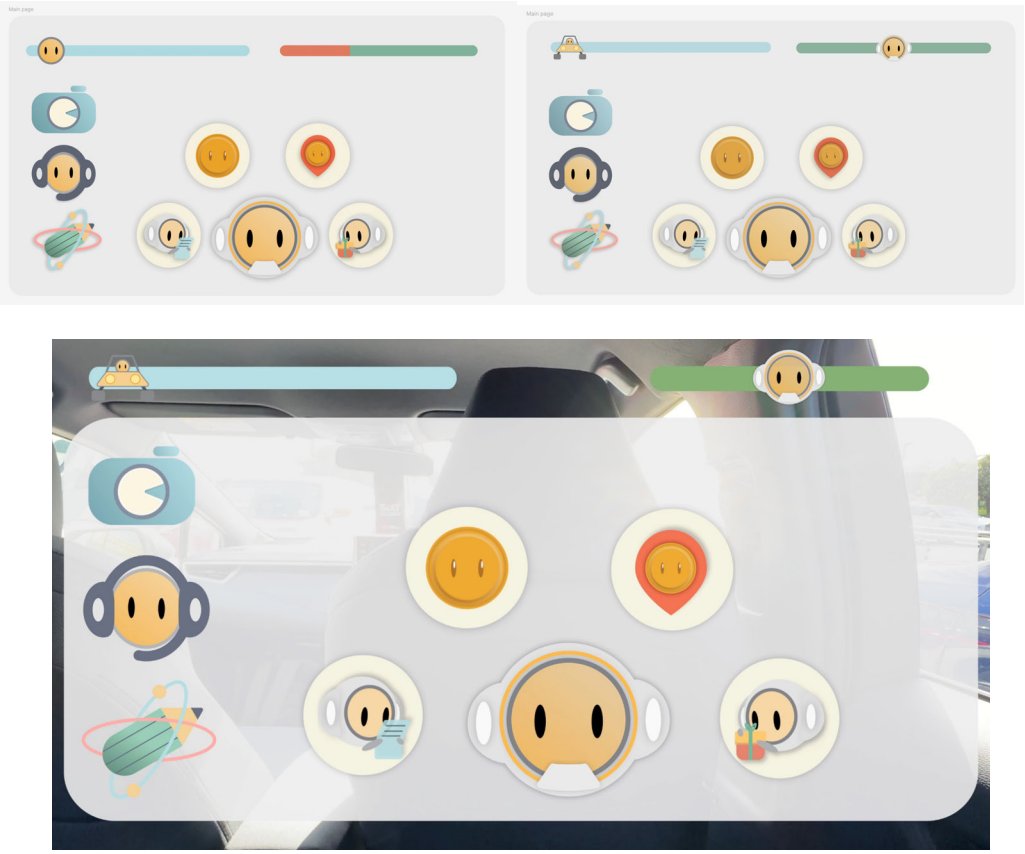


Fig. 25,26. User Interface develop and apply in the game, designed by author, 2024.

The main interface is mainly used as the entrance to display the game's categories. All functions can be found more intuitively on this page, and each icon is designed to be larger in size, which reduces the difficulty of AR gesture operation and allows more accurate clicks. The overall style of colours and icons is unified, but each icon has its function and appearance divided for easy search. After feedback and analysis, figure 26 was updated from 25, and the route preview and character status bar above have been added. The route preview was to reduce the impatience caused by children's lack of understanding of the route and travel time, so that they can intuitively see the distance to the destination. The icon was also modified to have a clearer understanding of the function. The style of the status bar on the right has also been changed, from three sections to one section. At the same time, the device can recognize the child's volume and produce fluctuations, and the character status will also change negatively. This way, children can understand that their own volume will be very disturbing to others.

5.3.3 Camera and intelligent assistant pages

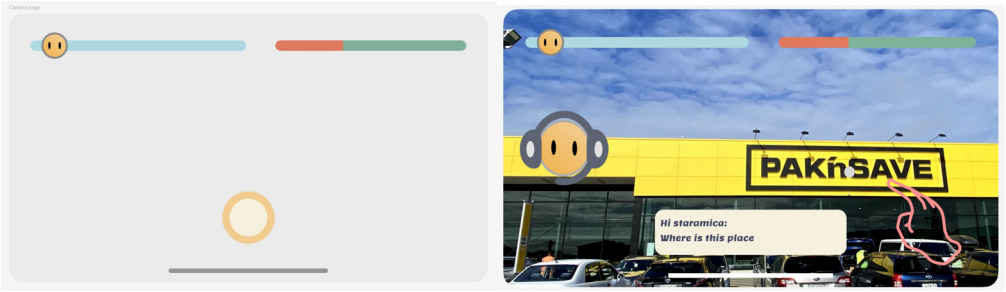
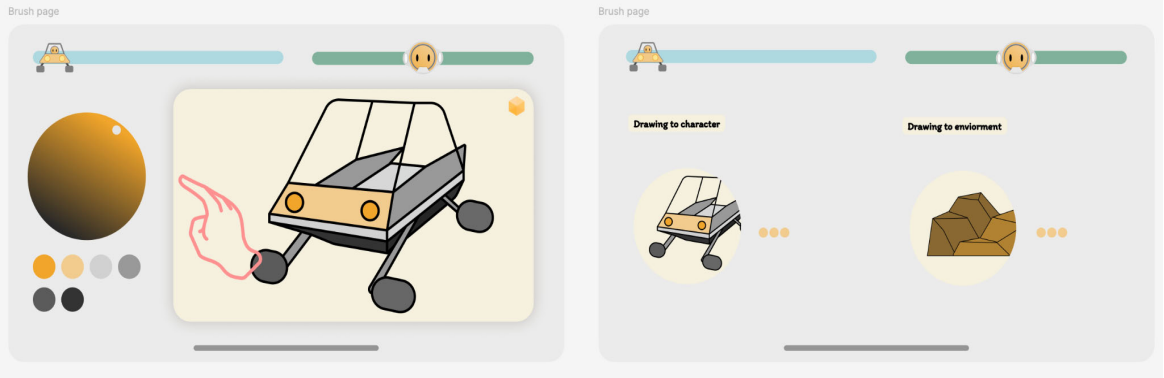


Fig. 27,28. User Interface of camera and intelligent assistant, design by author, 2024.

The camera interface is relatively simple, with only the photo button at the bottom and the viewfinder in the middle. It is set to record beautiful moments, such as the unique scenery or creatures in different places. The photos will be saved in the device's album, so you can easily review the interesting things in the past journey.

The initial idea of this setting is to provide children with an intelligent assistant, a platform for them to acquire knowledge during their travels, and to learn about the places they're visiting during their travels to broaden their knowledge.

5.3.4 Drawing pages



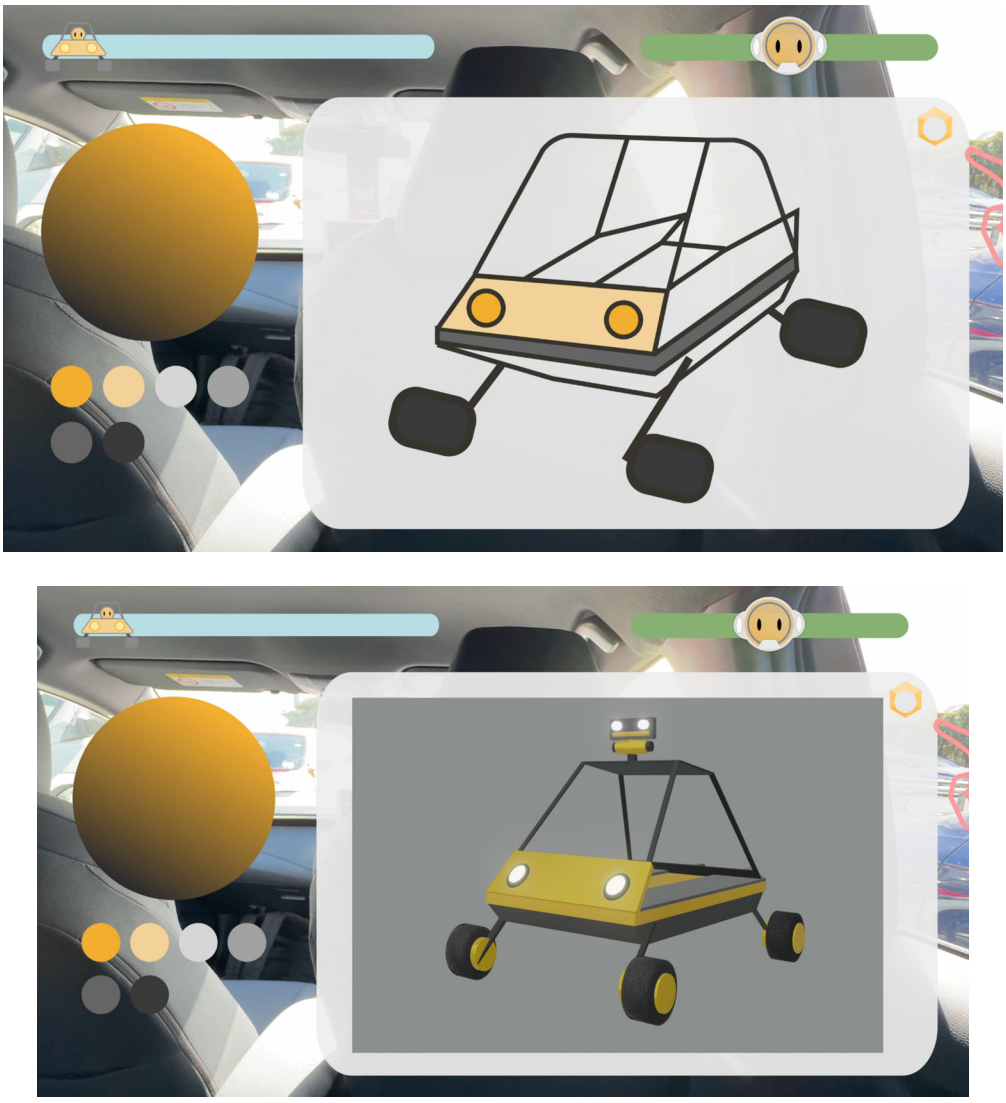


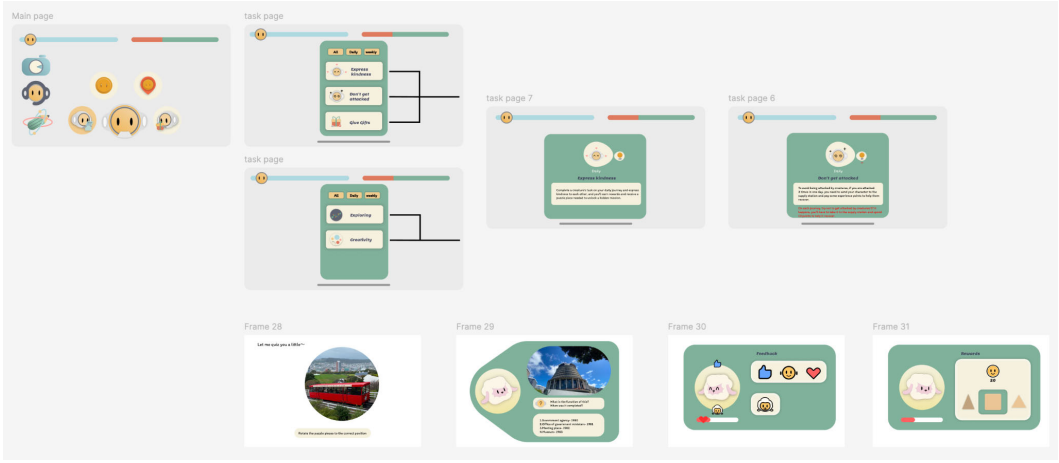
Fig. 29-31. User Interface develop and applied in Glimmer, designed by author, 2024.

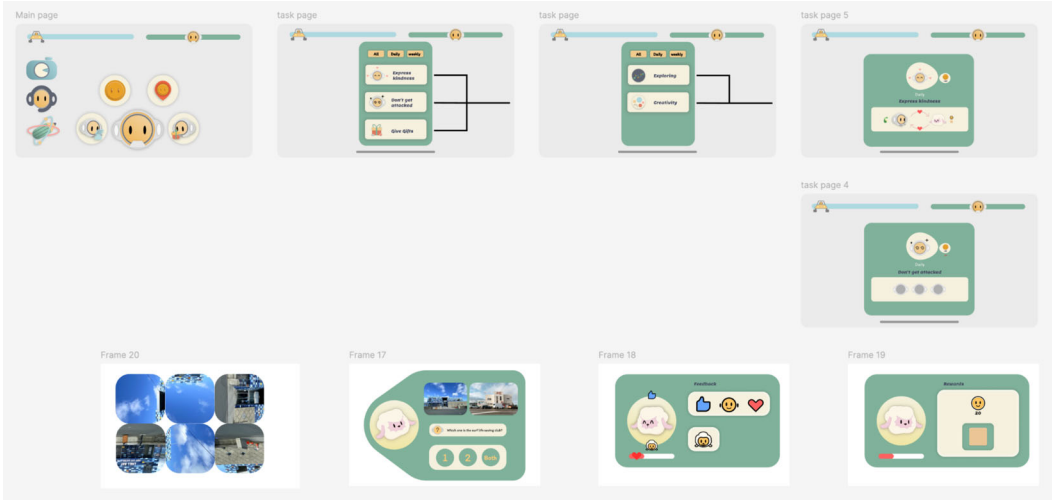
Drawing is one of the key points of this project. Through the interpretation of drawing in Section 4.4, a drawing experience based on AR devices is set up. The player can select colours and draw graphics in the drawing board interface through gestures. After completion, you can use the 3D generation button on the upper right of the drawing board to convert the 2D image into a 3D model and place it into the AR overlaid real-world environment. You can also view the drawings you have drawn in the past in the back interface. The intention of the drawing feature is to reduce children's boredom and negative emotions during the journey and allows them to express their creative thinking.

This case study is showing a toy cart, the cart can be virtually placed in the passing by outside landscape. Recognising the topography, the cart will react to obstacles and utilise the real landscape to drive over. The features of recognising and adapting to

external factors is an additional reason AR has been chosen to be the medium for this project.

5.3.5 Task pages.






All
Daily
weekly
Express kindness
Don't get attacked
Give gifts
you can do it!
20
Express kindness
Daily
20


Let me quiz you a little~
Lyall bay
Rotate the puzzle to the correct position


which one is the Surf life saving club?
1
2
Both

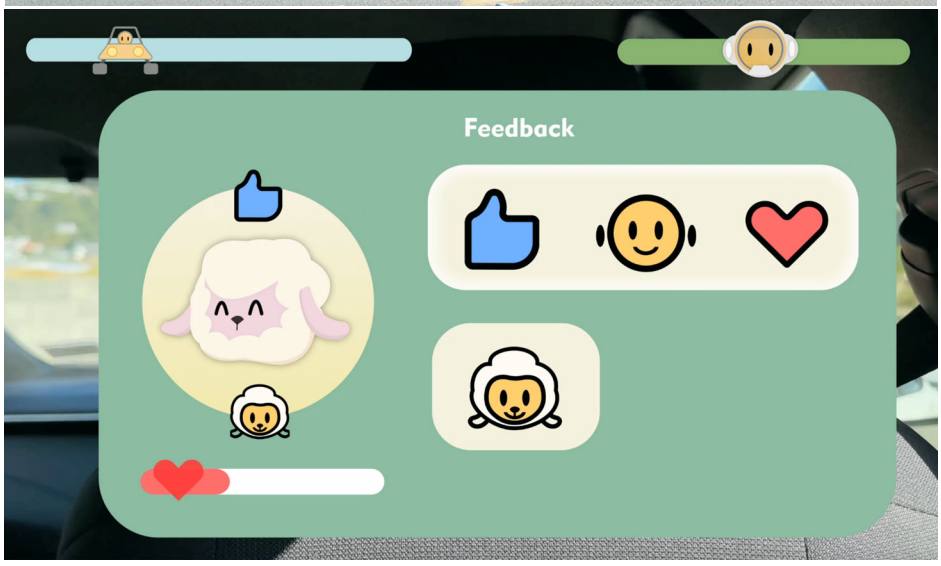

Feedback

Fig. 32-40. User Interface developed and applied in Glimmer, designed by author, 2024.

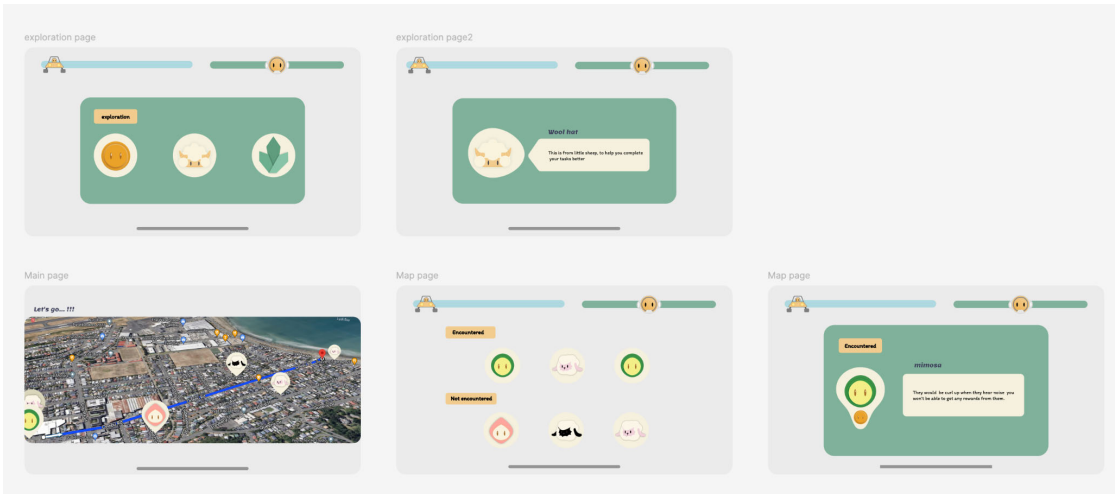
The tasks module is an important part of the mechanism that reflects the rewards and noise reactions. The interface part is divided into daily and weekly quests, and further divided into multiple sections. For example, the daily short-term task is to show kindness to creatures, the basic principle of this task is to exchange gifts with creatures in a quiet manner and get a reward. failing to meet the requirements will result in being attacked by creatures and denied progress in the game. The weekly ones are long-term tasks, dedicated to promoting good behaviour that children can maintain over time. This design concept sets up roles and more scenarios that require quietness, and all interactive creatures in the scene will be given corresponding reward strategies. However, when children are making loud noises, not all interactions can be carried out. If they show an action of wanting to be quiet at this time, they will be praised and encouraged in time, and the phased results will be used as a reward strategy to keep children quiet and positive during the journey, and comfort them when they have negative emotions.

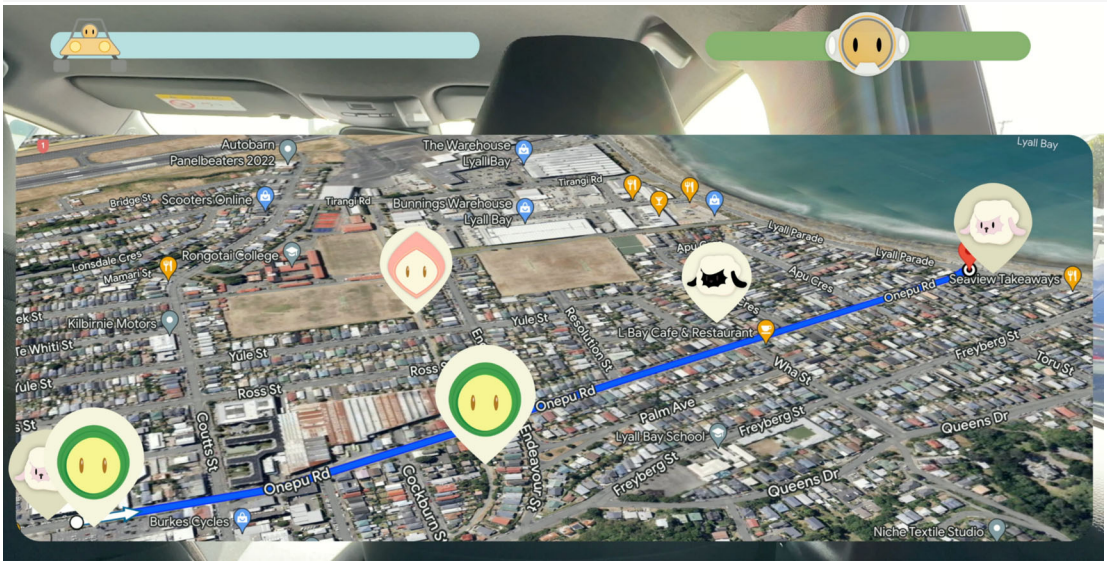
Text has also been reduced to increase accessibility for a young audience and where applicable, the interface relies on visuals, so that children can understand the meaning of the tasks in a quick and direct way.

From figures 37 to 40 are the sections to make friends with the creatures. These will give the corresponding tasks, the source of the tasks is related to, the journey through the region's iconic attractions or architectural information and presented in the form of puzzles and selection of pictures**.** Through these tasks, children have a wider understanding of the local attractions and environment. Upon completion of the task, the creatures can be brought a little closer together by conveying compliments to each other, and after three interactions, they can become friends to gain rewards and

explore more interesting places. The whole process needs to be kept quiet, if a sound is made it interrupts the quest process and only resumes after the player becomes quiet again.

5.3.6 Explore and collect pages





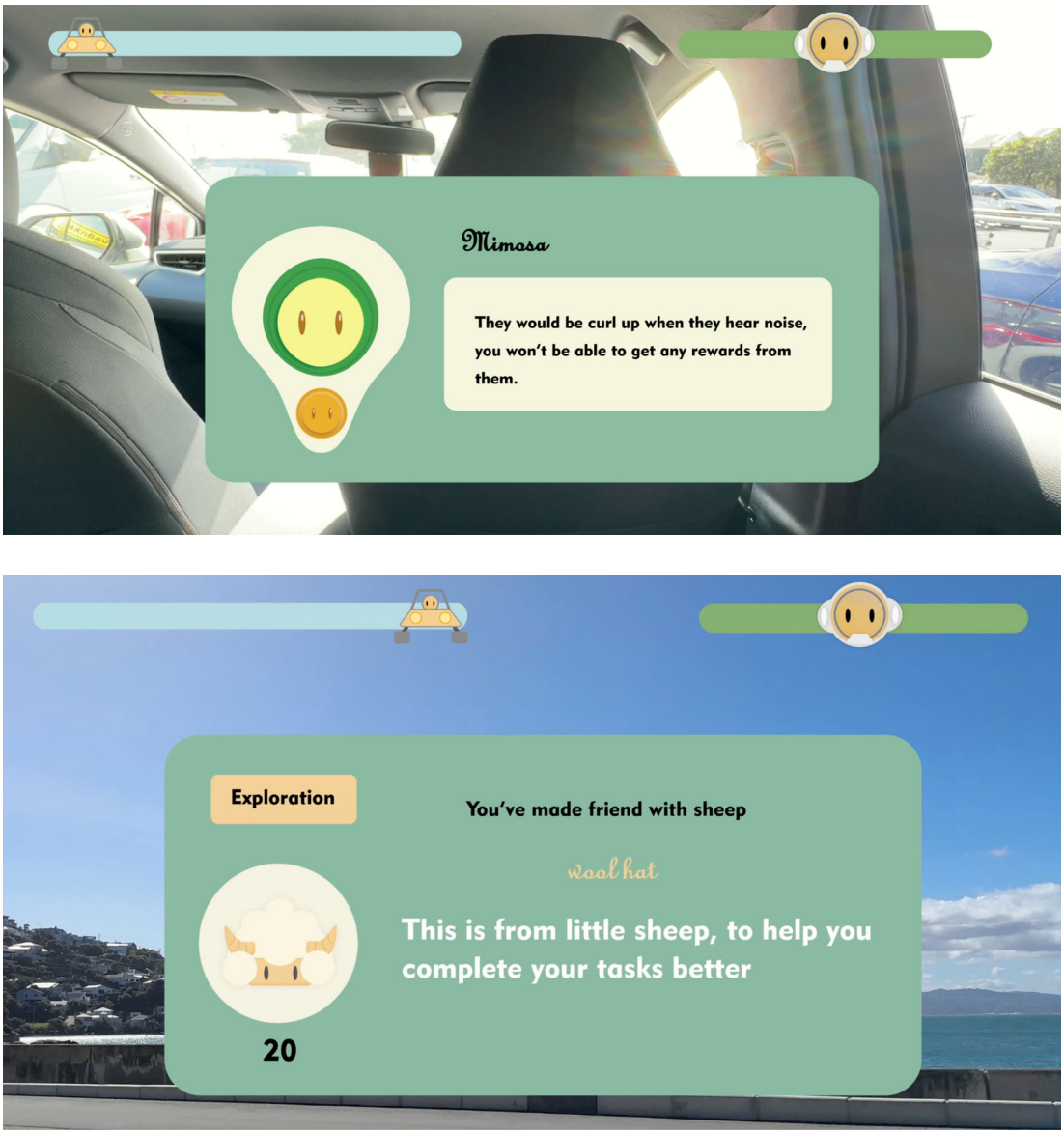


Fig. 41-44. User Interface develop and apply in the game, designed by author, 2024.
Fig 44. used by Google map

The Explore and Collect module is built to be displayed at the beginning and end of a journey. Before starting, children can view the creatures they will encounter on each journey and view their profiles and hints, a brief description of each creature's characteristics. Players can prepare gifts in advance they plan to give to each other and manage their behaviour. At the end of the journey, the interface displays the creatures encountered and not encountered on the way, as well as an overview of all the rewards obtained and their effects, the gifts given to you will vary from creature to creature, all of them in accordance with their own characteristics, but all of them can have a positive effect on the next exploration of a different place.

5.3.7 Rewards and redemption

Fig. 45-47. User Interface developed and applied in Glimmer, designed by author, 2024.

This module contains a reward mechanism designed to motivate positive behaviour in children. It will show, among other things, the coin rewards you get throughout the journey, and the rewards from different creatures, which can be converted into points, which will be given according to the difficulty of the task and the child's performance. In the next step, you can choose between gifts for the avatars or for the creatures. The equipment for the characters requires different points depending on their role. The number of points for gifts to creatures varies according to the rarity of the creature and is also set to consider the habits of different creatures. There is also a hidden gift each week, which requires better performance throughout the week to unlock, so if you want to redeem a better gift, you need to be able to keep quiet throughout the overall game, which adds more fun to your journey and helps with the development of good behaviour and positivity.

6.0 Conclusion

The research for this project stems from the fact that children get bored while travelling, which can lead to noise and bad behaviour trying to attract the attention of the driver, thus distracting the driver, and having a possible negative impact on traffic safety. This project aims to provide children with interesting, long-term engagement in the form of a game to alleviate their boredom and improve their behaviours to positively affect the driver's task.

In Glimmer, the focus is on a noise recognition mechanism and reward mechanics. The game content is designed to alleviate children's boredom and utilises a range of modules aimed at distracting children from boredom and diverting their focus on interesting tasks and puzzles. Tasks: to recognise children's voices and influence the course of the task. and a reward module to motivate children to change their behaviour and can remain positive over time.

The application of AR technology is also a key focus of this project, serving as the foundation for all its content. All game functions can be implemented on AR devices. For example, character settings can be displayed near the child at a similar size, using the AR device's camera to capture the external environment, making it feel like a passenger or a friend accompanying them. The drawing module allows for creation in a 3D space, placing the created artwork into the real topography, enabling interaction with virtual objects and external factors alike. This provides children with a sense of immersion and direct interactivity.

In the future, more features are likely to be explored, such as allowing children to share their collections with other app users, enabling online interaction and cooperative tasks between children in different cars, and facilitating their communication and game challenges during the journey. More opportunities include different characters and tasks tailored to various countries and regions. Also, the gameplay could expand beyond travel environments, and could also be enjoyed in other settings and contexts.

Overall, this exploration demonstrates the potential of design thinking in children's behaviour, using children's emotions and behaviours as an opportunity for innovation. Glimmer illustrates how travelling scenarios can provide children with new immersive experiences with the potential to enhance driving safety for all.

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